National Institute for Health and Care Excellence

Final

Intrapartum care for women with existing medical conditions or obstetric complications and their babies

[G] Evidence reviews for subarachnoid haemorrhage or arterio-venous malformation of the brain

NICE guideline NG121

Evidence reviews for women at high risk of adverse outcomes for themselves and/or their baby because of existing maternal medical conditions

March 2019

Final

Developed by the National Guideline Alliance hosted by the Royal College of Obstetricians and Gynaecologists

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Contents

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain

This evidence report contains information on 2 reviews relating to intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain.

- Which women with a history of intracranial haemorrhage or a cerebrovascular malformation should avoid labour?
- How should the second stage of labour be managed for women with a history of intracranial haemorrhage or with a cerebrovascular malformation?

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

Review question

Which women with a history of intracranial haemorrhage or a cerebrovascular malformation should avoid labour?

Introduction

The aim of this review is to determine whether women with a history of intracranial haemorrhage or a cerebrovascular malformation can have a labour.

Summary of the protocol

See Table 1 for a summary of the population, intervention, comparison and outcomes (PICO) characteristics of this review.

Table 1: Summary of the protocol (PICO) table

Population	Pregnant women who have a history of intracranial haemorrhage or have a cerebrovascular malformation and who are planning for birth
Intervention	Intervention 1: • Elective caesarean section
Comparison	Comparison 1: • Spontaneous labour and birth* Comparison 2: • Assisted second stage of labour**
Outcome	For the woman: • mortality • major morbidity (including recurrent intracranial haemorrhage and stroke/cerebrovascular accident (CVA)) • women's satisfaction with labour and birth (including psychological wellbeing) • admission to a high dependency unit (HDU) or intensive treatment unit (ITU) • re-admission to hospital with a cerebral event within 6 weeks of the birth • duration of hospital stay For the baby: • mortality • major morbidity (hypoxia-ischaemia)

- admission to a neonatal unit

**Spontaneous labour and birth referred to non-assisted vaginal birth with or without epidural anaesthesia/analgesia*
***Assisted second stage of labour referred to forceps-assisted or ventouse-assisted vaginal birth with or without epidural anaesthesia/analgesia*

For further details see the full review protocol in Appendix A. The search strategies are presented in Appendix B.

Clinical evidence

Included studies

In total, one study of prospective case series and 9 studies of retrospective case series were included for this review (see 'Summary of clinical studies included in the evidence review').

Of these, 9 studies examined women undergoing caesarean section and those having spontaneous vaginal birth (Cohen-Gadol 2009, Fliegner 1969, Fukuda 2013, Fukushima 2012, Horton 1990, Kalani 2013, Minielly 1979, Sato 2015, Sencer 1964) whereas 6 studies examined women undergoing caesarean section and assisted birth (Cohen-Gadol 2009, Fliegner 1969, Katsuragi 2018, Minielly 1979, Sato 2015, Sencer 1964).

Evidence from the studies included in the review is summarised below (see 'Quality assessment of clinical studies included in the evidence review').

Data was reported on the critical outcomes for the woman, mortality, major morbidity, and the important outcome re-admission to hospital with a cerebral event within 6 weeks of birth. Data was also reported for the critical outcome for the baby, mortality, and the important outcome major morbidity. There was no evidence identified for the following outcomes for the woman, women's satisfaction with labour and birth (critical outcome), admission to a high-dependency (HDU) or intensive treatment unit (ITU) (important outcome) and duration of hospital stay (outcome of limited importance). There was no evidence available for the following outcome for the baby, admission to a neonatal unit (important outcome).

See also the study selection flow chart in Appendix C.

Excluded studies

Studies not included in this review with reasons for their exclusions are provided in Appendix D.

Summary of clinical studies included in the evidence review

Table 2 provides a brief summary of the included studies.

Table 2: Summary of included studies

Study	Population	Intervention/Comparison	Outcomes	Comments
Cohen-Gadol 2009 Retrospective case series USA	N=11 women with intracranial vascular lesions	• Caesarean section (n=4) • Non-instrumental vaginal birth (n=5) • Forceps-assisted vaginal birth (n=2)	For the woman: • Mortality For the baby: • Mortality	• Out of 34 pregnant women with documented intracranial pathological findings were evaluated between 1969 and 2005, those with neoplastic lesions were excluded from the review. • Out of 11 women included, 10 women presented with intracranial haemorrhage during their index pregnancies. • Surgical treatment for a cerebrovascular malformation before birth: n=1 in the caesarean section group, n=1 in the instrumental vaginal birth group, n=5 in the non-instrumental vaginal birth group
Fliegner 1969 Retrospective case series Australia	N=14 women with spontaneous subarachnoid haemorrhage before or during pregnancy	• Elective caesarean section (n=6) • Non-instrumental vaginal birth (n=4) • Forceps-assisted birth (n=4)	For the woman: • Mortality For the baby: • Mortality	• Seven women were managed conservatively whereas 7 women had surgical treatment (one postpartum; 6 before birth: 2 in non-instrumental vaginal birth group, 1 in instrumental vaginal birth group, 3 in caesarean section group)
Fukuda 2013	N=7 women with ruptured or unruptured AVM,	• Caesarean section (n=5) versus	For the woman: • Mortality	• One woman was managed conservatively

Study	Population	Intervention/Comparison	Outcomes	Comments
Retrospective case series Japan	detected during or before pregnancy	• Vaginal birth (n=2)	For the baby: • Mortality • Neonatal intubation	whereas 6 women had surgical treatment (2 before pregnancy (both had caesarean section), 3 during pregnancy (2 with caesarean section and 1 with vaginal birth) and 1 postpartum).
Fukushima 2012 Retrospective case series Japan	N=22 women with either a pre-existing diagnosis of moyamoya disease or diagnosed within 1 month of birth	• Caesarean section (n=18) • Vaginal birth without anaesthesia (n=3) • Vaginal birth with general anaesthesia (n=1)	For the woman: • Transient ischaemic attack and/or visual disturbances	• In the caesarean section group, 7 women (10 births) had undergone bypass surgery and 1 woman (1 birth) had undergone clipping of a brain aneurysm before birth. Among women with a vaginal birth, no bypass surgery had been performed before birth.
Horton 1990 Retrospective case series USA	N=438 pregnancies among 238 women treated with proton beam therapy for cerebrovascular arteriovenous malformations between 1977 – 1986	• Caesarean section (n=63) • Vaginal birth (n=375)	For the baby: • Mortality	• The study excluded women with haemorrhages or pregnancies after proton beam therapy.
Kalani 2013 Prospective case series USA	N=168 pregnancies among 64 women with cerebral cavernous malformations	• Caesarean section (n=19) • Vaginal birth (n=149)	For the woman: • Symptomatic haemorrhage	
Katsuragi 2018	N=30 pregnancies with	• Caesarean section (n=13)	For the baby: • Mortality	• Out of 36 pregnancies

Study	Population	Intervention/Comparison	Outcomes	Comments
Retrospective case series Japan	intracranial arterio-venous malformation (other than HHT)	• Vaginal birth with vacuum extraction or forceps (n=17)	For the baby: • Mortality	reported, 6 had either miscarriage or therapeutic abortion and were excluded for the review. • AVM treatment before birth: n=9 in the caesarean section group, n=10 in the assisted birth group
Minielly 1979 Retrospective case series Canada	N=7 women presenting with subarachnoid haemorrhage during pregnancy, but before labour	• Caesarean section (n=1) • Vaginal birth (n=4) • Forceps-assisted vaginal birth (n=2)	For the woman: • Mortality For the baby: • Mortality	• Apart from the woman who had caesarean section, all other women had surgical treatment for intracranial lesion before labour.
Sato 2015 Retrospective case series Japan	N=14 pregnancies among 12 women with a history of moyamoya disease between 2004 and 2013	• Caesarean section (n=4) • Vacuum/forceps-assisted vaginal birth under epidural analgesia (n=6) • Non-assisted vaginal birth under epidural analgesia (n=4)	For the woman: • Intrapartum stroke For the baby: • Mortality • Major morbidity	• Six pregnancies with vaginal births (unspecified if assisted or not) and 3 pregnancies with caesarean section had a history of prophylactic bypass surgery.
Sencer 1964 Retrospective case series USA	N=14 pregnancies among 8 women with history of spontaneous subarachnoid haemorrhage before pregnancy	• Caesarean section (n=1) • Normal birth (n=3) • Forceps-assisted birth (n=10)	For the woman: • Mortality For the baby: • Mortality	• One woman had surgical treatment before birth and she delivered by forceps. • Phrases such as “delivered normally” and “delivered without difficulty” or “without difficulty or sequelae” were used inferring no neonatal deaths

N: total number of participants in each study; AVM: arteriovenous malformation; HHT: hereditary haemorrhagic telangiectasia

See also the study evidence tables in Appendix E. No meta-analysis was undertaken for this review (and so there are no forest plots in Appendix F).

Quality assessment of clinical studies included in the evidence review

The clinical evidence profiles for this review question are presented in Table 3 to Table 6.

Table 3: Clinical evidence profile for caesarean section versus spontaneous labour and birth, outcomes for the women

Study	Number of pregnancies with outcome/Total number of pregnancies at risk (%)		Quality	Importance
	Caesarean section	Spontaneous birth		
Mortality				
Cohen-Gadol (2009) Retrospective case series	0/4 (0%)	0/5 (0%)	Very low[1]	Critical
Fliegner 1969 Retrospective case series	0/6 (0%)	0/4 (0%)	Very low[1]	Critical
Fukuda 2013 Retrospective case series	0/5 (0%)	0/2 (0%)	Very low[1]	Critical
Minielly 1979 Retrospective case series	1/1 (100%)	0/4 (0%)	Very low[1]	Critical
Sencer 1964 Retrospective case series	0/1 (0%)	0/3 (0%)	Very low[1]	Critical
Major morbidity: transient ischaemic attack and/or Visual disturbances				
Fukushima 2012 Retrospective case series	2/18 (11%)	2/4 (50%)	Very low[1]	Critical
Major morbidity: intrapartum stroke				
Sato 2015 Retrospective case series	0/4 (0%)	0/4 (0%)	Very low[1]	Critical
Major morbidity: symptomatic haemorrhage				
Kalani (2013) Prospective case series	1/19 (5%)	4/149 (2.7%)	Very low[1]	Critical

[1] *Descriptive data from a case series study*

Table 4: Clinical evidence profile for caesarean section versus spontaneous labour and birth, outcomes for the baby

Study	Number of pregnancies with outcome/Total number of pregnancies at risk (%)		Quality	Importance
	Caesarean section	Spontaneous birth		
Mortality				
Cohen-Gadol 2009 Retrospective case series	0/4 (0%)	0/5 (0%)	Very low[1]	Critical

Study	Number of pregnancies with outcome/Total number of pregnancies at risk (%)		Quality	Importance
	Caesarean section	Spontaneous birth		
Fliegner 1969 Retrospective case series	0/6 (0%)	0/4 (0%)	Very low[1]	Critical
Fukuda 2013 Retrospective case series	0/5 (0%)	0/2 (0%)	Very low[1]	Critical
Horton 1990 Retrospective case series	0/63 (0%)	0/375 (0%)	Very low[1]	Critical
Minielly 1979 Retrospective case series	0/1 (0%)	0/4 (0%)	Very low[1]	Critical
Sato 2015 Retrospective case series	0/4 (0%)	0/4 (0%)	Very low[1]	Critical
Sencer 1964 Retrospective case series	0/1 (0%)	0/3 (0%)	Very low[1]	Critical
Major morbidity (hypoxia-ischaemia): neonatal intubation				
Fukuda 2013 Retrospective case series	2/5 (40%)	0/2 (0%)	Very low[1]	Important
Major morbidity				
Sato 2015 Retrospective case series	0/4 (0%)	0/4 (0%)	Very low[1]	Important

[1] *Descriptive data from a case series study*

Table 5: Clinical evidence profile for caesarean section versus assisted second stage of labour, outcomes for the women

Study	Number of pregnancies with outcome/Total number of pregnancies at risk (%)		Quality	Importance
	Caesarean section	Assisted birth		
Mortality				
Cohen-Gadol 2009 Retrospective case series	0/4 (0%)	0/2 (0%)	Very low[1]	Critical
Fliegner 1969 Retrospective case series	0/6 (0%)	0/4 (0%)	Very low[1]	Critical
Minielly 1979 Retrospective case series	1/1 (100%)	0/2 (0%)	Very low[1]	Critical
Katsuragi 2018 Retrospective case series	0/13 (0%)	0/17 (0%)	Very low[1]	Critical
Sencer 1964 Retrospective case series	0/1 (0%)	0/10 (0%)	Very low[1]	Critical
Major morbidity: intrapartum stroke				
Sato 2015	0/4 (0%)	0/6 (0%)	Very low[1]	Critical

Study	Number of pregnancies with outcome/Total number of pregnancies at risk (%)		Quality	Importance
	Caesarean section	Assisted birth		
Retrospective case series				

[1] *Descriptive data from a case series study.*

Table 6: Clinical evidence profile for caesarean section versus assisted second stage of labour, outcomes for the baby

Study	Number of pregnancies with outcome/Total number of pregnancies at risk (%)		Quality	Importance
	Caesarean section	Assisted birth		
Mortality				
Cohen-Gadol 2009 Retrospective case series	0/4 (0%)	0/2 (0%)	Very low[1]	Critical
Fliegner 1969 Retrospective case series	0/6 (0%)	0/4 (0%)	Very low[1]	Critical
Katsuragi 2018 Retrospective case series	0/13 (0%)	0/17 (0%)	Very low[1]	Critical
Minielly 1979 Retrospective case series	0/1 (0%)	0/2 (0%)	Very low[1]	Critical
Sato 2015 Retrospective case series	0/4 (0%)	0/6 (0%)	Very low[1]	Critical
Sencer 1964 Retrospective case series	0/1 (0%)	0/10 (0%)	Very low[1]	Critical
Major morbidity				
Sato 2015 Retrospective case series	0/4 (0%)	0/6 (0%)	Very low[1]	Important

[1] *Descriptive data from a case series study*

Economic evidence

Included studies

No economic evidence was identified for this review.

See the study selection flow chart in Supplement 2 (Health economics).

Excluded studies

No full-text copies of articles were requested for this review and so there is no excluded studies list (see Supplement 2 (Health economics)).

Summary of studies included in the economic evidence review

No economic evidence was identified for this review (and so there are no economic evidence tables in Supplement 2 (Health economics)).

Economic model

No economic modelling was undertaken for this review because the committee agreed that other topics were higher priorities for economic evaluation (see Supplement 2 (Health economics)).

Evidence statements

Caesarean section versus spontaneous labour and birth

Outcomes for the woman

Mortality

Very low quality evidence from 5 studies of retrospective case series of women with a risk of cerebrovascular haemorrhage (N=9, N=10, N=7, N=5, N=4) reported 1 maternal death in women who had a caesarean section (n=17), whereas there were no maternal deaths in women who had a spontaneous birth (n=18). However, the woman who died presented with haemorrhage at near labour and it was not clear whether the death was due to caesarean section. Eight women in the caesarean section group and 12 women in the spontaneous birth group had surgical treatment for cerebrovascular malformations before birth.

Major morbidity: transient ischaemic attack and/or visual disturbances

Very low quality evidence from 1 study of retrospective case series of women with moyamoya disease (N=22) reported that 1 woman had a transient ischaemic attack and 1 had visual disturbances among 18 women who had a caesarean section, whereas 2 women had transient ischaemic attacks during the postpartum period out of 4 women who had a spontaneous birth. In the caesarean section group, 10 women had prophylactic cerebral bypass surgery before birth and 1 woman had undergone clipping of a brain aneurysm before birth.

Major morbidity: intrapartum stroke

Very low quality evidence from 1 study of retrospective case series of women with moyamoya disease (n=8) reported that no women who had either a caesarean section (n=4) or a non-assisted vaginal birth (n=4) under epidural analgesia experienced an intrapartum stroke.

Major morbidity: symptomatic haemorrhage

Very low quality evidence from one study of prospective case series of women with cerebral cavernous malformations (N=168) reported that 1 woman had a symptomatic haemorrhage among 19 women who had a caesarean section, whereas 4 women had symptomatic haemorrhages among 149 women who had spontaneous births.

Outcomes for the baby

Mortality

Very low quality evidence from 7 studies of retrospective case series of women with cerebrovascular malformations (N=9, N=10, N=7, N=438, N=5, N=8, N=4) reported that there were no deaths among the babies of women who had either caesarean section (n=84) or spontaneous vaginal births (n=397). Eight women in the caesarean section group and 12 women in the spontaneous vaginal birth group had surgical treatment for cerebrovascular malformations before birth.

Major morbidity (hypoxia-ischaemia): neonatal intubation

Very low quality evidence from 1 study of retrospective case series including women with ruptured or unruptured arteriovenous malformations detected during or before pregnancy (N=7) reported that 2 babies born to women who had caesarean sections (n=5) were intubated while no babies born to women who had spontaneous vaginal births (n=2) were intubated. It should be noted that 4 out of 5 women who had a caesarean section had undergone surgical treatment for cerebrovascular malformation before labour whereas of the 2 women who had a spontaneous vaginal birth, 1 had undergone surgical treatment for cerebrovascular malformation during pregnancy.

Major morbidity

Very low quality evidence from 1 retrospective study of a case series of pregnant women with moyamoya disease (N=8) reported that “all infants were healthy without sequelae”. There was no report of any major neonatal event in either the caesarean section group (n=4) or the spontaneous vaginal birth under epidural analgesia group (n=4).

Caesarean section versus assisted second stage of labour

Outcomes for the woman

Mortality

Very low quality evidence from 5 studies of retrospective case series of women with a risk of cerebrovascular haemorrhage (N=6, N=10, N=3, N=30, N=11) reported that 1 out of 25 women who had a caesarean section died, whereas there were no maternal deaths among 35 women who had an assisted second stage of labour. However, the woman who died presented with haemorrhage at near labour and it was not clear whether the death was due to caesarean section. 13 women in the caesarean section group and 15 women in the assisted birth group had surgical treatment for cerebrovascular malformations before birth.

Major morbidity: intrapartum stroke

Very low quality evidence from 1 study of retrospective case series of pregnant women with moyamoya disease (n=10) reported that no women who had either a caesarean section (n=4) or a forceps-assisted vaginal birth under epidural analgesia (n=6) experienced an intrapartum stroke.

Outcomes for the baby

Mortality

Very low quality evidence from 6 studies of retrospective case series of women with a risk of intracranial bleed due to cerebrovascular malformations (N=6, N=10, N=30, N=3, N=10, N=11) reported that there were no deaths among the babies of women who had either caesarean section (n=29) or assisted second stage of labour (n=41). 13 women in the caesarean section group and 15 women in the assisted second stage of labour group had surgical treatment for intracranial lesions before birth.

Major morbidity

Very low quality evidence from 1 retrospective study of a case series of pregnant women with moyamoya disease (N=10) reported that “all infants were healthy without sequelae”. There was no report of any major neonatal event in either the caesarean section group (n=4) or the forceps-assisted second stage of labour group (n=6).

The committee’s discussion of the evidence

See the committee’s discussion of the evidence under ‘Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – management of the second stage of labour.

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

Review question

How should the second stage of labour be managed for women with a history of intracranial haemorrhage or with a cerebrovascular malformation?

Introduction

The aim of this review is to determine the effective management of the second stage of labour in women with a history of intracranial haemorrhage or with a cerebrovascular malformation.

Summary of the protocol

Table 7 provides a summary of the population, intervention, comparison and outcome (PICO) characteristics of this review.

Table 7: Summary of the protocol (PICO table)

Population	Women in the second stage of labour who have a history of intracranial haemorrhage or have a cerebrovascular malformation
Intervention	Reduction of haemodynamic stresses by: Intervention 1: • insertion of epidural anaesthesia prior to second stage of labour Intervention 2: • instrumental/operative vaginal birth Intervention 3: • combination of the above interventions
Comparison	Comparison 1: • Non-instrumental vaginal birth
Outcome	For the woman: • mortality • major morbidity (including recurrent intracranial haemorrhage and stroke (CVA)) • mode of birth • admission to a high dependency unit (HDU) or intensive treatment unit (ITU) • women's satisfaction with labour and birth (including psychological wellbeing)

	For the baby: • mortality • major morbidity (hypoxia ischaemia) • admission to a neonatal unit

For further details see the full review protocol in Appendix A. The search strategies are presented in Appendix B.

Clinical evidence

Included studies

In total, 5 studies of retrospective case series were included for this review (see 'Summary of clinical studies included in the evidence review').

All studies examined women undergoing instrumental vaginal birth and those having non-instrumental vaginal birth (Cohen-Gadol 2009, Fliegner 1969, Minielly 1979, Sato 2015, Sencer 1964).

Evidence from the studies included in the review is summarised below (see 'Quality assessment of clinical studies included in the evidence review').

Data was reported for the critical outcomes for the woman, mortality and major morbidity. Data was also reported for the critical outcomes for the baby, mortality and major morbidity. There was no evidence identified for the critical outcome for the woman, mode of birth, and the important outcomes for the woman, admission to a high dependency unit (HDU) or intensive treatment unit (ITU), and women's satisfaction with labour and birth (including psychological wellbeing). There was no evidence available for the outcome of limited importance for the baby, admission to a neonatal unit.

There was no evidence available for the following intervention, insertion of epidural anaesthesia prior to second stage of labour or combined epidural anaesthesia and instrumental birth.

See also the study selection flow chart in Appendix C.

Excluded studies

Studies not included in this review with reasons for their exclusions are provided in Appendix D.

Summary of clinical studies included in the evidence review

Table 8 provides a brief summary of the included studies.

Table 8: Summary of included studies

Study	Population	Intervention/Comparison*	Outcomes	Comments
Cohen-Gadol 2009 Retrospective case series USA	N=11 women with intracranial vascular lesions	• Instrumental vaginal birth (forceps) (n=2) • Non-instrumental vaginal birth (n=5)	For the woman: • Mortality For the baby: • Mortality	• All 7 women presented with intracranial haemorrhage during their index pregnancies. • Surgical treatment for a cerebrovascular malformation before birth: n=1 in the instrumental vaginal birth group, n=5 in the non-instrumental vaginal birth group
Fliegner 1969 Retrospective case series Australia	N=14 women with spontaneous subarachnoid haemorrhage before or during pregnancy	• Instrumental vaginal birth (forceps) (n=4) • Non-instrumental vaginal birth (n=4)	For the woman: • Mortality For the baby: • Mortality	• 3 women had surgical treatment (1 in instrumental vaginal birth group, 2 in non-instrumental vaginal birth group) whereas 5 women had conservative treatment
Minielly 1979 Retrospective case series Canada	N=7 women presenting with subarachnoid haemorrhage during pregnancy, but before labour	• Instrumental vaginal birth with forceps (n=2) • Non-instrumental vaginal birth (n=4)	For the woman: • Mortality For the baby: • Mortality	All women had surgical treatment before birth.
Sato 2015	N=14 pregnancies among 8 women	• Instrumental vaginal birth	For the woman:	Six women with vaginal birth (unspecified if

Study	Population	Intervention/Comparison*	Outcomes	Comments
Retrospective case series Japan	with moyamoya disease without recent ischemic symptoms and no maternal or fetal problems	(vacuum/forceps) (n=6) • Non-instrumental vaginal birth (n=4)	• Intrapartum stroke For the baby: • Mortality • Major morbidity	instrumental or not) had a history of bypass surgery.
Sencer 1964 Retrospective case series USA	N=14 pregnancies among 7 women with spontaneous sub-arachnoid haemorrhage before pregnancy	• Instrumental vaginal birth (forceps) (n=10 births) • Non-instrumental vaginal birth (n=3)	For the woman: • Mortality For the baby: • Mortality	• One woman had surgical treatment before birth and she delivered by forceps. • Phrases such as “delivered normally” and “delivered without difficulty” or “without difficulty or sequelae” were used inferring no neonatal deaths

N: Total number of participants in each study; n=number of participants
**This represented only the number of woman in intervention or comparison of interest for this review.*

See also the study evidence tables in Appendix E. No meta-analysis was undertaken for this review (and so there are no forest plots in Appendix F).

Quality assessment of clinical studies included in the evidence review

The clinical evidence profiles for this review question are presented in Table 9.

Table 9: Clinical evidence profile for instrumental vaginal birth versus non-instrumental vaginal birth, outcomes for the women

Study	Number of pregnancies with outcome/Total number of pregnancies at risk (%)		Quality	Importance
	Instrumental births	Non-instrumental births		
Mortality				
Cohen-Gadol 2009 Retrospective case series	0/2 (0%)	0/5 (0%)	Very low[1]	Critical
Fliegner 1969	0/4 (0%)	0/4 (0%)	Very low[1]	Critical

Study	Number of pregnancies with outcome/Total number of pregnancies at risk (%)		Quality	Importance
	Instrumental births	Non-instrumental births		
Retrospective case series				
Minielly 1979 Retrospective case series	0/2*(0%)	0/4 (0%)	Very low[1]	Critical
Sencer 1964 Retrospective case series	0/10 (0%)	0/3 (0%)	Very low[1]	Critical
Major morbidity: intrapartum stroke				
Sato 2015 Retrospective case series	0/6 (0%)	0/4 (0%)	Very low[1]	Critical

[1] *Descriptive data from a case series study.*

Table 10: Clinical evidence profile for instrumental vaginal birth versus non-instrumental vaginal birth, outcomes for the baby

Study	Number of pregnancies with outcome/Total number of pregnancies at risk (%)		Quality	Importance
	Instrumental births	Non-instrumental births		
Mortality				
Cohen-Gadol 2009 Retrospective case series	0/2 (0%)	0/5 (0%)	Very low[1]	Critical
Fliegner 1969 Retrospective case series	0/4 (0%)	0/4 (0%)	Very low[1]	Critical
Minielly 1979 Retrospective case series	0/2*(0%)	0/4 (0%)	Very low[1]	Critical
Sato 2015 Retrospective case series	0/6 (0%)	0/4 (0%)	Very low[1]	Critical
Sencer 1964 Retrospective case series	0/10 (0%)	0/3 (0%)	Very low[1]	Critical
Major morbidity				
Sato 2015 Retrospective case series	0/6 (0%)	0/4 (0%)	Very low[1]	Important

[1] *Descriptive data from a case series study.*

Economic evidence

Included studies

No economic evidence was identified for this review.

See the study selection flow chart in Supplement 2 (Health economics).

Excluded studies

No full-text copies of articles were requested for this review and so there is no excluded studies list (see Supplement 2 (Health economics)).

Summary of studies included in the economic evidence review

No economic evidence was identified for this review (and so there are no economic evidence tables in Supplement 2 (Health economics)).

Economic model

No economic modelling was undertaken for this review because the committee agreed that other topics were higher priorities for economic evaluation (see Supplement 2 (Health economics)).

Evidence statements

Instrumental vaginal birth versus non-instrumental vaginal birth

Outcomes for the woman

Mortality

Very low quality evidence from 4 studies of retrospective case series of women with risk of intracranial bleeds (N=7, N=8, N=6, N=13) showed that there were no maternal deaths in those who had an instrumental vaginal birth with forceps (n=18) nor in those who had a non-instrumental vaginal birth (n=16). Five women in the group who had an instrumental birth and 11 women in the group who had a non-instrumental birth underwent surgical treatment for a cerebrovascular malformations before birth.

Major morbidity: intrapartum stroke

Very low quality evidence from 1 study of retrospective case series of women with moyamoya disease (N=10) showed that there were no intrapartum strokes in those who had an instrumental vaginal birth with vacuum or forceps under epidural analgesia (n=6) nor in those who had a non-instrumental vaginal birth under epidural analgesia (n=4). Six women in an undefined birth group had a history of cerebral bypass surgery.

Outcomes for the baby

Mortality

Very low quality evidence from 5 studies of retrospective case series of women with intracranial vascular lesions (N=7, N=8, N=6, N=10, N=13) showed that there were no deaths of the baby in those who had an instrumental vaginal birth with forceps (n=24) nor in those who had a non-instrumental vaginal birth (n=20). Five women in the instrumental birth group and 11 women in the non-instrumental birth group underwent surgical treatment for a cerebrovascular malformation before birth. Another 6 women in an undefined group had a history of cerebral bypass surgery.

Major morbidity

Very low quality evidence from 1 study of retrospective case series of women with moyamoya disease (N=10) showed that there were no major neonatal morbidities in those who had an instrumental vaginal birth with vacuum or forceps under epidural analgesia (n=6) nor in those who had a non-instrumental vaginal birth under epidural analgesia (n=4). Six women in an undefined birth group had a history of cerebral bypass surgery.

The committee's discussion of the evidence

The outcomes that matter most

This section documenting the committee's discussion of the evidence covers both review questions related to intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain.

The committee highlighted that maternal outcomes were generally more important than fetal outcomes for both review questions, as fetal outcomes are largely reliant upon maternal conditions.

For the question on mode of birth, the committee selected maternal mortality and major morbidity as critical outcomes for the woman. The committee also prioritised women's satisfaction with labour and birth (including psychological wellbeing) as a critical outcome. They noted that only being offered a caesarean section rather than the option of an attempt at a vaginal birth might result in the woman feeling dissatisfied with her birth experience, and they agreed that data on women's satisfaction would inform decisions regarding mode of birth. The committee also selected mortality as a critical outcome for the baby. The committee selected admission to a high dependency unit (HDU) or intensive therapy unit (ITU) as an important outcome for the woman because this can reflect a variety of major maternal morbidities. The committee selected re-admission to hospital with a cerebral event within 6 weeks of the birth as an important outcome because this group of women is at risk of specific catastrophic conditions such as stroke. The committee considered major neonatal morbidity (hypoxia-ischaemia) and admission to a neonatal unit to be important outcomes.

For the question on management of the second stage of labour, the committee selected maternal mortality and major morbidity (including recurrent intracranial haemorrhage and stroke) as critical outcomes. Mode of birth was also prioritised as a critical outcome. If the woman was considered to be at low risk of intracranial haemorrhage and she was judged to be suitable for vaginal birth and then required an emergency caesarean section, this would

indicate that something had gone critically wrong. Moreover, having a caesarean section when already in the second stage of labour (cervix fully dilated) might be physically and psychologically damaging for the woman and the baby (especially in the context of a known cerebral pathology). For the baby, mortality and major morbidity (hypoxia ischaemia) were rated as critical outcomes. Maternal admission to HDU or ITU was rated as an important outcome for the woman because, as for mode of birth, this would indicate that an adverse event had occurred during the birth. Women's satisfaction with labour and birth (including psychological wellbeing) was also considered to be an important outcome because, according to the committee's experience, in current practice there is a tendency to avoid the use of an epidural during labour for women who have a history of subarachnoid malformation or arteriovenous malformation, and this could result in the woman having a poor experience of labour.

The quality of the evidence

No comparative experimental studies were identified nor any comparative observational studies. Small case series and case reports were the only included studies. All studies were quality appraised and although some clearly reported relevant information (such as demographic data, women's clinical condition and outcomes) they were assessed as being of very low quality because of the non-comparative study design.

In some studies, the mortality outcome was not reported however it seemed clear from the description of the cases that there had been no catastrophic events (such as death), therefore mortality was included in the guideline review. However the poor or incomplete reporting as well as very small sample size made it difficult to draw conclusions about the occurrence of major or minor morbidities. However, one study (Sato 2015) reported more clearly where no major neonatal morbidities was assumed based on a narrative description that 'All 14 infants were healthy without sequelae'.

Benefits and harms

The committee described how the principles of multidisciplinary team working should be followed in this group of women as they have pathologies that are relatively rare and require highly individualised care with input from a number of specialists to interpret specialist scans, information from previous surgical procedures and obstetric complications. The committee explained that a specialist with expertise in managing neurovascular conditions during pregnancy should be included in the core multidisciplinary team because failure to properly manage the neurovascular condition could lead to fatal consequences for the woman. The committee explained that there was no evidence as to exactly which speciality the neurovascular expert should come from but they should have a suitable level of expertise to add to the team's decision-making. The committee emphasised that the woman should be involved in planning her care.

The committee agreed that when a woman has a fully treated cerebrovascular malformation or has had intracranial bleeding more than 2 years previously, the likelihood of further intracranial bleeding is low and therefore the woman can be classified as being at low risk of intrapartum intracranial bleeding. The committee did not find any evidence suggesting increased risk of intracranial bleeding during the intrapartum period in women with a low risk of bleeding. This was supported by their clinical experience. Consequently they determined that in the group of women with a low risk of bleeding, decisions on mode of birth should be taken on the basis of factors other than the risk of bleeding (for example, the woman's preference and the risk of an obstetric complication). The committee explained that a

possible consequence of recommending that all women with a risk of an intracranial bleed have a caesarean section was that this course of action was likely to be distressing for some women and it potentially carried higher risks in some situations. The committee described how in their experience the benefit was avoiding potentially catastrophic intracranial bleeding, but discussed how many women gave birth without knowing they had a low-risk cerebrovascular malformation (that is, it was discovered after the birth) and therefore the risk of a catastrophic bleed in this low risk group must be very low – especially in the absence of evidence contradicting this conclusion. The committee explained that in the absence of any other conditions (for example, a genetic condition which had led to the malformation), it might be appropriate to refer to, for example, the NICE guideline on intrapartum care for healthy women and babies (CG190) to guide the decision, as there would be no reason to manage labour any differently than for a healthy woman. The committee added that if, after a discussion of the risks, the woman's preference was for a caesarean section to lower her chance of an intracranial bleed even further then this would be entirely consistent with their recommendations.

On the other hand, the committee described how the lack of evidence of risk of intracranial bleeding in the intrapartum period in women at high risk of bleeding was less compelling. There was a belief in the committee that women considered at high risk of intracranial bleeding would not be included in studies because these women would currently be advised to have an elective caesarean section to minimise their risk of complications. The committee explained that their experience was that high-risk malformations were rare but likely to bleed even with high quality management. The committee described how – in their experience – the risk of an intracranial bleed was high enough in some groups to consider a caesarean section after discussing the benefits and risks with the woman, regardless of the women's original preference,. The committee believed that a caesarean section would likely be safer than an active or passive labour as it would avoid all activities which could raise intracranial pressure. The committee discussed some examples of conditions that might be considered high risk, but emphasised that a detailed risk assessment should occur as part of multidisciplinary discussion.

The committee described, based on their experience, how some women at high risk of bleeding might still prefer to aim for a vaginal birth. They explained that many women who would not consent to a caesarean section might consent to labour management strategies to reduce the potential for raised intracranial pressure, however they clarified that caesarean section was still significantly more effective at controlling intracranial pressure. On the basis of their experience, they recommended adequate pain management to avoid risks associated with adrenaline response. In addition, an assisted second stage of labour was considered safer than active pushing. The committee found it important that the benefits and risks of an assisted second stage of labour, as compared to active pushing alone, should be explained to the woman. The committee justified strong recommendations here because lowering intracranial pressure is of lifesaving importance during labour and they believed that these techniques would lower intracranial pressure without increasing other risks.

Furthermore, the committee suggested that women presenting for the first time in labour with a history of cerebrovascular malformation or past intracranial bleed and of unknown risk of intracranial haemorrhage should be regarded as being at high risk, and caesarean section or instrumental vaginal birth should be considered with appropriate consent. This is because the bleed risk will not be known, and it would not be possible to conduct the tests necessary to find out. The harm of such an approach would largely be the risk of a negative experience for the woman, whereas the risk of not adequately assessing the chance of a bleed is that

the woman could die. Therefore the committee believed it was appropriate to take a cautious approach with this group of women.

Finally, the committee expressed their opinion that regional analgesia should not be withheld routinely from women who have no history suggesting multiple cerebrovascular malformations. The committee explained that women with a genetic propensity to cerebrovascular malformations have a high chance of vascular malformation in the spine and that this could cause haemorrhage if anaesthesia or analgesia were administered. However women with cerebrovascular malformations that are not genetic in cause have a similar risk of vascular malformation in the spine as do the general population, and therefore the committee believed that the risk of haemorrhage was low enough to justify prioritising the woman's experience of birth.

Cost effectiveness and resource use

The evidence was limited and the committee made a qualitative assessment of cost effectiveness.

The committee noted the available evidence did not indicate any maternal or neonatal deaths or morbidities related to maternal cerebrovascular malformation or a history of intracranial bleeding. Nevertheless, they did not think that there was sufficient evidence to justify changing current practice on cost effectiveness grounds for women at a high risk of an intracranial bleed.

The committee believed that vaginal birth was a cost effective option for women at a low risk of intracranial bleeding although they acknowledged that some women would be anxious about a vaginal birth because of a theoretical risk of a bleed. Therefore, they recommended that mode of birth should be determined by a woman's preferences and obstetric indications in women at a low risk of an intracranial bleed. However, they considered that it was cost effective to recommend caesarean section for women with a high risk of an intracranial bleed because caesarean section should reduce the risks of raised intracranial pressure. They recognised that caesarean section is a more costly mode of birth, but it is generally considered to be cost effective in the NHS when there is an obstetric or medical indication.

The committee believed that it would be cost effective to offer most women a choice of regional analgesia or anaesthesia as they considered these extremely unlikely to provoke a bleed, which is the reason that some healthcare professionals are currently reluctant to offer it.

The committee considered the recommendations to be in line with current practice for women at high risk, however they believed that many healthcare professionals would currently offer an elective caesarean section to women at low risk. So these recommendations could lead to a major change in practice for these women, with fewer caesarean sections and a reduction in costs to the NHS. However, given the number of women affected, the committee did not think it likely that this would represent a significant resource impact.

Other factors the committee took into account

The committee concluded that no additional recommendations were needed for women with cognitive or physical disabilities, since although women in this group were at high risk for cognitive or physical disabilities due to their cerebrovascular malformations, the management

of these disabilities was not significantly different from other groups who do not have cerebrovascular malformations. The committee highlighted that while assessing individual risk of intracranial bleed for each woman, clinicians should consider the type of brain lesion and its severity as well as previous history of repair, as this could affect the level of cognitive or physical disabilities the woman might risk if an intracranial haemorrhage occurred.

The committee recommended further research to evaluate whether caesarean section protects against cerebral haemorrhage in women with a history of subarachnoid haemorrhage or cerebrovascular malformation. See Appendix L for further details.

Despite the low quality of the evidence, the committee decided to prioritise other areas addressed by the guideline for future research and therefore made no research recommendations regarding management of the second stage of labour for women with a history of subarachnoid haemorrhage or cerebrovascular malformation.

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Appendices

Appendix A – Review protocols

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

Item	Details	Working notes
Area in the scope	Women at high risk of adverse outcomes for themselves and/or their baby because of existing maternal medical conditions – intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth	
Review question in the scope	Which women with a history of subarachnoid haemorrhage or an arteriovenous malformation of the brain should avoid labour?	
Review question for the guideline	Which women with a history of intracranial haemorrhage or a cerebrovascular malformation should avoid labour?	
Objective	The aim of this review is to determine whether women with a history of intracranial haemorrhage or a cerebrovascular malformation can have a labour	
Population and directness	Pregnant women who have a history of intracranial haemorrhage or have a cerebrovascular malformation and who are planning for birth	
Intervention	Elective caesarean section	
Comparison	Spontaneous labour and birth Assisted second stage of labour	
Outcomes	Critical outcomes: • for the woman: o mortality o major morbidity (including recurrent intracranial haemorrhage and stroke/cerebrovascular accident (CVA)) o women's satisfaction with labour and birth (including psychological wellbeing) • for the baby: o mortality Important outcomes: • for the woman: o admission to a high dependency unit (HDU) or intensive treatment unit (ITU) o re-admission to hospital with a cerebral event within 6 weeks of the birth • for the baby: o major morbidity (hypoxia-ischaemia)	

Item	Details	Working notes
	○ admission to a neonatal unit Outcomes of limited importance: • for the woman: ○ duration of hospital stay	
Importance of outcomes	Preliminary classification of the outcomes for decision making: • critical (up to 3 outcomes) • important but not critical (up to 3 outcomes) • of limited importance (1 outcome)	Given the small volume of evidence available for inclusion overall, the committee agreed to consider more than the nominal maximum of 7 outcomes for this question
Setting	Obstetric units	
Stratified, subgroup and adjusted analyses	Groups that will be reviewed and analysed separately: • previous successful treatment of SAH/AVMs versus unsuccessful treatment or no treatment • parity • women who have received no antenatal care Potential confounders: • hypertension • family history of subarachnoid haemorrhage • drug use (cocaine) • parity • size of aneurysm/severity of intracranial haemorrhage/ cerebrovascular malformation	
Language	English	
Study design	• Published full-text papers only • Systematic reviews • RCTs • Only if RCTs unavailable or there is limited data to inform decision making: ○ prospective or retrospective comparative observational studies (including cohort and case-control studies) ○ case series studies • Prospective study designs will be prioritised over retrospective study designs • Conference abstracts will not be considered	

Item	Details	Working notes
Search strategy	Sources to be searched: Medline, Medline In-Process, CCTR, CDSR, DARE, HTA and Embase. Limits (e.g. date, study design): All study designs. Apply standard animal/non-English language filters. No date limit. Supplementary search techniques: No supplementary search techniques were used. See Appendix B for full strategies	
Review strategy	Appraisal of methodological quality: • the methodological quality of each study will be assessed using checklists recommended in the NICE guidelines manual 2014 (for example, AMSTAR or ROBIS for systematic reviews, and Cochrane RoB tool for RCTs) and the quality of the evidence for each outcome (that is, across studies) will be assessed using GRADE • if studies report only p-values, this information will be recorded in GRADE tables without an assessment of imprecision Synthesis of data: • meta-analysis will be conducted where appropriate • default MIDs will be used; 0.8 and 1.25 for dichotomous outcomes; 0.5 times the SD of the measurement in the control arm (or median score across control arms if multiple studies are included) for continuous outcomes • for continuous data, change scores will be used in preference to final scores for data from non-RCT studies; final and change scores will not be pooled; if any study reports both, the method used in the majority of studies will be adopted	Review questions selected as high priorities for health economic analysis (and those selected as medium priorities and where health economic analysis could influence recommendations) will be subject to dual weeding and study selection; any discrepancies will be resolved through discussion between the first and second reviewers or by reference to a third person. This review question was not prioritised for health economic analysis and so no formal dual weeding, study selection (inclusion/exclusion) or data extraction into evidence tables will be undertaken. However, internal (NGA) quality assurance processes will include consideration of the outcomes of weeding, study selection and data

Item	Details	Working notes
		extraction and the committee will review the results of study selection and data extraction
Equalities	Equalities considerations will be considered systematically in relation to the available evidence and draft recommendations. The guideline scope includes women with cognitive or physical disability as populations for whom there may be equalities issues. Women who have received no antenatal care will be considered as a subgroup for all systematic reviews performed within the medical conditions work stream and a specific question has been included in the obstetric complications work stream for this population	
Notes/additional information	None	
Key papers	• Steiner et al. European Stroke Organization Guidelines for the Management of Intracranial Aneurysms and Subarachnoid Haemorrhage, Cerebrovasc Dis 2013;35:93–112 (http://www.congrex-switzerland.com/fileadmin/files/2013/eso-stroke/pdf/ESO_SAH_Guideline_CVD.pdf) • James DK et al. High Risk Pregnancy. Management Options. Saunders Elsevier 4th edition, 2011 • Christopher S. Ogilvy et al. Recommendations for the Management of Intracranial Arteriovenous Malformations. A Statement for Healthcare Professionals From a Special Writing Group of the Stroke Council, American Stroke Association, 2001 (http://stroke.ahajournals.org/content/32/6/1458.full.pdf+html) • Mohr JP et al. Diagnosis and treatment of arteriovenous malformations. Curr Neurol Neurosci Rep. 2013 Feb;13(2):324 (http://link.springer.com/article/10.1007%2Fs11910-012-0324-1) • Tiel Groenestege AT et al. The risk of aneurysmal subarachnoid hemorrhage during pregnancy, delivery, and the puerperium in the Utrecht population: case-crossover study and standardized incidence ratio estimation. Stroke. 2009 Apr;40(4):1148-51 (http://www.ncbi.nlm.nih.gov/pubmed/19211489) • Dias MS, Sekhar LN. Intracranial hemorrhage from aneurysms and arteriovenous malformations during pregnancy and the puerperium. Neurosurgery. 1990 Dec;27(6):855-65; discussion 865-6 (http://www.ncbi.nlm.nih.gov/pubmed/2274125)	

Item	Details	Working notes
	• Laidler JA et al. The management of caesarean section in a patient with an intracranial arteriovenous malformation. Anaesthesia. 1989 Jun;44(6):490-1 (http://www.ncbi.nlm.nih.gov/pubmed/?term=The+management+of+Caesarean+section+in+a+patient+with+an+intracranial+arteriovenous+malformation)	

AMSTAR: Assessing the Methodological Quality of Systematic Reviews; AVM: arteriovenous malformation; CCTR: Cochrane Central Register of Controlled Trials; CDSR: Cochrane Database of Systematic Reviews; CVA: cerebrovascular accident; DARE: Database of Abstracts of Reviews of Effects; GRADE: Grading of Recommendations Assessment, Development and Evaluation; HDU: high dependency unit; HTA: Health Technology Assessment; ITU: intensive treatment unit; MBRRACE: Mothers and Babies – Reducing Risk through Audits and Confidential Enquiries across the UK; MID: minimally important difference; NGA: National Guideline Alliance; NICE: National Institute for Health and Care Excellence; RCT: randomised controlled trial; RoB: risk of bias; ROBIS: Risk of Bias in Systematic Reviews; SAH: subarachnoid haemorrhage; SD: standard deviation; UKOSS: UK-wide Obstetric Surveillance System

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

Item	Details	Working notes
Area in the scope	Women at high risk of adverse outcomes for themselves and/or their baby because of existing maternal medical conditions – intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – management of the second stage of labour	
Review question in the scope	How should the second stage of labour be managed for women with history of subarachnoid haemorrhage and/or arteriovenous malformation of the brain?	
Review question for the guideline	How should the second stage of labour be managed for women with a history of intracranial haemorrhage or with a cerebrovascular malformation?	
Objective	The aim of this review is to determine the effective management of the second stage of labour in women with a history of intracranial haemorrhage or with a cerebrovascular malformation	
Population and directness	Women in the second stage of labour who have a history of intracranial haemorrhage or have a cerebrovascular malformation	
Intervention	Reduction of hemodynamic stresses by: • insertion of epidural anaesthesia prior to second stage of labour • instrumental/operative vaginal birth • combination of the above interventions	
Comparison	• Non-instrumental vaginal birth	

Item	Details	Working notes

Outcomes	Critical outcomes:
	• for the woman:
	  ○ mortality
	  ○ major morbidity (including recurrent intracranial haemorrhage and stroke (CVA))
	  ○ mode of birth
	• for the baby:
	  ○ mortality
	  ○ major morbidity (hypoxia ischaemia)
	
	Important outcomes:
	• for the woman:
	  ○ admission to a high dependency unit (HDU) or intensive treatment unit (ITU)
	  ○ women's satisfaction with labour and birth (including psychological wellbeing)
	
	Outcomes of limited importance:
	• for the baby:
	  ○ admission to a neonatal unit	

Importance of outcomes	Preliminary classification of the outcomes for decision making: • critical (up to 3 outcomes) • important but not critical (up to 3 outcomes) • of limited importance (1 outcome)	Given the small volume of evidence available for inclusion overall, the committee agreed to consider more than the nominal maximum of 7 outcomes for this question
Setting	All settings	
Stratified, subgroup and adjusted analyses	Groups that will be reviewed and analysed separately if possible: • previous successful treatment of brain arteriovenous malformation/s vs unsuccessful treatment/no treatment • parity • women who have received no antenatal care <u>Potential confounders</u> • hypertension • family history of subarachnoid haemorrhage • drug use (cocaine) • parity • size of aneurysm / severity of subarachnoid haemorrhage and/or brain arteriovenous malformations	
Language	English	

Item	Details	Working notes
Study design	• Published full-text papers only • Systematic reviews • RCTs • Only if RCTs unavailable or there is limited data to inform decision making: ○ prospective or retrospective comparative cohort studies ○ case series studies • Prospective study designs will be prioritised over retrospective study designs • Conference abstracts will not be considered	
Search strategy	Sources to be searched: Medline, Medline In-Process, CCTR, CDSR, DARE, HTA and Embase. Limits (e.g. date, study design): All study designs. Apply standard animal/non-English language filters. No date limit. Supplementary search techniques: No supplementary search techniques were used. See Appendix B for full strategies	
Review strategy	Appraisal of methodological quality: • the methodological quality of each study will be assessed using checklists recommended in the NICE guidelines manual 2014 (for example, AMSTAR or ROBIS for systematic reviews, and Cochrane RoB tool for RCTs) and the quality of the evidence for each outcome (that is, across studies) will be assessed using GRADE • if studies report only p-values, this information will be recorded in GRADE tables without an assessment of imprecision Synthesis of data: • meta-analysis will be conducted where appropriate • default MIDs will be used; 0.8 and 1.25 for dichotomous outcomes; 0.5 times the SD of the measurement in the control arm (or median score across control arms if multiple studies are included) for continuous outcomes • for continuous data, change scores will be used in preference to final scores for data from non-RCT studies; final and change scores will not be pooled; if any study reports both, the method used in the majority of studies will be adopted	Review questions selected as high priorities for health economic analysis (and those selected as medium priorities and where health economic analysis could influence recommendations) will be subject to dual weeding and study selection; any discrepancies will be resolved through discussion between the first and second reviewers or by reference to a third person. This review question was not prioritised for health economic analysis and so no formal dual weeding, study selection (inclusion/exclusion) or data extraction into evidence tables will be undertaken. However, internal (NGA) quality assurance processes will include consideration of the outcomes of weeding,

Item	Details	Working notes
		study selection and data extraction and the committee will review the results of study selection and data extraction
Equalities	Equalities considerations will be considered systematically in relation to the available evidence and draft recommendations. The guideline scope includes women with cognitive or physical disability as populations for whom there may be equalities issues. Women who have received no antenatal care will be considered as a subgroup for all systematic reviews performed within the medical conditions work stream and a specific question has been included in the obstetric complications work stream for this population	

Notes/additional information	NICE guideline on intrapartum care for healthy women and babies 2017 (http://www.nice.org.uk/guidance/cg190/chapter/1-recommendations)
	The second stage of labour is defined as follows:
	"1.13.1
	• Passive second stage of labour:
	  ○ the finding of full dilatation of the cervix before or in the absence of involuntary expulsive contractions.
	• Onset of the active second stage of labour:
	  ○ the baby is visible
	  ○ expulsive contractions with a finding of full dilatation of the cervix or other signs of full dilatation of the cervix
	  ○ active maternal effort following confirmation of full dilatation of the cervix in the absence of expulsive contractions. [2007]"	

Key papers	• Steiner et al. European Stroke Organization Guidelines for the Management of Intracranial Aneurysms and Subarachnoid Haemorrhage, Cerebrovasc Dis 2013;35:93–112 (http://www.congrex-switzerland.com/fileadmin/files/2013/eso-stroke/pdf/ESO_SAH_Guideline_CVD.pdf) • James DK et al. High Risk Pregnancy. Management Options. Saunders Elsevier 4th edition, 2011 • Christopher S. Ogilvy et al. Recommendations for the Management of Intracranial Arteriovenous Malformations. A Statement for Healthcare Professionals From a Special Writing Group of the Stroke Council, American Stroke Association, 2001 (http://stroke.ahajournals.org/content/32/6/1458.full.pdf+html) • Mohr JP et al. Diagnosis and treatment of arteriovenous malformations. Curr Neurol Neurosci Rep. 2013	

Item	Details	Working notes
	Feb;13(2):324 (http://link.springer.com/article/10.1007%2Fs11910-012-0324-1) • Tiel Groenestege AT et al. The risk of aneurysmal subarachnoid hemorrhage during pregnancy, delivery, and the puerperium in the Utrecht population: case-crossover study and standardized incidence ratio estimation. Stroke. 2009 Apr;40(4):1148-51 (http://www.ncbi.nlm.nih.gov/pubmed/19211489) • Dias MS, Sekhar LN. Intracranial hemorrhage from aneurysms and arteriovenous malformations during pregnancy and the puerperium. Neurosurgery. 1990 Dec;27(6):855-65; discussion 865-6 (http://www.ncbi.nlm.nih.gov/pubmed/2274125) • Laidler JA et al. The management of caesarean section in a patient with an intracranial arteriovenous malformation. Anaesthesia. 1989 Jun;44(6):490-1 (http://www.ncbi.nlm.nih.gov/pubmed/?term=The+management+of+Caesarean+section+in+a+patient+with+an+intracranial+arteriovenous+malformation)	

AMSTAR: Assessing the Methodological Quality of Systematic Reviews; CCTR: Cochrane Central Register of Controlled Trials; CDSR: Cochrane Database of Systematic Reviews; CVA: cerebrovascular accident; DARE: Database of Abstracts of Reviews of Effects; GRADE: Grading of Recommendations Assessment, Development and Evaluation; HDU: high dependency unit; HTA: Health Technology Assessment; ITU: intensive treatment unit; MID: minimally important difference; NGA: National Guideline Alliance; NICE: National Institute for Health and Care Excellence; RCT: randomised controlled trial; RoB: risk of bias; ROBIS: Risk of Bias in Systematic Reviews; SD: standard deviation; UKOSS: UK Obstetric Surveillance System

Appendix B – Literature search strategies

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

Database: Medline; Medline EPub Ahead of Print; and Medline In-Process & Other Non-Indexed Citations

#	Searches
1	PREGNANCY/
2	PERIPARTUM PERIOD/
3	PARTURITION/
4	exp LABOR, OBSTETRIC/
5	OBSTETRIC LABOR, PREMATURE/
6	pregnan$.ti,ab.
7	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).ti,ab.
8	((during or giving or give) adj3 birth?).ti,ab.
9	or/1-8
10	INTRACRANIAL HEMORRHAGES/
11	SUBARACHNOID HEMORRHAGE/

#	Searches
12	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).ab,ti.
13	SAH?.ab,ti.
14	INTRACRANIAL ARTERIOVENOUS MALFORMATIONS/
15	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).ab,ti.
16	(cerebr$ adj3 malform$).ab,ti.
17	AVM?.ab,ti.
18	(recurr$ adj3 h?emorrhag$).ti,ab.
19	(Cerebr$ adj3 accident?).ti,ab.
20	cva.ti,ab.
21	HEMIPLEGIA/
22	hemiplegia?.ti,ab.
23	cavernoma?.ti,ab.
24	or/10-23
25	exp DELIVERY, OBSTETRIC/
26	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or vacuum$ or ventouse?) adj5 (birth$ or born or deliver$))).ti,ab.
27	episiotom$.ti,ab.
28	((normal$ or assist$) adj5 (birth$ or born or deliver$)).ti,ab.
29	or/25-28
30	9 and 24 and 29
31	UK Obstetric Surveillance System.ti,ab.
32	UKOSS.ti,ab.
33	"Mothers and babies? reducing risk through audits and confidential enquiries across the UK".ti,ab.
34	MBRRACE.ti,ab.
35	Scottish confidential audit of severe maternal morbidity.ti,ab.
36	SCASMM.ti,ab.
37	or/31-36
38	30 or 37
39	limit 38 to english language
40	LETTER/
41	EDITORIAL/
42	NEWS/
43	exp HISTORICAL ARTICLE/
44	ANECDOTES AS TOPIC/
45	COMMENT/
46	(letter or comment*).ti.
47	or/40-46
48	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
49	47 not 48
50	ANIMALS/ not HUMANS/

#	Searches
51	exp ANIMALS, LABORATORY/
52	exp ANIMAL EXPERIMENTATION/
53	exp MODELS, ANIMAL/
54	exp RODENTIA/
55	(rat or rats or mouse or mice).ti.
56	or/49-55
57	39 not 56

Database: Cochrane Central Register of Controlled Trials

#	Searches
1	PREGNANCY/
2	PERIPARTUM PERIOD/
3	PARTURITION/
4	exp LABOR, OBSTETRIC/
5	OBSTETRIC LABOR, PREMATURE/
6	pregnan$.ti,ab,kw.
7	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).ti,ab.
8	((during or giving or give) adj3 birth?).ti,ab.
9	or/1-8
10	INTRACRANIAL HEMORRHAGES/
11	SUBARACHNOID HEMORRHAGE/
12	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).ab,ti.
13	SAH?.ab,ti.
14	INTRACRANIAL ARTERIOVENOUS MALFORMATIONS/
15	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).ab,ti.
16	(cerebr$ adj3 malform$).ab,ti.
17	AVM?.ab,ti.
18	(recurr$ adj3 h?emorrhag$).ti,ab.
19	(Cerebr$ adj3 accident?).ti,ab.
20	cva.ti,ab.
21	HEMIPLEGIA/
22	hemiplegia?.ti,ab,kw.
23	cavernoma?.ti,ab,kw.
24	or/10-23
25	exp DELIVERY, OBSTETRIC/
26	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or vacuum$ or ventouse?) adj5 (birth$ or born or deliver$))).ti,ab.
27	episiotom$.ti,ab,kw.
28	((normal$ or assist$) adj5 (birth$ or born or deliver$)).ti,ab.
29	or/25-28
30	9 and 24 and 29

#	Searches
31	UK Obstetric Surveillance System.ti,ab.
32	UKOSS.ti,ab.
33	"Mothers and babies? reducing risk through audits and confidential enquiries across the UK".ti,ab.
34	MBRRACE.ti,ab.
35	Scottish confidential audit of severe maternal morbidity.ti,ab.
36	SCASMM.ti,ab.
37	or/31-36
38	30 or 37

Database: Cochrane Database of Systematic Reviews

#	Searches
1	PREGNANCY.kw.
2	PERIPARTUM PERIOD.kw.
3	PARTURITION.kw.
4	LABOR, OBSTETRIC.kw.
5	OBSTETRIC LABOR, PREMATURE.kw.
6	pregnan$.ti,ab.
7	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).ti,ab.
8	((during or giving or give) adj3 birth?).ti,ab.
9	or/1-8
10	INTRACRANIAL HEMORRHAGES.kw.
11	SUBARACHNOID HEMORRHAGE.kw.
12	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).ab,ti.
13	SAH?.ab,ti.
14	INTRACRANIAL ARTERIOVENOUS MALFORMATIONS.kw.
15	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).ab,ti.
16	(cerebr$ adj3 malform$).ab,ti.
17	AVM?.ab,ti.
18	(recurr$ adj3 h?emorrhag$).ti,ab.
19	(Cerebr$ adj3 accident?).ti,ab.
20	cva.ti,ab.
21	HEMIPLEGIA.kw.
22	hemiplegia?.ti,ab.
23	cavernoma?.ti,ab.
24	or/10-23
25	DELIVERY, OBSTETRIC.kw.
26	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or vacuum$ or ventouse?) adj5 (birth$ or born or deliver$))).ti,ab.
27	episiotom$.ti,ab.
28	((normal$ or assist$) adj5 (birth$ or born or deliver$)).ti,ab.

#	Searches
29	or/25-28
30	9 and 24 and 29
31	UK Obstetric Surveillance System.ti,ab.
32	UKOSS.ti,ab.
33	"Mothers and babies? reducing risk through audits and confidential enquiries across the UK".ti,ab.
34	MBRRACE.ti,ab.
35	Scottish confidential audit of severe maternal morbidity.ti,ab.
36	SCASMM.ti,ab.
37	or/31-36
38	30 or 37

Database: Database of Abstracts of Reviews of Effects

#	Searches
1	PREGNANCY.kw.
2	PERIPARTUM PERIOD.kw.
3	PARTURITION.kw.
4	LABOR, OBSTETRIC.kw.
5	OBSTETRIC LABOR, PREMATURE.kw.
6	pregnan$.tw,tx.
7	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).tw,tx.
8	((during or giving or give) adj3 birth?).tw,tx.
9	or/1-8
10	INTRACRANIAL HEMORRHAGES.kw.
11	SUBARACHNOID HEMORRHAGE.kw.
12	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).tw,tx.
13	SAH?.tw,tx.
14	INTRACRANIAL ARTERIOVENOUS MALFORMATIONS.kw.
15	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).tw,tx.
16	(cerebr$ adj3 malform$).tw,tx.
17	AVM?.tw,tx.
18	(recurr$ adj3 h?emorrhag$).tw,tx.
19	(Cerebr$ adj3 accident?).tw,tx.
20	cva.tw,tx.
21	HEMIPLEGIA.kw.
22	hemiplegia?.tw,tx.
23	cavernoma?.tw,tx.
24	or/10-23
25	DELIVERY, OBSTETRIC.kw.

#	Searches
26	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or vacuum$ or ventouse?) adj5 (birth$ or born or deliver$))).tw,tx.
27	episiotom$.tw,tx.
28	((normal$ or assist$) adj5 (birth$ or born or deliver$)).tw,tx.
29	or/25-28
30	9 and 24 and 29
31	UK Obstetric Surveillance System.tw,tx.
32	UKOSS.tw,tx.
33	"Mothers and babies? reducing risk through audits and confidential enquiries across the UK".tw,tx.
34	MBRRACE.tw,tx.
35	Scottish confidential audit of severe maternal morbidity.tw,tx.
36	SCASMM.tw,tx.
37	or/31-36
38	30 or 37

Database: Health Technology Assessment

#	Searches
1	PREGNANCY/
2	PERIPARTUM PERIOD/
3	PARTURITION/
4	exp LABOR, OBSTETRIC/
5	OBSTETRIC LABOR, PREMATURE/
6	pregnan$.tw.
7	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).tw.
8	((during or giving or give) adj3 birth?).tw.
9	or/1-8
10	INTRACRANIAL HEMORRHAGES/
11	SUBARACHNOID HEMORRHAGE/
12	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).tw.
13	SAH?.tw.
14	INTRACRANIAL ARTERIOVENOUS MALFORMATIONS/
15	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).tw.
16	(cerebr$ adj3 malform$).tw.
17	AVM?.tw.
18	(recurr$ adj3 h?emorrhag$).tw.
19	(Cerebr$ adj3 accident?).tw.
20	cva.tw.
21	HEMIPLEGIA/
22	hemiplegia?.tw.
23	cavernoma?.tw.

#	Searches
24	or/10-23
25	exp DELIVERY, OBSTETRIC/
26	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or vacuum$ or ventouse?) adj5 (birth$ or born or deliver$))).tw.
27	episiotom$.tw.
28	((normal$ or assist$) adj5 (birth$ or born or deliver$)).tw.
29	or/25-28
30	9 and 24 and 29
31	UK Obstetric Surveillance System.tw.
32	UKOSS.tw.
33	"Mothers and babies? reducing risk through audits and confidential enquiries across the UK".tw.
34	MBRRACE.tw.
35	Scottish confidential audit of severe maternal morbidity.tw.
36	SCASMM.tw.
37	or/31-36
38	30 or 37

Database: Embase

#	Searches
1	*PREGNANCY/
2	*PERINATAL PERIOD/
3	exp *BIRTH/
4	exp *LABOR/
5	*PREMATURE LABOR/
6	*INTRAPARTUM CARE/
7	pregnan$.ti,ab.
8	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).ti,ab.
9	((during or giving or give) adj3 birth?).ti,ab.
10	or/1-9
11	*BRAIN HEMORRHAGE/
12	*SUBARACHNOID HEMORRHAGE/
13	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).ab,ti.
14	SAH?.ab,ti.
15	*CEREBROVASCULAR MALFORMATION/
16	*BRAIN ARTERIOVENOUS MALFORMATION/
17	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).ab,ti.
18	(cerebr$ adj3 malform$).ab,ti.
19	AVM?.ab,ti.
20	(recurr$ adj3 h?emorrhag$).ti,ab.
21	*CEREBROVASCULAR ACCIDENT/

#	Searches
22	(Cerebr$ adj3 accident?).ti,ab.
23	cva.ti,ab.
24	*HEMIPLEGIA/
25	hemiplegia?.ti,ab.
26	cavernoma?.ti,ab.
27	or/11-26
28	*DELIVERY/ or exp *INSTRUMENTAL DELIVERY/ or exp *LABOR INDUCTION/ or *LABOR MANAGEMENT/ or *NATURAL CHILDBIRTH/ or *VAGINAL DELIVERY/
29	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or vacuum$ or ventouse?) adj5 (birth$ or born or deliver$))).ti,ab.
30	episiotom$.ti,ab.
31	((normal$ or assist$) adj5 (birth$ or born or deliver$)).ti,ab.
32	or/28-31
33	10 and 27 and 32
34	UK Obstetric Surveillance System.ti,ab.
35	UKOSS.ti,ab.
36	"Mothers and babies? reducing risk through audits and confidential enquiries across the UK".ti,ab.
37	MBRRACE.ti,ab.
38	Scottish confidential audit of severe maternal morbidity.ti,ab.
39	SCASMM.ti,ab.
40	or/34-39
41	33 or 40
42	limit 41 to english language
43	letter.pt. or LETTER/
44	note.pt.
45	editorial.pt.
46	(letter or comment*).ti.
47	or/43-46
48	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
49	47 not 48
50	ANIMAL/ not HUMAN/
51	NONHUMAN/
52	exp ANIMAL EXPERIMENT/
53	exp EXPERIMENTAL ANIMAL/
54	ANIMAL MODEL/
55	exp RODENT/
56	(rat or rats or mouse or mice).ti.
57	or/49-56
58	42 not 57

Database: Web of Science - Conference Proceedings Citation Index – Science

#	Searches
1	TOPIC:(pregnan* or labo$r or childbirth or partu* or intra$part* or peri$part* or birth*)
2	TOPIC:(h?emorrhag* NEAR/5 (subarachnoid or intracranial*))
3	TOPIC:((Intracranial* or cerebral* or brain$) NEAR/5 (arteriovenous or arterio-venous) NEAR/5 malform*)
4	TOPIC:(cerebr* adj3 malform*)
5	TOPIC:(recurr* NEAR/5 (h?emorrhag*)
6	TOPIC:(SAH$ or AVM$ or cva or hemiplegia$ or cavernoma$)
7	TOPIC:(cerebr* adj3 accident$)
8	or/2-7
9	TOPIC:(cesar$an* Caesar$an* or c section* or csection* or (deliver* NEAR/3 abdom*))
10	TOPIC:((vagina* or cephalic* or forcep$ or induc* or extract* or vacuum* or ventouse$) NEAR/5 (birth* or born or deliver*))
11	TOPIC:(episiotom*)
12	TOPIC:((normal* or assist*) NEAR/5 (birth$ or born or deliver*))
13	or/9-12
14	1 and 8 and 13
15	TOPIC:“UK Obstetric Surveillance System”
16	TOPIC:"Mothers and babies$ reducing risk through audits and confidential enquiries across the UK"
17	TOPIC:“Scottish confidential audit of severe maternal morbidity”
18	TOPIC:(UKOSS or MBRRACE or SCASMM)
19	or/15-18
20	14 or 19

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

Database: Medline; Medline EPub Ahead of Print; and Medline In-Process & Other Non-Indexed Citations

#	Searches
1	INTRACRANIAL HEMORRHAGES/
2	SUBARACHNOID HEMORRHAGE/
3	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).ab,ti.
4	SAH?.ab,ti.
5	INTRACRANIAL ARTERIOVENOUS MALFORMATIONS/
6	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).ab,ti.
7	(cerebr$ adj3 malform$).ab,ti.
8	AVM?.ab,ti.
9	or/1-8
10	PERIPARTUM PERIOD/

#	Searches
11	PARTURITION/
12	exp LABOR, OBSTETRIC/
13	exp DELIVERY, OBSTETRIC/
14	OBSTETRIC LABOR, PREMATURE/
15	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).ti,ab.
16	((during or giving or give) adj3 birth?).ti,ab.
17	or/10-16
18	ANESTHESIA, OBSTETRICAL/
19	ANESTHESIA, SPINAL/
20	ANESTHESIA, EPIDURAL/
21	ANALGESIA, OBSTETRICAL/
22	ANALGESIA, EPIDURAL/
23	INJECTIONS, EPIDURAL/
24	((Spinal$ or spinous or obstetric$) adj3 (analges$ or an?esth$)).ti,ab.
25	epidural$.ti,ab.
26	CSE.ti,ab.
27	central neuraxial block$.ti,ab.
28	(neuraxial adj3 (analges$ or an?esth$ or technique? or procedur$)).ti,ab.
29	or/18-28
30	exp Pregnancy/
31	pregnan$.ti,ab.
32	or/30-31
33	exp DELIVERY, OBSTETRIC/
34	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or ventouse?) adj3 (birth$ or born or deliver$))).ti,ab.
35	episiotom$.ti,ab.
36	or/33-35
37	*PREGNANCY COMPLICATIONS, CARDIOVASCULAR/
38	9 and 17
39	9 and 29 and 32
40	9 and 36
41	9 and 37
42	or/38-41
43	limit 42 to english language
44	LETTER/
45	EDITORIAL/
46	NEWS/
47	exp HISTORICAL ARTICLE/
48	ANECDOTES AS TOPIC/
49	COMMENT/
50	CASE REPORT/

#	Searches
51	(letter or comment*).ti.
52	or/44-51
53	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
54	52 not 53
55	ANIMALS/ not HUMANS/
56	exp ANIMALS, LABORATORY/
57	exp ANIMAL EXPERIMENTATION/
58	exp MODELS, ANIMAL/
59	exp RODENTIA/
60	(rat or rats or mouse or mice).ti.
61	or/54-60
62	43 not 61

Database: Cochrane Central Register of Controlled Trials

#	Searches
1	INTRACRANIAL HEMORRHAGES/
2	SUBARACHNOID HEMORRHAGE/
3	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).ab,ti.
4	SAH?.ab,ti.
5	INTRACRANIAL ARTERIOVENOUS MALFORMATIONS/
6	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).ab,ti.
7	(cerebr$ adj3 malform$).ab,ti.
8	AVM?.ab,ti.
9	or/1-8
10	PERIPARTUM PERIOD/
11	PARTURITION/
12	exp LABOR, OBSTETRIC/
13	exp DELIVERY, OBSTETRIC/
14	OBSTETRIC LABOR, PREMATURE/
15	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).ti,ab,kw.
16	((during or giving or give) adj3 birth?).ti,ab.
17	or/10-16
18	ANESTHESIA, OBSTETRICAL/
19	ANESTHESIA, SPINAL/
20	ANESTHESIA, EPIDURAL/
21	ANALGESIA, OBSTETRICAL/
22	ANALGESIA, EPIDURAL/
23	INJECTIONS, EPIDURAL/
24	((Spinal$ or spinous or obstetric$) adj3 (analges$ or an?esth$)).ti,ab.
25	epidural$.ti,ab,kw.

#	Searches
26	CSE.ti,ab.
27	central neuraxial block$.ti,ab,kw.
28	(neuraxial adj3 (analges$ or an?esth$ or technique? or procedur$)).ti,ab.
29	or/18-28
30	exp Pregnancy/
31	pregnan$.ti,ab,kw.
32	or/30-31
33	exp DELIVERY, OBSTETRIC/
34	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or ventouse?) adj3 (birth$ or born or deliver$))).ti,ab.
35	episiotom$.ti,ab,kw.
36	or/33-35
37	*PREGNANCY COMPLICATIONS, CARDIOVASCULAR/
38	9 and 17
39	9 and 29 and 32
40	9 and 36
41	9 and 37
42	or/38-41

Database: Cochrane Database of Systematic Reviews

#	Searches
1	INTRACRANIAL HEMORRHAGES.kw.
2	SUBARACHNOID HEMORRHAGE.kw.
3	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).ab,ti.
4	SAH?.ab,ti.
5	INTRACRANIAL ARTERIOVENOUS MALFORMATIONS.kw.
6	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).ab,ti.
7	(cerebr$ adj3 malform$).ab,ti.
8	AVM?.ab,ti.
9	or/1-8
10	PERIPARTUM PERIOD.kw.
11	PARTURITION.kw.
12	LABOR, OBSTETRIC.kw.
13	DELIVERY, OBSTETRIC.kw.
14	OBSTETRIC LABOR, PREMATURE.kw.
15	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).ti,ab.
16	((during or giving or give) adj3 birth?).ti,ab.
17	or/10-16
18	ANESTHESIA, OBSTETRICAL.kw.
19	ANESTHESIA, SPINAL.kw.
20	ANESTHESIA, EPIDURAL.kw.

#	Searches
21	ANALGESIA, OBSTETRICAL.kw.
22	ANALGESIA, EPIDURAL.kw.
23	INJECTIONS, EPIDURAL.kw.
24	((Spinal$ or spinous or obstetric$) adj3 (analges$ or an?esth$)).ti,ab.
25	epidural$.ti,ab.
26	CSE.ti,ab.
27	central neuraxial block$.ti,ab.
28	(neuraxial adj3 (analges$ or an?esth$ or technique? or procedur$)).ti,ab.
29	or/18-28
30	Pregnancy.kw.
31	pregnan$.ti,ab.
32	or/30-31
33	DELIVERY, OBSTETRIC.kw.
34	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or ventouse?) adj3 (birth$ or born or deliver$))).ti,ab.
35	episiotom$.ti,ab.
36	or/33-35
37	PREGNANCY COMPLICATIONS, CARDIOVASCULAR.kw.
38	9 and 17
39	9 and 29 and 32
40	9 and 36
41	9 and 37
42	or/38-41

Database: Database of Abstracts of Reviews of Effects

#	Searches
1	INTRACRANIAL HEMORRHAGES.kw.
2	SUBARACHNOID HEMORRHAGE.kw.
3	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).tw,tx.
4	SAH?.tw,tx.
5	INTRACRANIAL ARTERIOVENOUS MALFORMATIONS.kw.
6	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).tw,tx.
7	(cerebr$ adj3 malform$).tw,tx.
8	AVM?.tw,tx.
9	or/1-8
10	PERIPARTUM PERIOD.kw.
11	PARTURITION.kw.
12	LABOR, OBSTETRIC.kw.
13	DELIVERY, OBSTETRIC.kw.
14	OBSTETRIC LABOR, PREMATURE.kw.

#	Searches
15	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).tw,tx.
16	((during or giving or give) adj3 birth?).tw,tx.
17	or/10-16
18	ANESTHESIA, OBSTETRICAL.kw.
19	ANESTHESIA, SPINAL.kw.
20	ANESTHESIA, EPIDURAL.kw.
21	ANALGESIA, OBSTETRICAL.kw.
22	ANALGESIA, EPIDURAL.kw.
23	INJECTIONS, EPIDURAL.kw.
24	((Spinal$ or spinous or obstetric$) adj3 (analges$ or an?esth$)).tw,tx.
25	epidural$.tw,tx.
26	CSE.tw,tx.
27	central neuraxial block$.tw,tx.
28	(neuraxial adj3 (analges$ or an?esth$ or technique? or procedur$)).tw,tx.
29	or/18-28
30	Pregnancy.kw.
31	pregnan$.tw,tx.
32	or/30-31
33	DELIVERY, OBSTETRIC.kw.
34	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or ventouse?) adj3 (birth$ or born or deliver$))).tw,tx.
35	episiotom$.tw,tx.
36	or/33-35
37	PREGNANCY COMPLICATIONS, CARDIOVASCULAR.kw.
38	9 and 17
39	9 and 29 and 32
40	9 and 36
41	9 and 37
42	or/38-41

Database: Health Technology Assessment

#	Searches
1	INTRACRANIAL HEMORRHAGES/
2	SUBARACHNOID HEMORRHAGE/
3	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).tw.
4	SAH?.tw.
5	INTRACRANIAL ARTERIOVENOUS MALFORMATIONS/
6	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).tw.
7	(cerebr$ adj3 malform$).tw.
8	AVM?.tw.
9	or/1-8

#	Searches
10	PERIPARTUM PERIOD/
11	PARTURITION/
12	exp LABOR, OBSTETRIC/
13	exp DELIVERY, OBSTETRIC/
14	OBSTETRIC LABOR, PREMATURE/
15	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).tw.
16	((during or giving or give) adj3 birth?).tw.
17	or/10-16
18	ANESTHESIA, OBSTETRICAL/
19	ANESTHESIA, SPINAL/
20	ANESTHESIA, EPIDURAL/
21	ANALGESIA, OBSTETRICAL/
22	ANALGESIA, EPIDURAL/
23	INJECTIONS, EPIDURAL/
24	((Spinal$ or spinous or obstetric$) adj3 (analges$ or an?esth$)).tw.
25	epidural$.tw.
26	CSE.tw.
27	central neuraxial block$.tw.
28	(neuraxial adj3 (analges$ or an?esth$ or technique? or procedur$)).tw.
29	or/18-28
30	exp Pregnancy/
31	pregnan$.tw.
32	or/30-31
33	exp DELIVERY, OBSTETRIC/
34	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or ventouse?) adj3 (birth$ or born or deliver$))).tw.
35	episiotom$.tw.
36	or/33-35
37	*PREGNANCY COMPLICATIONS, CARDIOVASCULAR/
38	9 and 17
39	9 and 29 and 32
40	9 and 36
41	9 and 37
42	or/38-41

Database: Embase

#	Searches
1	*BRAIN HEMORRHAGE/
2	*SUBARACHNOID HEMORRHAGE/
3	(h?emorrhag$ adj3 (subarachnoid or intracranial$)).ab,ti.
4	SAH?.ab,ti.

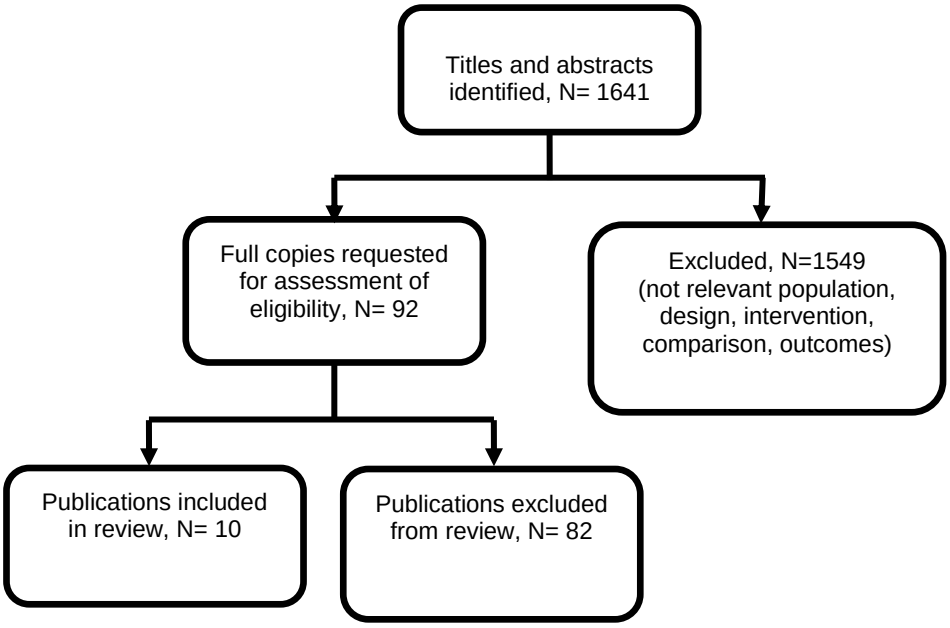
#	Searches
5	*CEREBROVASCULAR MALFORMATION/
6	*BRAIN ARTERIOVENOUS MALFORMATION/
7	((Intracranial$ or cerebr$ or brain?) adj5 (arteriovenous or arterio-venous) adj3 malform$).ab,ti.
8	(cerebr$ adj3 malform$).ab,ti.
9	AVM?.ab,ti.
10	or/1-9
11	*PERINATAL PERIOD/
12	exp *BIRTH/
13	exp *LABOR/
14	exp *DELIVERY/
15	*PREMATURE LABOR/
16	*INTRAPARTUM CARE/
17	(labo?r or childbirth or partu$ or intra?part$ or peri?part$).ti,ab.
18	((during or giving or give) adj3 birth?).ti,ab.
19	or/11-18
20	*OBSTETRIC ANESTHESIA/
21	*SPINAL ANESTHESIA/
22	*EPIDURAL ANESTHESIA/
23	*OBSTETRIC ANALGESIA/
24	*EPIDURAL DRUG ADMINISTRATION/
25	((Spinal$ or spinous or obstetric$) adj3 (analges$ or an?esth$)).ti,ab.
26	epidural$.ti,ab.
27	CSE.ti,ab.
28	central neuraxial block$.ti,ab.
29	(neuraxial adj3 (analges$ or an?esth$ or technique? or procedur$)).ti,ab.
30	or/20-29
31	*DELIVERY/ or exp *INSTRUMENTAL DELIVERY/ or exp *LABOR INDUCTION/ or *LABOR MANAGEMENT/ or *NATURAL CHILDBIRTH/ or *VAGINAL DELIVERY/
32	(c?esar#an$ or c section$ or csection$ or (deliver$ adj3 abdom$) or ((vagina$ or cephalic$ or forcep? or induc$ or extract$ or ventouse?) adj3 (birth$ or born or deliver$))).ti,ab.
33	episiotom$.ti,ab.
34	or/31-33
35	30 or 34
36	*PREGNANCY COMPLICATION/
37	10 and 19 and 35
38	10 and 36
39	or/37-38
40	limit 39 to english language
41	letter.pt. or LETTER/
42	note.pt.
43	editorial.pt.

#	Searches
44	CASE REPORT/ or CASE STUDY/
45	(letter or comment*).ti.
46	or/41-45
47	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
48	46 not 47
49	ANIMAL/ not HUMAN/
50	NONHUMAN/
51	exp ANIMAL EXPERIMENT/
52	exp EXPERIMENTAL ANIMAL/
53	ANIMAL MODEL/
54	exp RODENT/
55	(rat or rats or mouse or mice).ti.
56	or/48-55
57	40 not 56

Appendix C – Clinical evidence study selection

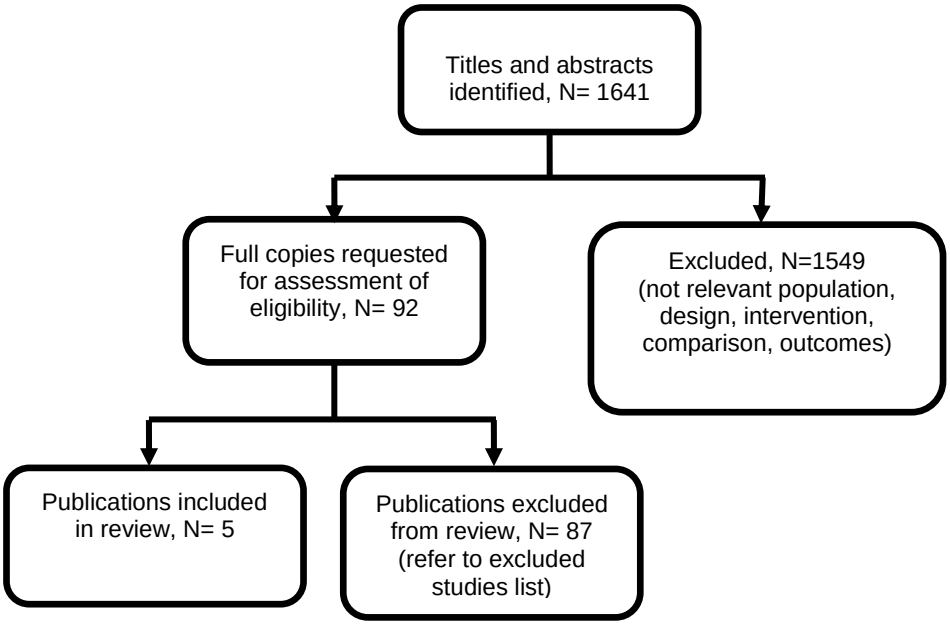
Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

Figure 1: Flow diagram of clinical article selection for intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth



Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

Figure 2: Flow diagram of clinical article selection for intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour



Appendix D – Excluded studies

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

Clinical studies

Study	Reason for exclusion
Agarwal, N., Guerra, J. C., Gala, N. B., Agarwal, P., Zouzias, A., Gandhi, C. D., Prestigiacomo, C. J., Current treatment options for cerebral arteriovenous malformations in pregnancy: a review of the literature, World Neurosurgery, 81, 83-90, 2014	Systematic review - with no relevant articles to include
Anonymous,, Maternal deaths due to stroke, Ohio State Medical Journal, 70, 172-174, 1974	Less than five case reports included in the article
Arnold, M., Camus-Jacqmin, M., Stapf, C., Ducros, A., Viswanathan, A., Berthet, K., Bousser, M. G., Postpartum cervicocephalic artery dissection, Stroke, 39, 2377-2379, 2008	No relevant comparison. No details regarding mode of birth
Barnes, J. E., Abbott, K. H., Cerebral complications incurred during pregnancy and the puerperium, American Journal of Obstetrics and Gynecology, 82, 192-207, 1961	Less than five cases included in the article
Barno, A., Freeman, D. W., Maternal deaths due to spontaneous subarachnoid hemorrhage, American Journal of Obstetrics & Gynecology, 125, 384-92, 1976	Population do not meet the inclusion criteria
Bashiri, A., Lazer, T., Burstein, E., Smolin, A., Lazer, S., Perry, Z. H., Mazor, M., Maternal and neonatal outcome following cerebrovascular accidents during pregnancy, Journal of Maternal-Fetal & Neonatal Medicine, 20, 241-7, 2007	Population do not meet the inclusion criteria- women have no history of AVM
Bateman,B.T., Olbrecht,V.A., Berman,M.F., Minehart,R.D., Schwamm,L.H., Leffert,L.R., Peripartum subarachnoid hemorrhage: nationwide data and institutional experience, Anesthesiology, 116, 324-333, 2012	No information regarding mode of birth
Block, H. S., Neurological Complications of Pregnancy, Current Neurology & Neuroscience Reports, 16, 67, 2016	Narrative literature review
Bryans, F. E., Vascular Accidents in Maternal Mortality, Clinical Obstetrics and Gynecology, 30, 861-873, 1963	Narrative literature review
Buckley, T. A., Yau, G. H., Poon, W. S., Oh, T., Caesarean section and ablation of a cerebral arterio-venous malformation, Anaesthesia & Intensive Care, 18, 248-51, 1990	Less than five case reports included in the article
Cantu-Brito, C., Arauz, A., Aburto, Y., Barinagarrementeria, F., Ruiz-Sandoval, J. L., Baizabal-Carvallo, J. F., Cerebrovascular	Outcomes not disaggregated by mode of birth

Study	Reason for exclusion
complications during pregnancy and postpartum: clinical and prognosis observations in 240 Hispanic women, European Journal of Neurology, 18, 819-25, 2011	
Christensen, E., Larsen, H., Fatal subarachnoid haemorrhages in pregnant women with intracranial and, Acta psychiatrica et neurologica Scandinavica, 29, 441-451, 1954	Less than five case reports included in the article
Coppage,K.H., Hinton,A.C., Moldenhauer,J., Kovilam,O., Barton,J.R., Sibai,B.M., Maternal and perinatal outcome in women with a history of stroke, American Journal of Obstetrics and Gynecology, 190, 1331-1334, 2004	Outcome data not disaggregated by mode of birth
Decker, A., Rowe, E. C., Subarachnoid hemorrhage complicating pregnancy, American journal of surgery, 85, 561-563, 1953	Less than five case reports included in the article
Dias, M. S., Neurovascular emergencies in pregnancy, Clinical Obstetrics & Gynecology, 37, 337-54, 1994	Narrative literature review
Dias, M. S., Sekhar, L. N., Intracranial hemorrhage from aneurysms and arteriovenous malformations during pregnancy and the puerperium, Neurosurgery, 27, 855-65; discussion 865-6, 1990	Review of individual case reports
Donaldson, J. O., Stroke, Clinical Obstetrics & Gynecology, 24, 825-35, 1981	Narrative literature review
Dunn, J. M., Raskind, R., Rupture of a cerebral arteriovenous malformation during pregnancy, Obstetrics & Gynecology, 30, 423-6, 1967	Less than five case reports included in the article
Dunn, J. M., Weiss, S. R., Raskind, R., Rupture of intracranial arteriovenous malformation in pregnancy, International Surgery, 49, 241-7, 1968	Less than five case reports included in the article
Elias,M., Abouleish,E., Bhandari,A., Arteriovenous malformation during pregnancy and labor--case review and management, Middle East Journal of Anesthesiology, 16, 231-237, 2001	Less than five case reports included in the article
Fairhall, J. M., Stoodley, M. A., Intracranial haemorrhage in pregnancy, Obstetric Medicine, 2, 142-8, 2009	Narrative literature review
Fayle, R. J. S., Armatage, R. J., Pregnancy in patients with moyamoya disease, Journal of Obstetrics and Gynaecology, 12, 173-176, 1992	Unable to extract outcome data for mode of birth
Foo, L., Bewley, S., Rudd, A., Maternal death from stroke: a thirty year national retrospective review, European Journal of Obstetrics, Gynecology, & Reproductive Biology, 171, 266-70, 2013	No information regarding mode of birth
Forster, D. M., Kunkler, I. H., Hartland, P., Risk of cerebral bleeding from arteriovenous malformations in pregnancy: the Sheffield	Unable to extract outcome data for mode of birth

Study	Reason for exclusion
experience, Stereotactic & Functional Neurosurgery, 61 Suppl 1, 20-2, 1993	
Freedman, R. L., Lucas, D. N., MBRRACE-UK: saving lives, improving mothers' care - implications for anaesthetists, International Journal of Obstetric Anesthesia, 24, 161-73, 2015	Commentary paper
Gibbs, C. E., Maternal death due to stroke, American Journal of Obstetrics and Gynecology, 119, 69-75, 1974	No information regarding mode of birth
Graham,J.G., Neurological complications of pregnancy and anaesthesia, Clinics in Obstetrics and Gynaecology, 9, 333-350, 1982	Narrative literature review
Groenestege, A. T. T., Rinkel, G. J. E., Van Der Bom, J. G., Algra, A., Klijn, C. J. M., The risk of aneurysmal subarachnoid hemorrhage during pregnancy, delivery, and the puerperium in the utrecht population case-crossover study and standardized incidence ratio estimation, Stroke, 40, 1148-1151, 2009	No relevant comparison. And insufficient number of women with history of intracranial haemorrhage
Gross, B. A., Du, R., Hemorrhage from arteriovenous malformations during pregnancy, Neurosurgery, 71, 349-55; discussion 355-6, 2012	No information regarding mode of birth for the majority of women
Heidrich, R., Niedner, K., Pregnancy and subarachnoid haemorrhage, European Neurology, 3, 38-49, 1970	Narrative literature review plus case report - less than five cases included
Heiskanen, O., Nikki, P., Rupture of intracranial arterial aneurysm during pregnancy, Acta neurologica Scandinavica, 39, 202-208, 1963	Population do not meet inclusion criteria - women do not have a history of SAH or vascular malformation
Hunt, H. B., Schifrin, B. S., Suzuki, K., Ruptured berry aneurysms and pregnancy, Obstetrics & Gynecology, 43, 827-37, 1974	Narrative literature review plus case report - less than five cases included
Jaigobin, C., Silver, F. L., Stroke and pregnancy, Stroke, 31, 2948-51, 2000	No information regarding mode of birth
Jarvinen, P. A., Huhmar, E., Non-toxemic subarachnoid hemorrhage during pregnancy, delivery, or puerperium, Annales Chirurgiae et Gynaecologiae Fenniae, 43, 85-94, 1954	Narrative literature review plus case report - less than five cases included
Kalani, M. Y., Zabramski, J. M., Risk for symptomatic hemorrhage of cerebral cavernous malformations during pregnancy, Journal of Neurosurgery, 118, 50-5, 2013	Population do not meet the inclusion criteria - women had cerebral cavernous malformations
Kamrin, R. P., Masland, W., Intracranial Surgery under Hypothermia during Pregnancy, Archives of Neurology, 13, 70-76, 1965	Narrative literature review plus case report - less than five cases included
Karjalainen, A. O., Spontaneous subarachnoid haemorrhage in pregnancy, Annales Chirurgiae et Gynaecologiae Fenniae, 54, 437-42, 1965	Less than five case reports included in the article
Kataoka, H., Miyoshi, T., Neki, R., Yoshimatsu, J., Ishibashi-Ueda, H., Iihara, K., Subarachnoid hemorrhage from intracranial aneurysms during	Less than five case reports included in the article

Study	Reason for exclusion
pregnancy and the puerperium, Neurologia Medico-Chirurgica, 53, 549-54, 2013	
Kemp, B., Knight, M., Maternal mortality in the UK: An update, Obstetrics, Gynaecology and Reproductive Medicine, 26, 26-28, 2016	Commentary paper
Kim, Y. W., Neal, D., Hoh, B. L., Cerebral aneurysms in pregnancy and delivery: pregnancy and delivery do not increase the risk of aneurysm rupture, Neurosurgery, 72, 143-9; discussion 150, 2013	Outcomes not disaggregated by mode of birth
Kuklina, E. V., Tong, X., Bansil, P., George, M. G., Callaghan, W. M., Trends in pregnancy hospitalizations that included a stroke in the United States from 1994 to 2007: reasons for concern?, Stroke, 42, 2564-70, 2011	No information regarding mode of birth
Liang, Z. W., Lin, L., Gao, W. L., Feng, L. M., A clinical characteristic analysis of pregnancy-associated intracranial haemorrhage in China, Scientific reports, 5, 9509, 2015	No information regarding mode of birth
Liu, X. J., Zhang, D., Wang, S., Zhao, Y. L., Ye, X., Rong, W., Yong, C., Kang, S., Zhao, J. Z., Intracranial hemorrhage from moyamoya disease during pregnancy and puerperium, International Journal of Gynaecology & Obstetrics, 125, 150-3, 2014	No information regarding mode of birth
Lv, X., Liu, P., Li, Y., The clinical characteristics and treatment of cerebral AVM in pregnancy, Neuroradiology Journal, 28, 234-7, 2015	Narrative literature review
Lv, X., Liu, P., Li, Y., Pre-existing, incidental and hemorrhagic AVMs in pregnancy and postpartum: Gestational age, morbidity and mortality, management and risk to the fetus, Interventional Neuroradiology, 22, 206-11, 2016	Unable to extract data for mode of birth
Lv, Xianli, Li, Wei, He, Hongwei, Jiang, Chuhan, Li, Youxiang, Known and unknown cerebral arteriovenous malformations in pregnancies: haemorrhage risk and influence on obstetric management, The neuroradiology journal, 30, 437-441, 2017	Data presented were not sufficiently clear for data extraction
Lv, Xianli, Li, Youxiang, The clinical characteristics and treatment of cerebral AVM in pregnancy, The neuroradiology journal, 28, 385-8, 2015	Narrative literature review
Lv, Xianli, Liu, Peng, Li, Youxiang, Pre-existing, incidental and hemorrhagic AVMs in pregnancy and postpartum: Gestational age, morbidity and mortality, management and risk to the fetus, Interventional neuroradiology : journal of peritherapeutic neuroradiology, surgical procedures and related neurosciences, 22, 206-11, 2016	Data presented were not sufficiently clear for data extraction

Study	Reason for exclusion
Macintyre, M. M., Neurosurgical emergency in early pregnancy, Nursing Times, 70, 1572-5, 1974	Less than five case reports included in the article
Maheshwari, M. C., Bhargava, S., Evaluation of peripartum strokes by computed tomography, Clinical Radiology, 34, 633-637, 1983	Not information regarding mode of birth
Marx,G.F., Obstetric anesthesia in the presence of medical complications, Clinical Obstetrics and Gynecology, 17, 165-181, 1974	Narrative Literature review
Miller, E. C., Yaghi, S., Boehme, A. K., Willey, J. Z., Elkind, M. S. V., Marshall, R. S., Mechanisms and outcomes of stroke during pregnancy and the postpartum period, Neurology: Clinical Practice, 6, 29-39, 2016	No information regarding mode of birth
Nornes, H., Lundar, T., Wikeby, P., Cerebral arteriovenous malformations; results of microsurgical management, Acta Neurochirurgica, 50, 243-57, 1979	Population not relevant - only two pregnant women were included
Pool, J. L., Treatment of Intracranial Aneurysms during Pregnancy, JAMA : the journal of the American Medical Association, 192, 209-214, 1965	Review of individual case reports
Porras, J. L., Yang, W., Philadelphia, E., Law, J., Garzon-Muvdi, T., Caplan, J. M., Colby, G. P., Coon, A. L., Tamargo, R. J., Huang, J., Hemorrhage Risk of Brain Arteriovenous Malformations during Pregnancy and Puerperium in a North American Cohort, Stroke, 48, 1507-1513, 2017	Data presented were not sufficiently clear enough for data extraction
Reichman, O. H., Karlman, R. L., Berry aneurysm, Surgical Clinics of North America, 75, 115-21, 1995	Narrative literature review
Robinson, J. L., Hall, C. J., Some aspects of subarachnoid haemorrhage in pregnancy, Journal of Neurology, Neurosurgery & Psychiatry, 34, 109, 1971	Outcome data not disaggregated by mode of birth
Robinson, J. L., Hall, C. J., Sedzimir, C. B., Subarachnoid hemorrhage in pregnancy, Journal of Neurosurgery, 36, 27-33, 1972	Unable to extract data for mode of birth
Robinson, J. L., Hall, C. S., Sedzimir, C. B., Arteriovenous malformations, aneurysms, and pregnancy, Journal of Neurosurgery, 41, 63-70, 1974	Outcome data not disaggregated by mode of birth
Roman, H., Descargues, G., Lopes, M., Emery, E., Clavier, E., Diguet, A., Freger, P., Marpeau, L., Proust, F., Subarachnoid hemorrhage due to cerebral aneurysmal rupture during pregnancy, Acta Obstetricia et Gynecologica Scandinavica, 83, 330-4, 2004	Less than five case reports included in the article
Samad, K., Hasan, S. F., Hoda, M. Q., Anesthetic management of combined caesarean section and clipping of ruptured cerebral aneurysm.[Erratum	Less than five case reports included in the article

Study	Reason for exclusion
appears in J Pak Med Assoc. 2004 Sep;54(9):497 Note: Hoda, S F [corrected to Hasan, S F]], JPMA - Journal of the Pakistan Medical Association, 54, 330-2, 2004	
Scott,C.A., Bewley,S., Rudd,A., Spark,P., Kurinczuk,J.J., Brocklehurst,P., Knight,M., Incidence, risk factors, management, and outcomes of stroke in pregnancy, Obstetrics and Gynecology, 120, 318-324, 2012	Outcome data not disaggregated by mode of birth
Scudamore, J. H., Moir, J. C., Rupture of an intracranial aneurysm during pregnancy, Journal of Obstetrics & Gynaecology of the British Commonwealth, 73, 1019-20, 1966	Less than five case reports included in the article
Seeho, S. K. M., Austin, K., Ibiebele, I., Ford, J. B., Torvaldsen, S., Pregnancy outcomes in women with a history of stroke, Journal of Paediatrics and Child Health, 54, 46, 2018	Conference abstract
Simonazzi, G., Curti, A., Rapacchia, G., Gabrielli, S., Pilu, G., Rizzo, N., Pozzati, E., Symptomatic cerebral cavernomas in pregnancy: a series of 6 cases and review of the literature, Journal of Maternal-Fetal & Neonatal Medicine, 27, 261-4, 2014	Population do not meet inclusion criteria
Spaargaren, L., Ozsarlak, O., Van Goethem, J. W., Parizel, P. M., Intraventricular hemorrhage due to left frontal lobe arteriovenous malformation, Jbr-Btr: Organe de la Societe Royale Belge de Radiologie, 86, 170-1, 2003	Less than five case reports included in the article
Speck, G., Rupture of an aneurysm of the circle of Willis complicating pregnancy, Virginia medical monthly, 81, 270-272, 1954	Less than five case reports included in the article
Srinivasan, K., Cerebral venous and arterial thrombosis in pregnancy and puerperium. A study of 135 patients, Angiology, 34, 731-46, 1983	Population do not meet inclusion criteria
Srinivasan, K., Natarajan, M., Cerebral venous and arterial thrombosis in pregnancy and puerperium. A study of 90 patients, Neurology India, 22, 131-140, 1974	Population do not meet inclusion criteria
Stoodley, M. A., Macdonald, R. L., Weir, B. K., Pregnancy and intracranial aneurysms, Neurosurgery Clinics of North America, 9, 549-56, 1998	Narrative literature review
Takahashi, J. C., Iihara, K., Ishii, A., Watanabe, E., Ikeda, T., Miyamoto, S., Pregnancy-associated intracranial hemorrhage: results of a survey of neurosurgical institutes across Japan, Journal of Stroke & Cerebrovascular Diseases, 23, e65-71, 2014	Unable to extract outcome data
Trodella, G. F., Pregnancy complicated by subarachnoid hemorrhage, American Journal of Obstetrics and Gynecology, 63, 1377-1378, 1952	Less than five case reports included in the article

Study	Reason for exclusion
Tuttelman, R. M., Gleicher, N., Central nervous system hemorrhage complicating pregnancy, Obstetrics & Gynecology, 58, 651-7, 1981	Less than five case reports included in the article
Warren, T. M., Fletcher, M., Anaesthetic management of the obstetric patient with neurological disease, Clinics in Anaesthesiology, 4, 291-304, 1986	Narrative literature review
Wiebers, D. O., Subarachnoid hemorrhage in pregnancy, Seminars in Neurology, 8, 226-9, 1988	Narrative literature review
Wiebers, D. O., Whisnant, J. P., The incidence of stroke among pregnant women in Rochester, Minn, 1955 through 1979, JAMA, 254, 3055-7, 1985	A full text copy of the article could not be obtained
Wilterdink, J. L., Feldmann, E., Cerebral hemorrhage, Advances in Neurology, 64, 13-23, 1994	Narrative literature review
Wilterdink, J. L., Feldmann, E., Intracranial hemorrhage, Advances in Neurology, 90, 63-74, 2002	Narrative literature review
Witiw, C. D., Abou-Hamden, A., Kulkarni, A. V., Silvaggio, J. A., Schneider, C., Wallace, M. C., Cerebral cavernous malformations and pregnancy: hemorrhage risk and influence on obstetrical management, Neurosurgery, 71, 626-30; discussion 631, 2012	Unable to extract outcome data for mode of birth
Wlody, D., The critically ill parturient: Subarachnoid hemorrhage, mitral stenosis, and postpartum hemorrhage, Progress in Anesthesiology, 11, 415-424, 1997	A full text copy of the article could not be obtained
Yahalom, G., Yagoda, A., Hoffmann, C., Dollberg, O., Gadoth, N., Multiple cavernomatosis presenting during pregnancy, Israel Medical Association Journal: Imaj, 14, 450-1, 2012	Less than five case reports included in the article
Zofkie, A., Cunningham, F. G., 33-Year single center experience with pregnancy-associated strokes, American Journal of Obstetrics and Gynecology, 218, S476-S477, 2018	Conference abstract

Economic studies

See Supplement 2 (Health economics) for details of economic evidence reviews and health economic modelling.

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

Clinical studies

Study	Reason for exclusion
Agarwal, N., Guerra, J. C., Gala, N. B., Agarwal, P., Zouzias, A., Gandhi, C. D., Prestigiacomo, C. J., Current treatment options for cerebral arteriovenous malformations in pregnancy: a review of the literature, World Neurosurgery, 81, 83-90, 2014	Systematic review - with no relevant articles included
Anonymous,, Maternal deaths due to stroke, Ohio State Medical Journal, 70, 172-174, 1974	Less than five case reports included in the article
Arnold, M., Camus-Jacqmin, M., Stapf, C., Ducros, A., Viswanathan, A., Berthet, K., Bousser, M. G., Postpartum cervicocephalic artery dissection, Stroke, 39, 2377-2379, 2008	No relevant intervention or comparison, no information regarding mode of birth
Barnes, J. E., Abbott, K. H., Cerebral complications incurred during pregnancy and the puerperium, American Journal of Obstetrics and Gynecology, 82, 192-207, 1961	Less than five case reports included in article
Barno, A., Freeman, D. W., Maternal deaths due to spontaneous subarachnoid hemorrhage, American Journal of Obstetrics & Gynecology, 125, 384-92, 1976	Systematic review - with no relevant articles included
Bashiri, A., Lazer, T., Burstein, E., Smolin, A., Lazer, S., Perry, Z. H., Mazor, M., Maternal and neonatal outcome following cerebrovascular accidents during pregnancy, Journal of Maternal-Fetal & Neonatal Medicine, 20, 241-7, 2007	Population do not meet inclusion criteria
Bateman,B.T., Olbrecht,V.A., Berman,M.F., Minehart,R.D., Schwamm,L.H., Leffert,L.R., Peripartum subarachnoid hemorrhage: nationwide data and institutional experience, Anesthesiology, 116, 324-333, 2012	Intervention and comparison not relevant
Block, H. S., Neurological Complications of Pregnancy, Current Neurology & Neuroscience Reports, 16, 67, 2016	Narrative literature review
Bryans, F. E., Vascular Accidents in Maternal Mortality, Clinical Obstetrics and Gynecology, 30, 861-873, 1963	Narrative literature review
Buckley, T. A., Yau, G. H., Poon, W. S., Oh, T., Caesarean section and ablation of a cerebral arterio-venous malformation, Anaesthesia & Intensive Care, 18, 248-51, 1990	Less than five case reports included in the article
Cantu-Brito, C., Arauz, A., Aburto, Y., Barinagarrementeria, F., Ruiz-Sandoval, J. L., Baizabal-Carvallo, J. F., Cerebrovascular complications during pregnancy and postpartum: clinical and prognosis observations in 240 Hispanic women, European Journal of Neurology, 18, 819-25, 2011	Outcomes were not disaggregated by management of the second stage of labour

Study	Reason for exclusion
Christensen, E., Larsen, H., Fatal subarachnoid haemorrhages in pregnant women with intracranial and, Acta psychiatrica et neurologica Scandinavica, 29, 441-451, 1954	Less than five case reports included in the article
Coppage,K.H., Hinton,A.C., Moldenhauer,J., Kovilam,O., Barton,J.R., Sibai,B.M., Maternal and perinatal outcome in women with a history of stroke, American Journal of Obstetrics and Gynecology, 190, 1331-1334, 2004	Outcome data were not disaggregated by management of the second stage of labour
Decker, A., Rowe, E. C., Subarachnoid hemorrhage complicating pregnancy, American journal of surgery, 85, 561-563, 1953	Less than five case reports included in the article
Dias, M. S., Neurovascular emergencies in pregnancy, Clinical Obstetrics & Gynecology, 37, 337-54, 1994	Narrative literature review
Dias, M. S., Sekhar, L. N., Intracranial hemorrhage from aneurysms and arteriovenous malformations during pregnancy and the puerperium, Neurosurgery, 27, 855-65; discussion 865-6, 1990	Review of individual case reports
Donaldson, J. O., Stroke, Clinical Obstetrics & Gynecology, 24, 825-35, 1981	Narrative literature review
Dunn, J. M., Raskind, R., Rupture of a cerebral arteriovenous malformation during pregnancy, Obstetrics & Gynecology, 30, 423-6, 1967	Less than five case reports included in the article
Dunn, J. M., Weiss, S. R., Raskind, R., Rupture of intracranial arteriovenous malformation in pregnancy, International Surgery, 49, 241-7, 1968	Less than five case reports included in the article
Elias,M., Abouleish,E., Bhandari,A., Arteriovenous malformation during pregnancy and labor--case review and management, Middle East Journal of Anesthesiology, 16, 231-237, 2001	Less than five case reports included in the article
Fairhall, J. M., Stoodley, M. A., Intracranial haemorrhage in pregnancy, Obstetric Medicine, 2, 142-8, 2009	Narrative literature review
Fayle, R. J. S., Armatage, R. J., Pregnancy in patients with moyamoya disease, Journal of Obstetrics and Gynaecology, 12, 173-176, 1992	Unable to extract outcome data for individual management of the second stage of labour
Foo, L., Bewley, S., Rudd, A., Maternal death from stroke: a thirty year national retrospective review, European Journal of Obstetrics, Gynecology, & Reproductive Biology, 171, 266-70, 2013	Outcome data were not disaggregated by management of the second stage of labour
Forster, D. M., Kunkler, I. H., Hartland, P., Risk of cerebral bleeding from arteriovenous malformations in pregnancy: the Sheffield experience, Stereotactic & Functional Neurosurgery, 61 Suppl 1, 20-2, 1993	Unable to extract outcome data for individual management of the second stage of labour
Freedman, R. L., Lucas, D. N., MBRRACE-UK: saving lives, improving mothers' care -	Commentary paper

Study	Reason for exclusion
implications for anaesthetists, International Journal of Obstetric Anesthesia, 24, 161-73, 2015	
Fukuda,K., Hamano,E., Nakajima,N., Katsuragi,S., Ikeda,T., Takahashi,J.C., Miyamoto,S., Iihara,K., Pregnancy and delivery management in patients with cerebral arteriovenous malformation: A single-center experience, Neurologia Medico-Chirurgica, 53, 565-570, 2013	Less than five case reports included in the article
Fukushima, K., Yumoto, Y., Kondo, Y., Fujita, Y., Morokuma, S., Tsukimori, K., Wake, N., A retrospective chart review of the perinatal period in 22 pregnancies of 16 women with Moyamoya disease, Journal of Clinical Neuroscience, 19, 1358-62, 2012	Less than five case reports included in the article
Gibbs, C. E., Maternal death due to stroke, American Journal of Obstetrics and Gynecology, 119, 69-75, 1974	Intervention and comparator not relevant - no information on the second stage of labour
Graham,J.G., Neurological complications of pregnancy and anaesthesia, Clinics in Obstetrics and Gynaecology, 9, 333-350, 1982	Narrative literature review
Groenestege, A. T. T., Rinkel, G. J. E., Van Der Bom, J. G., Algra, A., Klijn, C. J. M., The risk of aneurysmal subarachnoid hemorrhage during pregnancy, delivery, and the puerperium in the utrecht population case-crossover study and standardized incidence ratio estimation, Stroke, 40, 1148-1151, 2009	No relevant comparator and insufficient number of women with a history of intracranial haemorrhage
Gross, B. A., Du, R., Hemorrhage from arteriovenous malformations during pregnancy, Neurosurgery, 71, 349-55; discussion 355-6, 2012	Management of the second stage of labour was only reported for four women
Heidrich, R., Niedner, K., Pregnancy and subarachnoid haemorrhage, European Neurology, 3, 38-49, 1970	Narrative literature review and case report - with less than five case reports included
Heiskanen, O., Nikki, P., Rupture of intracranial arterial aneurysm during pregnancy, Acta neurologica Scandinavica, 39, 202-208, 1963	Population do not meet inclusion criteria
Horton, J. C., Chambers, W. A., Lyons, S. L., Adams, R. D., Kjellberg, R. N., Pregnancy and the risk of hemorrhage from cerebral arteriovenous malformations, Neurosurgery, 27, 867-71; discussion 871-2, 1990	The study did not specify whether vaginal deliveries were instrumental or non-instrumental or whether epidural anaesthesia was used
Hunt, H. B., Schifrin, B. S., Suzuki, K., Ruptured berry aneurysms and pregnancy, Obstetrics & Gynecology, 43, 827-37, 1974	Narrative literature review and case report - with less than five case reports included
Jaigobin, C., Silver, F. L., Stroke and pregnancy, Stroke, 31, 2948-51, 2000	Intervention not relevant - no information about the management of the second stage of labour
Jarvinen, P. A., Huhmar, E., Non-toxemic subarachnoid hemorrhage during pregnancy, delivery, or puerperium, Annales Chirurgiae et Gynaecologiae Fenniae, 43, 85-94, 1954	Narrative literature review and case report - with less than five case reports included

Study	Reason for exclusion
Kalani, M. Y. S., Zabramski, J. M., Risk for symptomatic hemorrhage of cerebral cavernous malformations during pregnancy: Clinical article, Journal of Neurosurgery, 118, 50-55, 2013	The study did not specify whether vaginal deliveries were instrumental or non-instrumental or whether epidural anaesthesia was used
Kalani, M. Y., Zabramski, J. M., Risk for symptomatic hemorrhage of cerebral cavernous malformations during pregnancy, Journal of Neurosurgery, 118, 50-5, 2013	The study did not specify whether vaginal deliveries were instrumental or non-instrumental or whether epidural anaesthesia was used
Kamrin, R. P., Masland, W., Intracranial Surgery under Hypothermia during Pregnancy, Archives of Neurology, 13, 70-76, 1965	Narrative literature review and case report - with less than five case reports included
Karjalainen, A. O., Spontaneous subarachnoid haemorrhage in pregnancy, Annales Chirurgiae et Gynaecologiae Fenniae, 54, 437-42, 1965	Less than five case reports included in the article
Kataoka, H., Miyoshi, T., Neki, R., Yoshimatsu, J., Ishibashi-Ueda, H., Iihara, K., Subarachnoid hemorrhage from intracranial aneurysms during pregnancy and the puerperium, Neurologia Medico-Chirurgica, 53, 549-54, 2013	No vaginal birth outcomes reported
Katsuragi, Shinji, Yoshimatsu, Jun, Tanaka, Hiroaki, Tanaka, Kayo, Nii, Masafumi, Miyoshi, Takekazu, Neki, Reiko, Toyoda, Kazunori, Nagatsuka, Kazuyuki, Takahashi, Jun C., Fukuda, Kenji, Hamano, Eika, Satow, Tetsu, Miyamoto, Susumu, Iihara, Koji, Ikeda, Tomoaki, Management of pregnancy complicated with intracranial arteriovenous malformation, The journal of obstetrics and gynaecology research, 44, 673-680, 2018	No relevant comparison
Kemp, B., Knight, M., Maternal mortality in the UK: An update, Obstetrics, Gynaecology and Reproductive Medicine, 26, 26-28, 2016	Commentary paper
Kim, Y. W., Neal, D., Hoh, B. L., Cerebral aneurysms in pregnancy and delivery: pregnancy and delivery do not increase the risk of aneurysm rupture, Neurosurgery, 72, 143-9; discussion 150, 2013	Outcomes not disaggregated by management of the second stage of labour
Kuklina, E. V., Tong, X., Bansil, P., George, M. G., Callaghan, W. M., Trends in pregnancy hospitalizations that included a stroke in the United States from 1994 to 2007: reasons for concern?, Stroke, 42, 2564-70, 2011	No relevant intervention - no information about the management of the second stage of labour
Liang, Z. W., Lin, L., Gao, W. L., Feng, L. M., A clinical characteristic analysis of pregnancy-associated intracranial haemorrhage in China, Scientific reports, 5, 9509, 2015	Mode of birth was not reported in both groups
Liu, X. J., Zhang, D., Wang, S., Zhao, Y. L., Ye, X., Rong, W., Yong, C., Kang, S., Zhao, J. Z., Intracranial hemorrhage from moyamoya disease during pregnancy and puerperium, International Journal of Gynaecology & Obstetrics, 125, 150-3, 2014	No relevant intervention - no information about the management of the second stage of labour

Study	Reason for exclusion
Lv, X., Liu, P., Li, Y., Pre-existing, incidental and hemorrhagic AVMs in pregnancy and postpartum: Gestational age, morbidity and mortality, management and risk to the fetus, Interventional Neuroradiology, 22, 206-11, 2016	Unable to extract data for management of the second stage of labour
Lv, X., Liu, P., Li, Y., The clinical characteristics and treatment of cerebral AVM in pregnancy, Neuroradiology Journal, 28, 234-7, 2015	Narrative literature review
Lv, Xianli, Li, Wei, He, Hongwei, Jiang, Chuhan, Li, Youxiang, Known and unknown cerebral arteriovenous malformations in pregnancies: haemorrhage risk and influence on obstetric management, The neuroradiology journal, 30, 437-441, 2017	Data presented were not sufficiently clear for data extraction
Lv, Xianli, Li, Youxiang, The clinical characteristics and treatment of cerebral AVM in pregnancy, The neuroradiology journal, 28, 385-8, 2015	Narrative literature review
Lv, Xianli, Liu, Peng, Li, Youxiang, Pre-existing, incidental and hemorrhagic AVMs in pregnancy and postpartum: Gestational age, morbidity and mortality, management and risk to the fetus, Interventional neuroradiology : journal of peritherapeutic neuroradiology, surgical procedures and related neurosciences, 22, 206-11, 2016	Data presented were not sufficiently clear for data extraction
Macintyre, M. M., Neurosurgical emergency in early pregnancy, Nursing Times, 70, 1572-5, 1974	Less than five case reports included in the article
Maheshwari, M. C., Bhargava, S., Evaluation of peripartum strokes by computed tomography, Clinical Radiology, 34, 633-637, 1983	No relevant intervention - no information about the management of the second stage of labour
Marx,G.F., Obstetric anesthesia in the presence of medical complications, Clinical Obstetrics and Gynecology, 17, 165-181, 1974	Narrative literature review
Miller, E. C., Yaghi, S., Boehme, A. K., Willey, J. Z., Elkind, M. S. V., Marshall, R. S., Mechanisms and outcomes of stroke during pregnancy and the postpartum period, Neurology: Clinical Practice, 6, 29-39, 2016	No relevant intervention - no information about the management of the second stage of labour
Nornes, H., Lundar, T., Wikeby, P., Cerebral arteriovenous malformations; results of microsurgical management, Acta Neurochirurgica, 50, 243-57, 1979	Only two pregnant women were included in the study population
Pool, J. L., Treatment of Intracranial Aneurysms during Pregnancy, JAMA : the journal of the American Medical Association, 192, 209-214, 1965	Review of individual case report
Porras, J. L., Yang, W., Philadelphia, E., Law, J., Garzon-Muvdi, T., Caplan, J. M., Colby, G. P., Coon, A. L., Tamargo, R. J., Huang, J., Hemorrhage Risk of Brain Arteriovenous	Data presented were not sufficiently clear for data extraction

Study	Reason for exclusion
Malformations during Pregnancy and Puerperium in a North American Cohort, Stroke, 48, 1507-1513, 2017	
Reichman, O. H., Karlman, R. L., Berry aneurysm, Surgical Clinics of North America, 75, 115-21, 1995	Narrative literature review
Robinson, J. L., Hall, C. J., Some aspects of subarachnoid haemorrhage in pregnancy, Journal of Neurology, Neurosurgery & Psychiatry, 34, 109, 1971	Outcome data not disaggregated by management of the second stage of labour
Robinson, J. L., Hall, C. J., Sedzimir, C. B., Subarachnoid hemorrhage in pregnancy, Journal of Neurosurgery, 36, 27-33, 1972	Unable to extract data for management of the second stage of labour
Robinson, J. L., Hall, C. S., Sedzimir, C. B., Arteriovenous malformations, aneurysms, and pregnancy, Journal of Neurosurgery, 41, 63-70, 1974	Outcome data for relevant population were not disaggregated by management of the second stage of labour
Roman, H., Descargues, G., Lopes, M., Emery, E., Clavier, E., Diguet, A., Freger, P., Marpeau, L., Proust, F., Subarachnoid hemorrhage due to cerebral aneurysmal rupture during pregnancy, Acta Obstetricia et Gynecologica Scandinavica, 83, 330-4, 2004	Unclear population
Samad, K., Hasan, S. F., Hoda, M. Q., Anesthetic management of combined caesarean section and clipping of ruptured cerebral aneurysm.[Erratum appears in J Pak Med Assoc. 2004 Sep;54(9):497 Note: Hoda, S F [corrected to Hasan, S F]], JPMA - Journal of the Pakistan Medical Association, 54, 330-2, 2004	Less than five case reports included in the article
Scott,C.A., Bewley,S., Rudd,A., Spark,P., Kurinczuk,J.J., Brocklehurst,P., Knight,M., Incidence, risk factors, management, and outcomes of stroke in pregnancy, Obstetrics and Gynecology, 120, 318-324, 2012	Outcome data not disaggregated by management of the second stage of labour
Scudamore, J. H., Moir, J. C., Rupture of an intracranial aneurysm during pregnancy, Journal of Obstetrics & Gynaecology of the British Commonwealth, 73, 1019-20, 1966	Less than five case reports included in the article
Seeho, S. K. M., Austin, K., Ibiebele, I., Ford, J. B., Torvaldsen, S., Pregnancy outcomes in women with a history of stroke, Journal of Paediatrics and Child Health, 54, 46, 2018	Conference abstract
Simonazzi, G., Curti, A., Rapacchia, G., Gabrielli, S., Pilu, G., Rizzo, N., Pozzati, E., Symptomatic cerebral cavernomas in pregnancy: a series of 6 cases and review of the literature, Journal of Maternal-Fetal & Neonatal Medicine, 27, 261-4, 2014	The study did not specify whether vaginal deliveries were instrumental or non-instrumental or whether epidural anaesthesia was used
Spaargaren, L., Ozsarlak, O., Van Goethem, J. W., Parizel, P. M., Intraventricular hemorrhage due to left frontal lobe arteriovenous malformation,	Less than five case reports included in the article

Study	Reason for exclusion
Jbr-Btr: Organe de la Societe Royale Belge de Radiologie, 86, 170-1, 2003	
Speck, G., Rupture of an aneurysm of the circle of Willis complicating pregnancy, Virginia medical monthly, 81, 270-272, 1954	Less than five case reports included in the article
Srinivasan, K., Cerebral venous and arterial thrombosis in pregnancy and puerperium. A study of 135 patients, Angiology, 34, 731-46, 1983	Population do not meet inclusion criteria - women with cerebral Venous Thrombosis
Srinivasan, K., Natarajan, M., Cerebral venous and arterial thrombosis in pregnancy and puerperium. A study of 90 patients, Neurology India, 22, 131-140, 1974	Population do not meet inclusion criteria - women with cerebral Venous Thrombosis
Stoodley, M. A., Macdonald, R. L., Weir, B. K., Pregnancy and intracranial aneurysms, Neurosurgery Clinics of North America, 9, 549-56, 1998	Narrative literature review
Takahashi, J. C., Iihara, K., Ishii, A., Watanabe, E., Ikeda, T., Miyamoto, S., Pregnancy-associated intracranial hemorrhage: results of a survey of neurosurgical institutes across Japan, Journal of Stroke & Cerebrovascular Diseases, 23, e65-71, 2014	Unable to extract outcome data
Trodella, G. F., Pregnancy complicated by subarachnoid hemorrhage, American Journal of Obstetrics and Gynecology, 63, 1377-1378, 1952	Less than five case reports included in the article
Tuttelman, R. M., Gleicher, N., Central nervous system hemorrhage complicating pregnancy, Obstetrics & Gynecology, 58, 651-7, 1981	Less than five case reports included in the article
Warren, T. M., Fletcher, M., Anaesthetic management of the obstetric patient with neurological disease, Clinics in Anaesthesiology, 4, 291-304, 1986	Narrative literature review
Wiebers, D. O., Subarachnoid hemorrhage in pregnancy, Seminars in Neurology, 8, 226-9, 1988	Narrative literature review
Wiebers, D. O., Whisnant, J. P., The incidence of stroke among pregnant women in Rochester, Minn, 1955 through 1979, JAMA, 254, 3055-7, 1985	A full text copy of the article could not be obtained
Wilterdink, J. L., Feldmann, E., Cerebral hemorrhage, Advances in Neurology, 64, 13-23, 1994	Narrative literature review
Wilterdink, J. L., Feldmann, E., Intracranial hemorrhage, Advances in Neurology, 90, 63-74, 2002	Narrative literature review
Witiw, C. D., Abou-Hamden, A., Kulkarni, A. V., Silvaggio, J. A., Schneider, C., Wallace, M. C., Cerebral cavernous malformations and pregnancy: hemorrhage risk and influence on obstetrical management, Neurosurgery, 71, 626-30; discussion 631, 2012	Unable to extract outcome data for different birth methods

Study	Reason for exclusion
Wlody, D., The critically ill parturient: Subarachnoid hemorrhage, mitral stenosis, and postpartum hemorrhage, Progress in Anesthesiology, 11, 415-424, 1997	A full text copy of the article could not be obtained
Yahalom, G., Yagoda, A., Hoffmann, C., Dollberg, O., Gadoth, N., Multiple cavernomatosis presenting during pregnancy, Israel Medical Association Journal: Imaj, 14, 450-1, 2012	Less than five case reports included in the article
Zofkie, A., Cunningham, F. G., 33-Year single center experience with pregnancy-associated strokes, American Journal of Obstetrics and Gynecology, 218, S476-S477, 2018	Conference abstract

Economic studies

See Supplement 2 (Health economics) for details of economic evidence reviews and health economic modelling.

Appendix E – Clinical evidence tables

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Full citation Fliegner, J. R., Hooper, R. S., Kloss, M., Subarachnoid haemorrhage and pregnancy, Journal of Obstetrics & Gynaecology of the British Commonwealth, 76, 912-7, 1969 **Ref Id** 391597	**Sample size** N=21 women • History of SAH: 21 women (21 pregnancies, 20 births) ○ vaginal birth: n=8 women (8 births) ○ caesarean section: n=6 women (6 births) ○ hysterotomy: n=1 woman (1 pregnancy) • Birth in the week when SAH occurred: n=5 women (5 births) • Birth before SAH: n=1 woman (1 birth) **Characteristics** Women with spontaneous subarachnoid haemorrhage before or during pregnancy attending the Royal's Women's Hospital, Melbourne, in the years 1945-1967.	**Interventions** • Elective caesarean section (n=6 women, 6 births) • Normal labour (n=4 women, 4 births) • Forceps assisted labour (n=4 women, 4 births)	**Details** Individual case reports were reviewed. Age, parity, duration of pregnancy, source of haemorrhage, treatment, and obstetrical management were described for each case.	**Results** Maternal mortality: 0 deaths Perinatal and neonatal mortality: 0 deaths	**Limitations** • Inclusion criteria: clearly described • Methods for identification and measurement of the condition: Yes • Consecutive inclusion of participants: Unclear • Complete inclusion of participants: Unclear • Demographics of participants: Clearly reported (age) • Clinical information of participants: Parity, presentation and timing of haemorrhage as well as the location of the lesion and treatment of the haemorrhage were reported • Outcomes or follow-up results: Not reported • Site demographic information: Yes • Statistical analysis: None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Country/ies where the study was carried out Australia **Study type** Retrospective case series **Aim of the study** To review cases of spontaneous subarachnoid haemorrhage and pregnancy in order to contribute to answering the following questions: Does pregnancy or labour	Age (mean): 27.9 years Parity (mean): 1.4 Treatment: Seven women were managed conservatively whereas seven women had surgical treatment (one postpartum and 6 before birth, namely 1 in non-instrumental vaginal birth group, 2 in instrumental vaginal birth group, 3 in caesarean section group) Characteristics relating to 4 women with instrumental vaginal birth: • Age range: 19-34 years • Parity: n=3 para 0, n=1 para 1 • Source of haemorrhage: n=1 arteriography normal, n=1 aneurysm of left posterior communicating artery, n=2 arteriography not performed • Treatment: n=3 had conservative treatment, n=1 ligation of common carotid artery • Timing of haemorrhage: n=4 during pregnancy (gestational age at time of haemorrhage: n=1: 6 weeks, n=2: 20 weeks, n=1: 34 weeks)				Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
predispose to the development of subarachnoid haemorrhage? What treatment should be undertaken? Should future pregnancies be advised? **Study dates** Not reported **Source of funding** Not reported	Characteristics relating to 4 women with non-instrumental vaginal birth: • Age range: 24-39 years • Parity: n=1 para 0, n=1 para 2, n=1 para 4, n=1 para 5 • Source of haemorrhage: n=2 aneurysm of left anterior cerebral artery, n=1 AVM, n=1 aneurysm of posterior communicating artery at junction with right internal carotid artery. • Treatment: n=2 had conservative treatment, n=1 aneurysm clipped, n=1 ligation of common carotid artery • Timing of haemorrhage: n=2 before pregnancy, n=2 during pregnancy (gestational age at time of haemorrhage: n=1: 20 weeks, n=1: 24 weeks) Characteristics of women who had a caesarean section: • Age range: 20-33 years • Parity: n=1 para 0, n=3 para 1, n=2 para 2,				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	• Source of haemorrhage: n=2 AVM, n=1 arteriography normal, n=2 aneurysm of right internal carotid artery, n=1 aneurysm of basilar artery • Treatment: n=1 excision post partum, n=2 conservative, n=1 aneurysm clipped, n=1 excision when 5 months pregnant, n=1 ligation of right common carotid artery • Timing of haemorrhage: n=1 before pregnancy, n=5 during pregnancy (gestational age at time of haemorrhage: n=1: 12 weeks, n=2: 20 weeks, n=1: 34 weeks, n=1: 36 weeks) **Inclusion criteria** Not reported **Exclusion criteria** Not reported				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Full citation Fukuda,K., Hamano,E., Nakajima,N., Katsuragi,S., Ikeda,T., Takahashi,J. C., Miyamoto,S., Iihara,K., Pregnancy and delivery management in patients with cerebral arteriovenous malformation: A single-center experience, Neurologia Medico-Chirurgica, 53, 565-570, 2013 **Ref Id** 293146	**Sample size** In total, nine women were included in the study. Two pregnancies being aborted were excluded from this review (n=7). **Characteristics** Age (mean): 29.6 years Parity (mean): 0.7 Four women presented with their first episode of intracerebral haemorrhage (ICH) during pregnancy (one at 21st week, one at 16th week, two at 25th week). The other two with headache and one with incidental finding of arteriovenous malformation (AVM) presented unruptured before pregnancy. The Spetzler-Martin grade was I in one patient, II in five, III in one and V in one. One patient was diagnosed with Pial arteriovenous fistula (AVF). One woman was managed conservatively whereas 6 women had surgical treatment (2 before pregnancy (both had caesarean	**Interventions** Caesarean section (CS) (n=5): One underwent CS for pulmonary AVF, one for severe pregnancy-induced hypertension, one for hemiparesis, the other two for previous CS) Vaginal birth (n=2)	**Details** Not reported	**Results** Four out of five women who had a caesarean section underwent surgical arteriovenous treatment (two before pregnancy and two during pregnancy) whereas one out of two women in vaginal birth group had surgical arteriovenous treatment during pregnancy. All infants were born well. Two infants in CS was temporarily intubated. All women had modified Rankin scale (mRS) of '0' apart from one woman in CS group (mRS=3).	**Limitations** • Inclusion criteria: clearly described • Methods for identification and measurement of the condition: Unclear • Consecutive inclusion of participants: Unclear • Complete inclusion of participants: Unclear • Demographics of participants: Yes (age, parity, AVM grade) • Clinical information of participants: Parity, presentation and timing of haemorrhage as well as the location of the lesion and treatment of the haemorrhage were reported • Outcomes or follow-up results: Unclear • Site demographic information: Yes • Statistical analysis: None Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Country/ies where the study was carried out Japan **Study type** Retrospective case series **Aim of the study** To examine the results of pregnancy and birth management in patients with AVMs in a single institution **Study dates** April 2005 and April 2011	section), 3 during pregnancy (2 with caesarean section and 1 with vaginal birth) and 1 postpartum). **Inclusion criteria** "Nine patients with AVM in pregnancy aged 22 to 34 years (mean 28.9±3.4 years) were treated in the National Cerebral and Cardiovascular Research Centre between April 2005 and April 2011." **Exclusion criteria** Not reported				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Source of funding None					
Full citation Horton, J. C., Chambers, W. A., Lyons, S. L., Adams, R. D., Kjellberg, R. N., Pregnancy and the risk of hemorrhage from cerebral arteriovenous malformations, Neurosurgery, 27, 867-71; discussion 871-2, 1990	**Sample size** n=438 births out of 238 women included **Characteristics** A total of 451 women received proton beam therapy between January 1977 and June 1986. In every case, the existence of an AVM was confirmed by cerebral arteriography performed at the Massachusetts General Hospital a few days before treatment. (Mean age at diagnosis (years): 27.5±12.9; Total number of haemorrhages: 459) Pregnancy occurred among 238 women, 540 pregnancies, resulting in 438 live births and 102 abortions. Of 238 women who became	**Interventions** Caesarean section n = 63 Vaginal births n = 375	**Details** Not reported	**Results** Haemorrhages occurred during 17 pregnancies (14 during gestation, two at 12-week postpartum and one at 7 days after elective abortion). Of the 14 pregnancies complicated by a cerebral haemorrhage during gestation, 3 resulted in abortion and 11 resulted in healthy, full-term infants. One baby was born by vaginal birth and 10 were born by	**Limitations** • Inclusion criteria: clearly described • Methods for identification and measurement of the condition: Clearly reported (AVM was confirmed by cerebral arteriography). • Consecutive inclusion of participants: Yes • Complete inclusion of participants: Yes, except for clearly defined exclusion criteria • Demographics of participants: Unclear • Clinical information of participants: Parity was not reported; number of women with pregnancy-induced hypertension was reported • Outcomes or follow-up results: Unclear • Sites demographic information: Site and Time clearly defined.

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Ref Id 461230 **Country/ies where the study was carried out** USA **Study type** Retrospective case series **Aim of the study** To reassess the risk of haemorrhage from a cerebral arteriovenous malformation (AVM) during pregnancy	pregnant, 141 (58.6%) experienced a cerebral haemorrhage before the date of their proton beam therapy. **Inclusion criteria** Women who received proton beam therapy between January 1977 and June 1986 who had a pregnancy with untreated AVMs. **Exclusion criteria** All haemorrhages and pregnancies that occurred after proton beam therapy were excluded.			caesarean section. Four of the mothers have permanent neurological deficits; the remaining 10 mothers have recovered completely. Number of live births: Caesarean section (63/63) and vaginal birth (375/375)	• Statistical analysis: Only descriptive in relation to the outcomes included in this review Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Study dates January 1977 to June 1986 **Source of funding** None					
Full citation Sencer, W., The Management of Spontaneous Intracranial Hemorrhage in Non-Eclamptic Pregnancy, Journal of the Mount Sinai Hospital, New York,	**Sample size** N= 9 women (15 pregnancies, 14 births) • Instrumental vaginal birth: 5 women (10 births) • Non-instrumental vaginal birth: 2 women (3 births) • Caesarean section: 1 woman (1 birth) • Termination of pregnancy: 1 woman (1 pregnancy) **Characteristics** Women with spontaneous sub-arachnoid haemorrhage before pregnancy	**Interventions** • instrumental vaginal birth: 5 women (10 births) • non-instrumental vaginal birth: 2 women (3 births) • caesarean section: 1 woman (1 birth)	**Details** Medical records were reviewed. Data was provided on age, location of vascular lesion, gestation weeks at presentation of haemorrhage and treatment for haemorrhage were provided for each case.	**Results** Maternal mortality: 0 deaths Perinatal mortality: 0 deaths	**Limitations** • Inclusion criteria: clearly described • Methods for identification and measurement of the condition: Not reported • Consecutive inclusion of participants: Yes • Complete inclusion of participants: Yes • Demographics of participants: Clearly reported (age) • Clinical information of participants: Parity was not reported; presentation and timing of haemorrhage was reported as well as the location of the lesion and treatment of the haemorrhage.

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
31, 487-539, 1964 **Ref Id** 461313 **Country/ies where the study was carried out** USA **Study type** Retrospective case series **Aim of the study** To contribute to answering the following questions: What should be the neurological management in terms of diagnostic	Age (mean): 33.5 years Parity (mean): 1.05 Characteristics relating to women with instrumental vaginal birth: • n=5 births para 0, n=3 births para 1, n=2 births para 2 • Source of haemorrhage: n=1 aneurysm at the base of the anterior cerebral artery, n=1 AVM in the region of the anterior choroidal artery and an intracerebral mass, n=1 AVM in the distribution of the left middle cerebral artery, n=2 unknown cause • Treatment: n=3 not reported, n=1: craniotomy, intracerebral hematoma evacuated, series of clips placed across the vessels of the lesion; n=1 "treated supportively" • Hypertension: n=1 had transient episodes of hypertension, the highest being 194/194. Characteristics relating to 2 women with non-instrumental vaginal birth: • n=2 births para 0, n=1 birth para 1				• Outcomes or follow-up results: Clearly reported • Site demographic information: Not reported • Statistical analysis: Only descriptive Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
procedures in the parturient? What is the preferable mode of birth for the baby, caesarean section or vaginal delivery? Should women be allowed to become pregnant again? **Study dates** Not reported **Source of funding** Not reported	• Source of haemorrhage: n=1 unknown cause, n=1 AVM of the left parieto-occipital region • Treatment: n=1 anticonvulsants, n=1 "treated supportively" Characteristics relating to woman who had a caesarean section: • n=1 para 0 • Source of haemorrhage: n=1 unknown cause • Treatment: n=1 "treated supportively" **Inclusion criteria** Pregnant patients with documented intracranial pathological findings evaluated at an institution between July 1969 and July 2005. **Exclusion criteria** Not reported				

Full citation	Sample size	Interventions	Details	Results	Limitations

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Minielly, R., Yuzpe, A. A., Drake, C. G., Subarachnoid hemorrhage secondary to ruptured cerebral aneurysm in pregnancy, Obstetrics & Gynecology, 53, 64-70, 1979 **Ref Id** 484982 **Country/ies where the study was carried out** Canada **Study type** Retrospective case series	N=8 women (8 pregnancies, 7 births) • Vaginal birth: n=6 women (6 births) • Caesarean section: n=1 woman (1 birth) • Termination of pregnancy: n=1 woman (1 pregnancy) **Characteristics** Women with subarachnoid haemorrhage due to ruptured cerebral aneurysm during pregnancy, but before labour. Pregnant women were treated for subarachnoid haemorrhage at the University at the University of Western Ontario hospitals between 1967 and 1977. Characteristics relating to women with instrumental vaginal birth: • Age range: 24-25 years • Parity: n=1 para 0, n=1 para 1 • Number of bleeds: n=2 had 1 bleed • Gestational age at bleed: n=1: 33 weeks, n=1: 35 weeks • Characteristics of aneurysm: n=1 6-7 mm anterior communicating	• Caesarean section (n=1 woman, 1 birth) • Non-instrumental vaginal birth (n=4 women, 4 births) • Forceps-assisted vaginal birth (n=2 women, 2 births)	Individual cases were reviewed. Data on age, parity, gestational age at bleed, location of aneurysm, number of bleeds and treatment were provided for each case.	Maternal mortality: caesarean section: 1 death vs vaginal birth: 0 deaths Perinatal and neonatal mortality: 0 deaths	• Inclusion criteria: Yes • Methods for identification and measurement of the condition: Yes • Consecutive inclusion of participants: Unclear • Complete inclusion of participants: Unclear • Demographics of participants: Yes • Clinical information of participants: Parity; presentation and timing of haemorrhage as well as the location of the lesion and treatment of the haemorrhage were reported • Outcomes or follow-up results: Unclear - Even the baby outcomes were poorly reported; unclear assisted or unassisted birth • Site demographic information: Yes • Statistical analysis: None Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Aim of the study To review the management of 8 pregnant patients suffering ruptured cerebral aneurysms during pregnancy. **Study dates** Not reported **Source of funding** Not reported	aneurysm, n=1 right common carotid communicating aneurysm. • Treatment: All women had surgical management of the ruptured aneurysm before birth. n=1 Heifetz clip, n=1 Selverstone clamp to the right carotid artery then a Weck clip to aneurysm. Characteristics relating to women with non-instrumental vaginal birth: • Age range: 29-33 years • Parity: n=1 para 1, n=3 para 2 • Number of bleeds: n=3 women had 1 bleed, n=1 woman had 2 bleeds • Gestational age at bleed: n=1 27 weeks, n=2 30 weeks, n=1 34 weeks. • Characteristics of aneurysm: n=1 giant aneurysm (2.5 cm) at the basilar bifurcation, n=1 large, left posterior communicating aneurysm, n=1 woman had 2 aneurysms of the basilar artery, n=1 left middle cerebral artery aneurysm. • Treatment: All women had surgical management of the ruptured aneurysm before birth. n=2 Heifetz				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	clip, n=2 women for a total of 3 aneurysm were managed with Scoville clip Characteristics relating to woman with caesarean section: • Age: 30 years • Parity: n=1: para 3 • Number of bleeds: n=1: 1 bleed • Gestational age at bleed: n=1: 36 weeks • Characteristics of aneurysm: n=1: Large, right vertebral basilar (3 cm) • Characteristics of haemorrhage: unreported • Treatment: Mannitol (aneurysm was inoperable) **Inclusion criteria** Not reported **Exclusion criteria** Not reported				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Full citation Cohen-Gadol, A. A., Friedman, J. A., Friedman, J. D., Tubbs, R. S., Munis, J. R., Meyer, F. B., Neurosurgical management of intracranial lesions in the pregnant patient: a 36-year institutional experience and review of the literature, Journal of Neurosurger	**Sample size** N=12 women (12 pregnancies, 11 births) • Vaginal birth: n=7 women (7 births) • Caesarean section: n=4 women (4 births) • Termination of pregnancy: n=1 woman (1 pregnancy) **Characteristics** Pregnant women with intracranial vascular lesions Characteristics relating to women with instrumental vaginal birth: • Age range: 19-31 years • Parity: not reported • Vascular lesions: n=2 AVM • Presentation of lesion: n=2 intracerebral haemorrhage • Gestational age at time of haemorrhage: n=1: 22 weeks, n=1: uncertain	**Interventions** • Caesarean section (n=4 women, 4 births) • Normal labour (n=5 women, 5 births) • Forceps assisted labour (n=2 women, 2 births)	**Details** Medical records were reviewed. Data was provided on age, location of vascular lesion, gestation weeks at presentation of haemorrhage and treatment for haemorrhage were provided for each case.	**Results** Perinatal mortality: 0 deaths	**Limitations** • Inclusion criteria: clearly described • Methods for identification and measurement of the condition: Not reported • Consecutive inclusion of participants: Yes • Complete inclusion of participants: Yes • Demographics of participants: Clearly reported (age) • Clinical information of participants: Parity was not reported; presentation and timing of haemorrhage was reported as well as the location of the lesion and treatment of the haemorrhage. • Outcomes or follow-up results: Clearly reported • Site demographic information: Not reported • Statistical analysis: Only descriptive Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
y, 111, 1150-7, 2009 **Ref Id** 506664 **Country/ies where the study was carried out** USA **Study type** Retrospectiv e case series **Aim of the study** To better characterize the optimal management strategies for intracranial pathological entities in pregnant women.	• Treatment: n=1 conservative; radiosurgery after birth; n=1 craniotomy and resection Characteristics relating to women with non-instrumental vaginal birth: • Age range: 19-30 years • Parity: not reported • Vascular lesions: n=3 aneurysms, n=2 AVM • Presentation of lesion: n=3 subarachnoid haemorrhage, n=1 intraventricular haemorrhage, n=1 intracerebral haemorrhage • Gestational age at time of haemorrhage: n=1: 22 weeks, n=1: 24 weeks, n=1: 25 weeks, n=1: 33 weeks, n=1: 34 weeks • Treatment: aneurysms: n=3 craniotomy and clipping; AVM: n=1 endovascular embolization ; radiosurgery after birth; n=1 craniotomy and resection Characteristics relating to women with caesarean section: • Age range: 21-35 years • Parity: Not reported				**Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Study dates Not reported **Source of funding** Not reported	• Vascular lesions: n=2 aneurysms (location: n=1 basilar artery, n=1 PICA), n=1 AVM, location: brainstem, n=1 cavernous malformation, location: pons. • Presentation of lesion: n=2 SAH, 1 asymptomatic, 1 hemianesthesia, and diplopia 1 week later • Gestational age at time of haemorrhage: n=1 : 29 weeks, n=1: 33 weeks, n=1: 34 weeks, n=1: 37 weeks • Treatment: aneurysms: n=1 C-section then clipping during same operation, n=1 no treatment; AVM: n=1 no treatment; cavernous malformation: n=1 craniotomy and resection after 2nd haemorrhage 1 week later. **Inclusion criteria** Pregnant patients with documented intracranial pathological findings evaluated at an institution between July 1969 and July 2005.				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	Exclusion criteria Not reported				
Full citation Fukushima, K., Yumoto, Y., Kondo, Y., Fujita, Y., Morokuma, S., Tsukimori, K., Wake, N., A retrospective chart review of the perinatal period in 22 pregnancies of 16 women with Moyamoya disease, Journal of Clinical Neuroscienc	**Sample size** N= 16 women, 22 pregnancies **Characteristics** Women with either a pre-existing diagnosis of moyamoya disease or diagnosed within one month of birth. All women were Japanese. Age (mean): 29.4 years Parity (mean): 0.5 Characteristics relating to 13 women (18 births) who had a caesarean section: • Age range: 24-37 years	**Interventions** • Caesarean section (n=13 women, 18 births) • Vaginal birth without anaesthesia (n=2 women, 3 births) • Vaginal birth with general anaesthesia (n=1 woman, 1 birth)	**Details** A retrospective chart review was performed, and maternal demographics characteristics (age, gravidity, parity, and previous history of Moyamoya disease) as well as mode of birth, anaesthesia, gestational age, obstetrical complications, neurological events and perinatal outcome (neonatal complications, birth weight).	**Results** Maternal neurological events during the perinatal period: • Visual disturbances: caesarean section (n=18): 1 event postpartum vs birth with anaesthesia (n=1): 0 events vs births without anaesthesia (n=3 births): 0 events • Transient ischemic attack: caesarean section (n=18): 1 event postpartum vs birth with anaesthesia (n=1): 0 events vs births	**Limitations** • Inclusion criteria: clearly described • Methods for identification and measurement of the condition: not reported • Consecutive inclusion of participants: not reported • Complete inclusion of participants: unclear, despite one clearly defined exclusion criterion • Demographics of participants: clearly reported (age) • Clinical information of participants: clearly reported (parity, gestational age at birth, age at diagnosis of moyamoya disease, initial symptoms of moyamoya disease, previous external carotid artery-internal carotid artery bypass) • Outcomes or follow-up results: clearly reported • Site's demographic information: site and time clearly defined; prevalence and incidence of moyamoya disease in Japan

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
e, 19, 1358-62, 2012 **Ref Id** 506697 **Country/ies where the study was carried out** Japan **Study type** Retrospective case series **Aim of the study** To present a retrospective chart review of 22 pregnancies of women with Moyamoya disease	• Parity range: 0-2 • Diagnosis of moyamoya disease: before pregnancy for all women • Previous external carotid-internal carotid artery bypass: n= 7 women (10 births): yes; 6 women (8 births): no (1 of the 6 women who had not undergone bypass surgery had undergone clipping of a brain aneurysm; she had 1 birth) Characteristics relating to 1 woman (1 birth) who had a vaginal birth with anaesthesia: • Age: 36 years • Parity: 2 • Diagnosis of moyamoya disease: before pregnancy • Previous external carotid-internal carotid artery bypass: no		The authors performed t-tests and chi-squared tests to compare the baseline characteristics and outcomes of surgically treated and non-treated groups.	without anaesthesia (n=3 births): 2 events postpartum No significant differences were found in the number of neurological events between the surgically treated and non-treated groups.	is provided; the authors mention that the disease predominantly affects women. • Statistical analysis: Outcomes are reported descriptively; the authors performed t-tests and chi-squared tests to compare the surgically treated and non-treated groups. They stated that no significant differences were found in maternal and neonatal outcomes however did not provide a p value. Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
managed under a standard protocol at a single institution. **Study dates** Not reported **Source of funding** The work was supported in part by a grant-in-aid from the Japan Ministry of Education (20591301).	Characteristics relating to 2 women (3 births) who had vaginal births without anaesthesia: • Age range: 29-36 years • Parity range: 0-1 • Diagnosis of moyamoya disease: postpartum: 2 women, 2 births; before pregnancy: 1 woman, 1 birth • Previous external carotid-internal carotid artery bypass: no The maternal age at pregnancy and the parity of patients without a bypass were significantly higher than those who had undergone a bypass. The age of moyamoya disease diagnosis and gravidity of non-bypassed patients were higher in patients who had undergone bypass surgery, although there was no statistical significance. **Inclusion criteria**				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	Women were cared for at the Comprehensive Maternity and Perinatal Care Unit and Department of Obstetrics and Gynaecology, Kyushu University Hospital, between January 1991 and March 2010. **Exclusion criteria** Women who chose termination of pregnancy before 22 weeks of gestation were excluded from the study.				
Full citation Kalani, M. Y. S., Zabramski, J. M., Risk for symptomatic hemorrhage of cerebral cavernous malformations during pregnancy: Clinical	**Sample size** Complete Data were available from 168 births among 64 patients (n=168). **Characteristics** Data on women with CCM were prospectively collected. Out of 64 women with CCM included, 36 were familial cases that is multiple lesions with a clear family history and 28 sporadic cases that is single, isolated	**Interventions** Vaginal births - 149 (47 sporadic and 102 familial CCM) Caesarean sections - 19 (9 sporadic and 10 familial CCM)	**Details** Not reported	**Results** Symptomatic haemorrhage was defined as the onset or exacerbation of seizures or any change in the neurological examination, including changes in motor or sensory function, visual field deficits, ataxia, dysmetria,	**Limitations** • Inclusion criteria: clearly described • Methods for identification and measurement of the condition: Clearly reported (MRI was used to determine the number of CCM and included only Type I, II and III). • Consecutive inclusion of participants: Yes • Complete inclusion of participants: No (Complete data were available for only 64 women) • Demographics of participants: No

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
article, Journal of Neurosurgery, 118, 50-55, 2013 **Ref Id** 506738 **Country/ies where the study was carried out** USA **Study type** Prospective case series **Aim of the study** To determine whether pregnancy, delivery and puperium are associated with an	lesions with no family history. The assumed gestation was 40 weeks. **Inclusion criteria** Female patients with CCM with data available for comprehensive neurological examinations, MRI studies of the brain and obstetric history were included. **Exclusion criteria** Not reported			nystagmus or changes in the level of consciousness. Out of 64 patients, ten women underwent 19 births by caesarean section: 5 cases for obstetric reasons, 8 for fear of possible haemorrhage and 6 for unknown reasons. There were no episodes of 'haemorrhage' in the 149 vaginal births. There were 5 symptomatic haemorrhages in 4 patients : Caesarean section: 1/19 'Vaginal' births: 4/149. The most common symptom was new-onset or exacerbation of	• Clinical information of participants: No. Only information on neurosurgical intervention for haemorrhage during pregnancy and puerperium were available. • Outcomes or follow-up results: Unclear • Sites demographic information: Yes; Place and Time defined: Barrow Neurological Institute between 1986 and 2010 • Statistical analysis: Only descriptive in relation to the outcomes included in this review. Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
increased risk of symptomatic haemorrhage and to quantify this risk **Study dates** Women with cerebral cavernous malformations (CCM) who were prospectively monitored between 1986 and 2010. **Source of funding** None				seizure activity (4 episodes) and 1 episode of temporary motor deficits. No patient required neurosurgical intervention for haemorrhage during pregnancy or puerperium.	

Full citation	Sample size	Interventions	Details	Results	Limitations

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Sato, K., Yamada, M., Okutomi, T., Kato, R., Unno, N., Fujii, K., Kumabe, T., Vaginal delivery under epidural analgesia in pregnant women with a diagnosis of moyamoya disease, Journal of Stroke and Cerebrovascular Diseases, 24, 921-924, 2015 **Ref Id** 506843	N=12 women (14 births) • vaginal birth: n=8 women (10 births) • caesarean section: 4 women (4 births) **Characteristics** Women with moyamoya disease without recent ischemic symptoms and no maternal or fetal problems Characteristics relating to 8 women with vaginal birth: • Age (mean): 31.2 years • Parity: not reported • 6 women had a history of bypass surgery. • 0 women had pregnancy-induced hypertension. Characteristics relating to 4 women with caesarean section: • Age (mean): 31.2 years	• Caesarean section (n=4 women, 4 births) • Vaginal birth under epidural analgesia (EA) (n=8 women, 10 births) (6 births with vacuum/forceps)	Mean age, mean gestation days, number of women with pregnancy-induced hypertension and number of women with a history of bypass surgery was provided. Outcomes were provided for the vaginal deliveries without disaggregating by instrumental vs non-instrumental delivery.	Number of intrapartum strokes: 0 Number of transient ischemic attacks: caesarean section: 0 vs vaginal birth: 2 during both 2 postpartum periods in 1 patient. Number of perinatal or neonatal deaths: 0 Number of cases with major neonatal morbidity: 0 (Please note, sentence ""All 14 infants were healthy without sequelae" was used to infer that there were 0 neonatal deaths and 0 cases of major neonatal morbidity).	• Inclusion criteria: clearly described • Methods for identification and measurement of the condition: Clearly reported (moyamoya disease was diagnosed according to the criteria issued by the Japanese Ministry of Health, Labour and Welfare). • Consecutive inclusion of participants: Yes • Complete inclusion of participants: Yes, except for clearly defined exclusion criteria • Demographics of participants: Clearly reported (mean age) • Clinical information of participants: Parity was not reported; number of women with pregnancy-induced hypertension was reported as well as the number of women with history of bypass surgery. • Outcomes or follow-up results: Clearly reported • Sites demographic information: The authors mentioned some relevant information, i.e. the following: moyamoya disease occurred more commonly in young people and women; the incidence of stroke during delivery in patients with moyamoya disease remained unclear; in Japan caesarean section was the most

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Country/ies where the study was carried out Japan **Study type** Retrospective case series **Aim of the study** To confirm the safety of vaginal delivery under epidural analgesia for women with a diagnosis of moyamoya disease. **Study dates**	• Parity: not reported • 3 women had a history of bypass surgery. • 1 woman had pregnancy-induced hypertension. **Inclusion criteria** Consecutive cases of women with moyamoya disease without recent ischemic symptoms and no maternal or fetal problems with deliveries at Kitasato University Hospital between September 2004 and January 2013. **Exclusion criteria** Women with moyamoya disease diagnosed after birth were excluded.				frequently chosen mode of delivery in people with moyamoya disease. • Statistical analysis: Only descriptive in relation to the outcomes included in this review. Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Not reported **Source of funding** No financial support was received by the authors for this study.					
Full citation Katsuragi, Shinji, Yoshimatsu, Jun, Tanaka, Hiroaki, Tanaka, Kayo, Nii, Masafumi, Miyoshi, Takekazu, Neki, Reiko, Toyoda, Kazunori, Nagatsuka, Kazuyuki,	**Sample size** N=36 among 26 pregnancies Among 36 pregnancies with i-AVM, there were 3 miscarriages and 3 termination of pregnancy before 22 weeks and were excluded. **Characteristics** Median gestational week at birth : 38 (24-40) weeks Median birthweight at first continued pregnancy : 2882 (810-4180) g	**Interventions** Glasgow coma scale (GCS) was used during pregnancy and modified Rankin Scale (mRS) was used at 1 year after birth. Brain magnetic resonance imaging (MRI) as used to diagnose AVM - "irregular/globoid masses	**Details** Not reported	**Results** Total number of cases included (n=30); All these women had live births and there was no maternal death. Ruptured AVM in pregnancy (all cases were unknown AVM at conception) = 8 AVM treatment during pregnancy/before birth = 4	**Limitations** • Inclusion criteria: Yes • Methods for identification and measurement of the condition: Yes • Consecutive inclusion of participants: Yes • Complete inclusion of participants: Yes • Demographics of participants: No, "Only gestational weeks and birth weight were reported" • Clinical information of participants: No, "There were some cases missing in detail description and no reason was justified"

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Takahashi, Jun C., Fukuda, Kenji, Hamano, Eika, Satow, Tetsu, Miyamoto, Susumu, Iihara, Koji, Ikeda, Tomoaki, Management of pregnancy complicated with intracranial arteriovenous malformation, The journal of obstetrics and gynecology research, 44, 673-680, 2018 **Ref Id** 834377	**Inclusion criteria** Case series identified from charts in National Cerebral and Cardiovascular Center **Exclusion criteria** • AVM other than intracranial lesions • Cerebral AVM associated with hereditary haemorrhagic telangiectasia	anywhere within the hemispheres or brainstem". If symptoms suggested of bleeding --> CT was done. Operation risk of AVM was assessed by Spetzler and Martin (S-M) grade. During pregnancy, coagulopathy and hypertension were ruled out. Cases were discussed during MDT meeting. Caesarean section was planned for residual intracranial AVM (iAVM) with indicated treatment after		(1 vaginal birth with epidural; 2 CS for twins/CPD; 1 EmCS for DVT) No AVM treatment before birth = 4 (1 vaginal birth with forceps due to AVM rupture occurred at 2nd stage of labour; 2EmCS for residual AVM with indication for treatment after birth; 1EmCS for AVM which was managed conservatively) Unruptured AVM in pregnancy (all cases were known at conception) = 22 AVM treatment before conception = 15 (4 CS; 2Em CS for Nonreassuring fetal status or Pregnancy-induced hypertension; 8 VB with epidural	• Outcomes or follow-up results: No, "No information on newly born babies other than "live birth" • Site demographic information: Yes • Statistical analysis: Yes Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series. **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Country/ies where the study was carried out Japan **Study type** Retrospective case series **Aim of the study** To examine the pregnancy outcomes among women with intracranial arteriovenous malformation (AVM) **Study dates**		birth or those with severe hypertension. Vaginal birth with epidural anaesthesia was tried in those with either residual i-AVM lesion or neurological symptoms such as paralysis and hemianopia. Blood pressure was monitored 2 hourly during labour and if >160/110 mmHg, nicardipine hydrochloride drip infusion was given and if persisted, caesarean section was performed. Vacuum extraction or forceps birth was		assisted birth; 1 assisted birth VB) No AVM treatment before conception = 7 (6 VB with epidural assisted birth; 1EmCS for non-assuring fetal status) "More cases where the initial rupture of i-AVM occurred during pregnancy decreased in mRS score at 1 year after delivery than those where the diagnosis of i-AVM had been made at conception (36%, 0%, P < 0.005)." **Principle of management** Management of iAVM rupture depended on conscious level, site of haemorrhage and diagnosed weeks of gestation.	

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
January 1981 to December 2013 **Source of funding** Institutional resources		used in the second stage of labour to avoid maternal abdominal muscle pressure damaging maternal brain vessels because of a pressure increase in the thoracic cavity		1. If severe maternal disturbed consciousness, paralysis progressing --> • 1st and 2nd trimester, diagnosis of AVM, nidus in operable location --> removal and continue pregnancy • onset at second stage of labour --> mechanical vaginal birth, head CT for diagnosis 2. Mildly disturbed consciousness, paralysis not progressing -->• 1st, 2nd trimester, diagnosis of AVM, nidus in operable location --> removal after 2 weeks and continue pregnancy	

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
				3. Any trimester, AVM located in brain stem • Rerupture would be critical for mother ---> pregnancy termination, GKS (Gamma Knife Radiosurgery) therapy	

AVM: arteriovenous malformation; AVF: arteriovenous fistula; CCM: cerebral cavernous malformation; CS: caesarean section; EA: epidural analgesia; GKS: Gamma Knife Radiosurgery; ICH: intracerebral haemorrhage; MDT: multidisciplinary team; mRS: modified Rankin Scale; PICA: posterior inferior cerebellar artery; SAH: subarachnoid haemorrhage

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Full citation Minielly, R., Yuzpe, A. A., Drake, C. G., Subarachnoid hemorrhage	**Sample size** N=8 women (8 pregnancies, 7 births) • Vaginal birth: n=6 women (6 births) (n=1 instrumental vaginal	**Interventions** • Instrumental vaginal birth with low forceps and monitor epidural (n=1)	**Details** Individual cases were reviewed. Data on age, parity, gestational age at bleed,	**Results** • Maternal mortality: instrumental vaginal births (n=2 births): 0 deaths vs non-	**Limitations** • Inclusion criteria: Yes • Methods for identification and measurement of the condition: Yes

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
secondary to ruptured cerebral aneurysm in pregnancy, Obstetrics & Gynecology, 53, 64-70, 1979 **Ref Id** 484982 **Country/ies where the study was carried out** Canada **Study type** Retrospective case series **Aim of the study** To review the management of 8 pregnant patients suffering ruptured cerebral aneurysms during pregnancy.	birth with low forceps and monitor epidural; n=1 instrumental vaginal birth with midforceps rotation; n=4 non-instrumental vaginal birth) • Caesarean section: n=1 woman (1 birth) • Termination of pregnancy: n=1 woman (1 pregnancy) **Characteristics** Women with subarachnoid haemorrhage due to ruptured cerebral aneurysm during pregnancy, but before labour. Pregnant women were treated for subarachnoid haemorrhage at the University of Western Ontario hospitals between 1967 and 1977. Characteristics relating to 2 women with	• Instrumental vaginal birth with midforceps rotation (n=1) • Non-instrumental vaginal birth (n=4)	location of aneurysm, number of bleeds and treatment were provided for each case.	instrumental vaginal births (n=4 births): 0 deaths • Perinatal and neonatal mortality: instrumental vaginal births (n=2 births): 0 deaths vs non-instrumental vaginal births (n=4 births): 0 deaths	• Consecutive inclusion of participants: Unclear • Complete inclusion of participants: Unclear • Demographics of participants: Yes • Clinical information of participants: Parity; presentation and timing of haemorrhage as well as the location of the lesion and treatment of the haemorrhage were reported • Outcomes or follow-up results: Unclear - Even the baby outcomes were poorly reported; unclear assisted or unassisted birth • Site demographic information: Yes • Statistical analysis: None Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series. **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Study dates Not reported **Source of funding** Not reported	instrumental vaginal birth: • Age range: 24-25 • Parity: n=1 para 0, n=1 para 1 • Number of bleeds: n=2 had 1 bleed • Gestational age at bleed: n=1: 33 weeks, n=1: 35 weeks • Characteristics of aneurysm: n=1 6-7 mm anterior communicating aneurysm, n=1 right common carotid communicating aneurysm. • Treatment: n=1 Heifetz clip, n=1 Selverstone clamp to the right carotid artery then a Weck clip to aneurysm. Characteristics relating to 4 women with non-instrumental vaginal birth: • Age range: 29-33				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	• Parity: n=1 para 1, n=3 para 2 • Number of bleeds: n=3 women had 1 bleed, n=1 woman had 2 bleeds • Gestational age at bleed: n=1 27 weeks, n=2 30 weeks, n=1 34 weeks. • Characteristics of aneurysm: n=1 giant aneurysm (2.5 cm) at the basilar bifurcation, n=1 large, left posterior communicating aneurysm, n=1 woman had 2 aneurysms of the basilar artery, n=1 left middle cerebral artery aneurysm. • Treatment: n=2 Heifetz clip, n=2 women for a total of 3 aneurysm were managed with Scoville clip **Inclusion criteria**				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	Not reported **Exclusion criteria** Not reported				
Full citation Fliegner, J. R., Hooper, R. S., Kloss, M., Subarachnoid haemorrhage and pregnancy, Journal of Obstetrics & Gynaecology of the British Commonwealth, 76, 912-7, 1969 **Ref Id** 391597 **Country/ies where the study was carried out** Australia **Study type**	**Sample size** N=21 women • History of SAH: 21 women (21 pregnancies, 20 births) ○ vaginal birth: n=8 women (8 births) (instrumental vaginal birth: 4 births, non-instrumental vaginal births: 4 births) ○ caesarean section: n=6 women (6 births) ○ hysterotomy: n=1 woman (1 pregnancy) ○ birth in the week when SAH occurred/birth potentially short time	**Interventions** • Instrumental vaginal birth (forceps) (n=4 women, 4 births) • Non-instrumental vaginal birth (n=4 women, 4 births)	**Details** Individual case reports were reviewed. Age, parity, duration of pregnancy, source of haemorrhage, treatment, and obstetrical management were described for each case.	**Results** • Maternal mortality: instrumental vaginal births (n=4 births): 0 deaths vs non-instrumental vaginal births (n=4 births): 0 deaths • Perinatal and neonatal mortality: instrumental vaginal births (n=4 births): 0 deaths vs non-instrumental vaginal births (n=4 births): 0 deaths	**Limitations** • Inclusion criteria: clearly described • Methods for identification and measurement of the condition: Ys • Consecutive inclusion of participants: Unclear • Complete inclusion of participants: Unclear • Demographics of participants: Clearly reported (age) • Clinical information of participants: Parity, presentation and timing of haemorrhage as well as the location of the lesion and treatment of the haemorrhage were reported

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Retrospective case series **Aim of the study** To review cases of spontaneous subarachnoid haemorrhage and pregnancy in order to contribute to answering the following questions: Does pregnancy or labour predispose to the development of subarachnoid haemorrhage? What treatment should be undertaken? Should future pregnancies be advised? **Study dates** Not reported **Source of funding** Not reported	○ after SAH: n=5 women (5 births) ○ birth before SAH: n=1 woman (1 birth) **Characteristics** Women with spontaneous subarachnoid haemorrhage before or during pregnancy attending the Royal's Women's Hospital, Melbourne, in the years 1945-1967. Characteristics relating to 4 women with instrumental vaginal birth: • Age range: 19-34 years • Parity: n=3 para 0, n=1 para 1 • Source of haemorrhage: n=1 arteriography normal, n=1 aneurysm of left posterior communicating artery,				• Outcomes or follow-up results: Not reported • Site demographic information: Yes • Statistical analysis: None Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	n=2 arteriography not performed • Treatment: n=3 had conservative treatment, n=1 ligation of common carotid artery • Timing of haemorrhage: n=4 during pregnancy (gestational age at time of haemorrhage: n=1: 6 weeks, n=2: 20 weeks, n=1: 34 weeks) Characteristics relating to 4 women with non-instrumental vaginal birth: • Age range: 24-39 years • Parity: n=1 para 0, n=1 para 2, n=1 para 4, n=1 para 5 • Source of haemorrhage: n=2 aneurysm of left anterior cerebral artery, n=1 AVM, n=1 aneurysm of posterior communicating artery				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	at junction with right internal carotid artery. • Treatment: n=2 had conservative treatment, n=1 aneurysm clipped, n=1 ligation of common carotid artery • Timing of haemorrhage: n=2 before pregnancy, n=2 during pregnancy (gestational age at time of haemorrhage: n=1: 20 weeks, n=1: 24 weeks) **Inclusion criteria** Not reported **Exclusion criteria** Not reported				
Full citation Sencer, W., The Management of	**Sample size** N= 9 women (15 pregnancies, 14 births)	**Interventions** • Instrumental vaginal birth	**Details** Individual cases were reviewed. Age, parity and	**Results** • Maternal mortality: instrumental vaginal births (n=10 births) : 0 deaths	**Limitations** • Inclusion criteria: clearly described

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Spontaneous Intracranial Hemorrhage in Non-Eclamptic Pregnancy, Journal of the Mount Sinai Hospital, New York, 31, 487-539, 1964 **Ref Id** 461313 **Country/ies where the study was carried out** USA **Study type** Retrospective case series **Aim of the study** To contribute to answering the following questions: What should be the neurological management in terms of diagnostic	• Vaginal birth: 7 women (13 births) (instrumental birth: 5 women (10 births), non-instrumental birth: 2 women (3 births)) • Caesarean section: 1 woman (1 birth) • Termination of pregnancy: 1 woman (1 pregnancy) **Characteristics** Women with spontaneous sub-arachnoid haemorrhage before pregnancy Characteristics relating to 5 women with instrumental vaginal birth (10 births): • Age range: 26-35 years • n=5 births para 0, n=3 births para 1, n=2 births para 2 • Source of haemorrhage: n=1 aneurysm at the base	(forceps) (n=10 births) • Non-instrumental vaginal birth (n=3)	obstetrical management was reported for each case.	vs non-instrumental vaginal births (3 births): 0 deaths • Perinatal and neonatal mortality: instrumental vaginal births (n=10 births): 0 deaths vs non-instrumental vaginal births (3 births): 0 deaths	• Methods for identification and measurement of the condition: Not reported • Consecutive inclusion of participants: Yes • Complete inclusion of participants: Yes • Demographics of participants: Clearly reported (age) • Clinical information of participants: Parity was not reported; presentation and timing of haemorrhage was reported as well as the location of the lesion and treatment of the haemorrhage. • Outcomes or follow-up results: Clearly reported • Site demographic information: Not reported • Statistical analysis: Only descriptive Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
procedures in the parturient? What is the preferable mode of birth for the baby, caesarean section or vaginal delivery? Should women be allowed to become pregnant again? **Study dates** Not reported **Source of funding** Not reported	of the anterior cerebral artery, n=1 AVM in the region of the anterior choroidal artery and an intracerebral mass, n=1 AVM in the distribution of the left middle cerebral artery, n=2 unknown cause • Treatment: n=3 not reported, n=1 series of clips placed across the vessels of the lesion, n=1 "treated supportively" • Hypertension: n=1 had transient episodes of hypertension, the highest being 194/194 Characteristics relating to 2 women with non-instrumental vaginal birth (3 births): • Age range: 26-30 years • n=2 births para 0, n=1 birth para 1 • Source of haemorrhage: n=1				**Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	unknown cause, n=1 AVM of the left parieto-occipital region • Treatment: n=1 anticonvulsants, n=1 "treated supportively" **Inclusion criteria** Not reported **Exclusion criteria** Not reported				
Full citation Cohen-Gadol, A. A., Friedman, J. A., Friedman, J. D., Tubbs, R. S., Munis, J. R., Meyer, F. B., Neurosurgical management of intracranial lesions in the pregnant patient: a 36-year institutional experience and	**Sample size** N=12 women (12 pregnancies, 11 births) • Vaginal birth: n=7 women (7 births) (instrumental vaginal birth: 2 women, 2 births; non-instrumental vaginal birth: 5 women, 5 births) • Caesarean section: n=4 women (4 births)	**Interventions** • Instrumental vaginal birth (forceps) (n=2) • Non-instrumental vaginal birth (n=5)	**Details** Medical records were reviewed. Data was provided on age, location of vascular lesion, gestation weeks at presentation of haemorrhage and treatment for haemorrhage were provided for each case.	**Results** • Maternal mortality: instrumental vaginal births: 0 deaths vs non-instrumental vaginal births: 0 deaths • Perinatal mortality: instrumental vaginal births: 0 deaths vs non-instrumental vaginal births: 0 deaths	**Limitations** • Inclusion criteria: clearly described • Methods for identification and measurement of the condition: Not reported • Consecutive inclusion of participants: Yes • Complete inclusion of participants: Yes

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
review of the literature, Journal of Neurosurgery, 111, 1150-7, 2009 **Ref Id** 506664 **Country/ies where the study was carried out** USA **Study type** Retrospective case series **Aim of the study** To better characterize the optimal management strategies for intracranial pathological entities in pregnant women. **Study dates**	• Termination of pregnancy: n=1 woman (1 pregnancy) **Characteristics** Pregnant women with intracranial vascular lesions Characteristics relating to 2 women with instrumental vaginal birth: • Age range: 19-31 years • Parity: not reported • Vascular lesions: n=2 AVM • Presentation of lesion: n=2 intracerebral haemorrhage • Gestational age at time of haemorrhage: n=1: 22 weeks, n=1: uncertain • Treatment: n=1 conservative, radiosurgery after				• Demographics of participants: Clearly reported (age) • Clinical information of participants: Parity was not reported; presentation and timing of haemorrhage was reported as well as the location of the lesion and treatment of the haemorrhage. • Outcomes or follow-up results: Clearly reported • Site demographic information: Not reported • Statistical analysis: Only descriptive Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Not reported **Source of funding** Not reported	birth; n=1 crani/resection Characteristics relating to 5 women with non-instrumental vaginal birth: • Age range: 19-30 years • Parity: not reported • Vascular lesions: n=3 aneurysms, n=2 AVM • Presentation of lesion: n=3 subarachnoid haemorrhage, n=1 intraventricular haemorrhage, n=1 intracerebral haemorrhage • Gestational age at time of haemorrhage: n=1: 22 weeks, n=1: 24 weeks, n=1: 25 weeks, n=1: 33 weeks, n=1: 34 weeks • Treatment: aneurysms: n=3 craniotomy and clipping; AVM: n=1 endovascular				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	embolization; radiosurgery after birth; n=1 craniotomy and resection **Inclusion criteria** Pregnant patients with documented intracranial pathological findings evaluated at an institution between July 1969 and July 2005. **Exclusion criteria** Not reported				
Full citation Sato, K., Yamada, M., Okutomi, T., Kato, R., Unno, N., Fujii, K., Kumabe, T., Vaginal delivery under epidural analgesia in pregnant women with a diagnosis of	**Sample size** N=12 women (14 births) • Vaginal birth: n=8 women (10 births) (6 instrumental vaginal births under epidural analgesia, 4 non-instrumental vaginal births under epidural analgesia)	**Interventions** • Instrumental vaginal birth (vacuum/forceps) under epidural analgesia (n=6 births) • Non-instrumental vaginal birth	**Details** Mean age, mean gestation days, number of women with pregnancy-induced hypertension and number of women with a history of bypass surgery	**Results** Maternal mortality: Instrumental vaginal birth under epidural analgesia (n=6 births): 0 deaths vs non-instrumental vaginal birth under epidural analgesia (n= 4 births): 0 deaths Perinatal and neonatal mortality: Instrumental vaginal	**Limitations** • Inclusion criteria: clearly described • Methods for identification and measurement of the condition: Clearly reported (moyamoya disease was diagnosed according to the criteria issued by the Japanese

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
moyamoya disease, Journal of Stroke and Cerebrovascular Diseases, 24, 921-924, 2015 **Ref Id** 506843 **Country/ies where the study was carried out** Japan **Study type** Retrospective case series **Aim of the study** To confirm the safety of vaginal delivery under epidural analgesia for women with a diagnosis of moyamoya disease.	• Caesarean section: 4 women (4 births) **Characteristics** Women with moyamoya disease without recent ischemic symptoms and no maternal or fetal problems Characteristics relating to 8 women with vaginal birth: • Age (mean): 31.2 years • Parity: not reported • 6 women had a history of bypass surgery. • 0 women had pregnancy-induced hypertension.	under epidural analgesia (n=4 births)	was provided. Outcomes were provided for the vaginal deliveries without disaggregating by instrumental vs non-instrumental delivery.	birth under epidural analgesia (n= 6 births): 0 deaths vs non-instrumental vaginal birth under epidural analgesia (n=4 births): 0 deaths Number of maternal intrapartum strokes: Instrumental vaginal birth under epidural analgesia (n=6 births): 0 strokes vs non-instrumental vaginal birth under epidural analgesia (n=4 births): 0 strokes Number of transient ischemic attacks: vaginal births (n=10 births): 2 events during both postpartum periods in 1 woman who had 2 vaginal births	Ministry of Health, Labour and Welfare). • Consecutive inclusion of participants: Yes • Complete inclusion of participants: Yes, except for clearly defined exclusion criteria • Demographics of participants: Clearly reported (mean age) • Clinical information of participants: Parity was not reported; number of women with pregnancy-induced hypertension was reported as well as the number of women with history of bypass surgery. • Outcomes or follow-up results: Clearly reported • Site's demographic information: The authors mentioned some relevant information, i.e. the following: moyamoya disease occurred more commonly in young people and women; the incidence of stroke during

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Study dates Not reported. **Source of funding** No financial support was received by the authors for this study.	**Inclusion criteria** Consecutive cases of women with moyamoya disease without recent ischemic symptoms and no maternal or fetal problems with deliveries at Kitasato University Hospital between September 2004 and January 2013. **Exclusion criteria** Women with moyamoya disease diagnosed after birth were excluded.				delivery in patients with moyamoya disease remained unclear; in Japan caesarean section was the most frequently chosen mode of delivery in people with moyamoya disease. • Statistical analysis: Only descriptive in relation to the outcomes included in this review. Limitations assessed using the Joanna Briggs Institute critical appraisal checklist for case series **Other information**

AVM: arteriovenous malformation; AVF: arteriovenous fistula; CCM: cerebral cavernous malformation; CS: caesarean section; DVT: deep vein thrombosis; Em CS: emergency caesarean section; GCS: Glasgow coma scale; GKS: Gamma Knife Radiosurgery; MRI: magnetic resonance imaging; mRS: modified Rankin Scale; SAH: subarachnoid haemorrhage; VB: vaginal birth

Appendix F – Forest plots

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

No meta-analysis was undertaken for this review and so there are no forest plots.

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

No meta-analysis was undertaken for this review and so there are no forest plots.

Appendix G – GRADE tables

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

Only case series were included in the review so there are no GRADE tables.

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

Only case series were included in the review so there are no GRADE tables

Appendix H – Economic evidence study selection

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

See Supplement 2 (Health economics) for details of economic evidence reviews and health economic modelling.

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

See Supplement 2 (Health economics) for details of economic evidence reviews and health economic modelling.

Appendix I – Economic evidence tables

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

See Supplement 2 (Health economics) for details of economic evidence reviews and health economic modelling.

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

See Supplement 2 (Health economics) for details of economic evidence reviews and health economic modelling.

Appendix J – Health economic evidence profiles

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

See Supplement 2 (Health economics) for details of economic evidence reviews and health economic modelling.

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

See Supplement 2 (Health economics) for details of economic evidence reviews and health economic modelling.

Appendix K – Health economic analysis

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

See Supplement 2 (Health economics) for details of economic evidence reviews and health economic modelling.

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

See Supplement 2 (Health economics) for details of economic evidence reviews and health economic modelling.

Appendix L – Research recommendations

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – mode of birth

Does caesarean section protect against cerebral haemorrhage in women with a history of subarachnoid haemorrhage or cerebro-vascular malformation?

Why this is important

Cerebrovascular malformations (CVMs) affect more than 3% of the population even though most people are unaware of their presence. Women with CVMs or who have had a previous subarachnoid haemorrhage are at risk of a further cerebral haemorrhage with potentially life-threatening consequences. It is uncertain whether natural childbirth poses an additional risk of cerebral haemorrhage to these women, or whether caesarean section is protective.

Furthermore, CVMs are a heterogeneous group of conditions with a variable risk of haemorrhage. Also, women with known CVM have a personal perception of the risk of recurrent cerebral haemorrhage and its consequences. This has made it difficult to generate high-quality evidence for recommending mode of birth for women with CVMs. Yet, the issue is a recurrent problem and caesarean section with its own attendant risks is the fall-back position. This may be a sensible option for some women who have had a recent cerebral bleed, but as most women with a CVM are unaware of their condition, it appears an excessive number of pregnant women with CVMs are being recommended a caesarean section.

Research recommendation rationale

Research question	Does caesarean section protect against cerebral haemorrhage in women with a history of subarachnoid haemorrhage or cerebro-vascular malformation?
Importance to 'patients' or the population	CVMs are a heterogeneous mixture of conditions with a variable risk of cerebral haemorrhage. Labour is suspected as being a risk factor for cerebral haemorrhage in women with CVM. As a consequence caesarean sections are recommended for many women, even though evidence is lacking.

Research question	Does caesarean section protect against cerebral haemorrhage in women with a history of subarachnoid haemorrhage or cerebro-vascular malformation?
Relevance to NICE guidance	High Priority: NICE guidance was based on expert opinion in the absence of evidence. Evidence to recommend one mode of childbirth over another is lacking.
Relevance to NHS	At present the perception is that an excessive number of women with a CVM and uncertain risk of cerebral haemorrhage are being offered caesarean section. Evidence to support or refute this advice would help decision making by clinicians and patients at the time of childbirth.
National priorities	There is a need to reduce the number of unnecessary caesarean sections.
Current evidence base	Small case series have been reported on which NICE recommendations have been based. Evidence from larger cases series or registry is needed.
Equalities	N/A

CVM: cerebrovascular malformation; N/A: not applicable; NICE: National Institute for Health and Care Excellence

Research recommendation PICO

Criterion	Explanation
Population	Pregnant women with a CVM or past cerebral haemorrhage
Intervention	National Registry of pregnant women with CVM or cerebral haemorrhage to record pregnancy outcome, including mode of childbirth
Comparator	National data on pregnancy outcome of women without a CVM or cerebral haemorrhage
Outcomes	• Intrapartum cerebral haemorrhage • Mode of delivery • Perinatal outcome • Maternal wellbeing
Study design	National Registry of pregnant women with CVM and/or history of cerebral haemorrhage
Timeframe	3 year data collection and review to decide on further follow up

CVM: cerebrovascular malformation

Intrapartum care for women with a history of subarachnoid haemorrhage or arteriovenous malformation of the brain – second stage of labour

No research recommendations were made for this review question.