



National Clinical Practice Guideline Diagnosis and Management of Placenta Accreta Spectrum (PAS)



**INSTITUTE OF
OBSTETRICIANS &
GYNAECOLOGISTS**

ROYAL COLLEGE OF
PHYSICIANS OF IRELAND

Guideline Development Group

Prof Donal Brennan (Consultant Gynaecological Oncologist)
Prof Shane Higgins (Consultant Fetal-Maternal Medicine)
Dr Helena Bartels (Specialist Registrar, Placenta Accreta Fellow)
Ms Naomi Cooney (Patient Advocate, Placenta Accreta Ireland)
Dr Róisín Ní Mhuircheartaigh (Consultant Anaesthesiologist)
Prof John Moriarty (Consultant Interventional Radiologist)
Prof David Brophy (Consultant Interventional Radiologist)
Dr Paul Downey (Consultant Pathologist)
Dr Jennifer Walsh (Consultant Fetal-Maternal Medicine)
Dr Bridgette Byrne (Consultant Obstetrician and Gynaecologist)
Dr Tony Geoghegan (Consultant Interventional Radiologist)
Dr Michael O'Leary (Consultant Gynaecological Oncologist)
Dr Jennifer Donnelly (Consultant Fetal Maternal Medicine)
Prof Richard Greene (Consultant Obstetrician and Gynaecologist)
Prof Gabrielle Colleran (Consultant Paediatric Radiologist)
Ms Claire Thompson (Consultant Gynaecological Oncologist)

Guideline Programme Team

Professor Keelin O'Donoghue (Clinical Lead)
Ms Nicolai Murphy (Programme Manager)

Approved by

The National Women and Infants Health Programme (NWIHP) and the Institute of Obstetricians and Gynaecologists (IOG) Clinical Advisory Group (CAG) 2022

Version Number: Version 1.0

Publication Date: December 2022

Date for Revision: December 2025

Electronic Location:

<https://www.hse.ie/eng/about/who/acute-hospitals-division/woman-infants/clinical-guidelines/>

<https://www.rcpi.ie/faculties/obstetricians-and-gynaecologists/national-clinical-guidelines-in-obstetrics-and-gynaecology/>

Version control

Version	Date Approved	Section numbers changed	Author

Cite this document as:

Bartels H.C, Walsh J.M, Ní Mhuircheartaigh R, Brophy D, Moriarty J, Geoghegan T, O'Leary M, Donnelly J. C, Colleran, G.C, Thompson, C, Cooney, N, Byrne, B, Downey, P, Greene, R, Higgins, S, Brennan, D.J. National Clinical Practice Guideline: Diagnosis and Management of Placenta Accreta Spectrum. National Women and Infants Health Programme and The Institute of Obstetricians and Gynaecologists. December 2022

Table of Contents

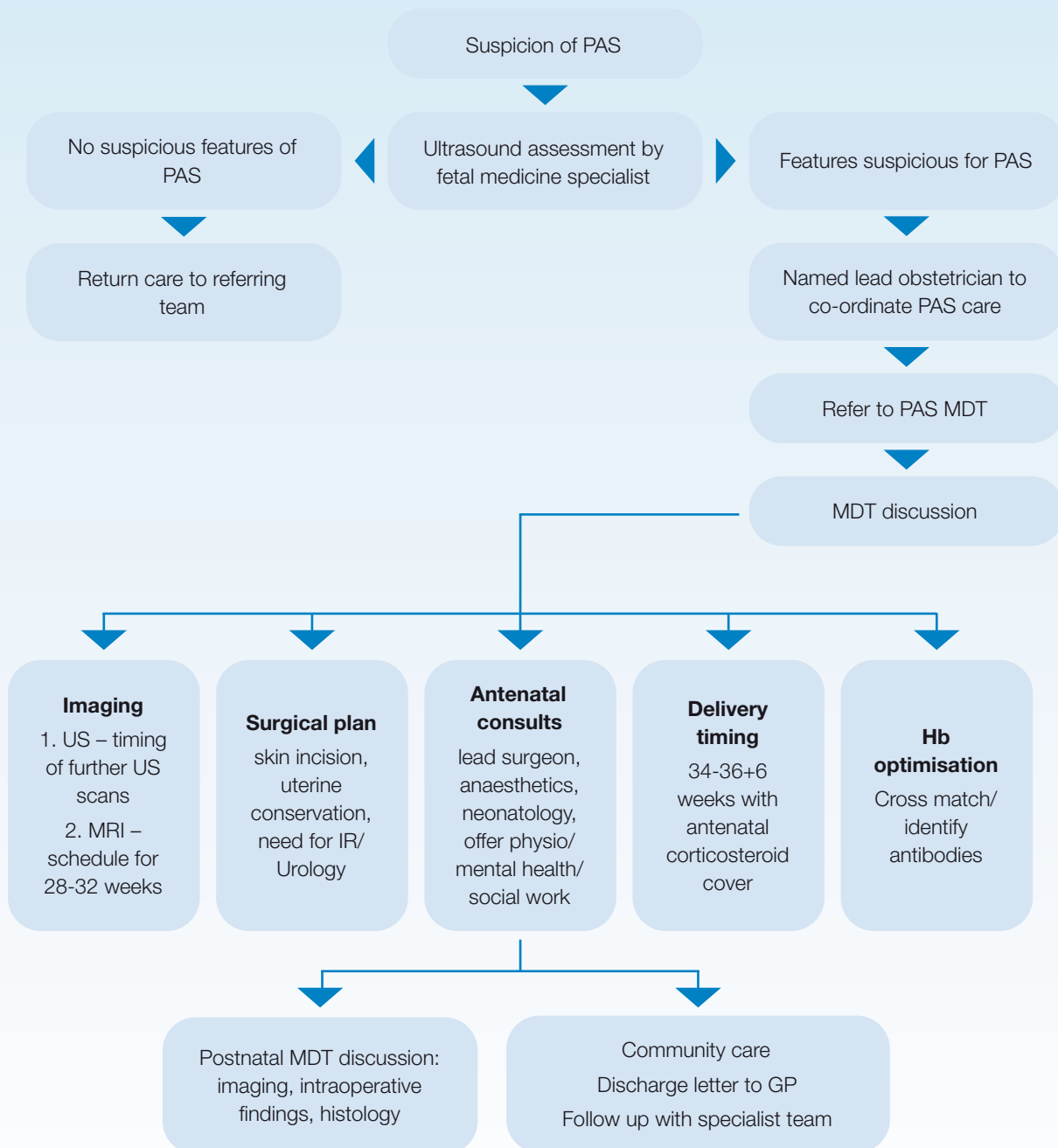
ALGORITHM	4
KEY RECOMMENDATIONS	5
CHAPTER 1: INITIATION	9
1.1 Purpose	9
1.2 Scope	9
1.3 Objective	9
1.4 Guideline development process	9
1.5 Stakeholder involvement	10
1.6 Disclosure of interests	10
1.7 Disclaimer	11
1.8 Use of language	12
CHAPTER 2: CLINICAL PRACTICE GUIDELINE	13
Clinical Questions; Section 1 – Diagnosis	14
Clinical Questions; Section 2 – Antenatal care	22
Clinical Questions; Section 3 – Peri-operative care	40
Clinical Questions; Section 4 – Intraoperative care	45
Clinical Questions; Section 5 – Postnatal care	53
CHAPTER 3: DEVELOPMENT OF CLINICAL PRACTICE GUIDELINE	58
3.1 Literature search strategy	58
3.2 Appraisal of evidence	58
3.3 AGREE II process	58
3.4 Literature review	58
3.5 Grades of recommendation	60
3.6 Future research	60

CHAPTER 4: GOVERNANCE AND APPROVAL	61
4.1 Formal governance arrangements	61
4.2 Guideline development standards	61
4.3 Copyright/Permission sought (if applicable)	61
CHAPTER 5: COMMUNICATION AND DISSEMINATION	62
CHAPTER 6: IMPLEMENTATION	63
6.1 Implementation plan	63
6.2 Education plans required to implement the Guideline	63
6.3 Barriers and facilitators	63
6.4 Resources necessary to implement recommendations	64
CHAPTER 7: AUDIT AND EVALUATION	65
7.1 Introduction to audit	65
7.2 Auditable standards	65
7.3 Evaluation	65
CHAPTER 8: REVISION PLAN	66
8.1 Procedure for the update of the Guideline	66
8.2 Method for amending the Guideline	66
CHAPTER 9: REFERENCES	67
Reference list	67
Bibliography	77
Supporting Evidence	77
GLOSSARY (for the Purpose of this Guideline)	78
Appendix 1: Expert Advisory Group Members 2021-	80
Appendix 2: Guideline Programme Process	82
Appendix 3: Proforma of ultrasound and MRI signs in PAS	83
Appendix 4: Placenta Accreta Syndrome (PAS) & Caesarean Hysterectomy: A Practical Pathway for Theatre Nurses	85
Appendix 5: Template for documentation of MDT outcome	86
Appendix 6: Mode of anaesthesia	88
Appendix 7: Supporting evidence for the implications of maternal anaesthesia for fetal and childhood outcomes	89

Appendix 8: Detailed description of surgical techniques	91
Appendix 9: AGREE II checklist	95
Appendix 10: Grades of Recommendation	101
Appendix 11: NWIHP/IOG CAG Membership 2022	104
Appendix 12: Policies, Procedures, Protocols and Guidelines Checklist	106

Algorithm

Referral Pathway for Placenta Accreta Spectrum (PAS)



Key Recommendations

1. We suggest that all women with a previous caesarean section should have placental location clearly documented at the fetal anatomy scan. *Grade 2A*
2. We suggest where features suspicious for Placenta Accreta Spectrum (PAS) are identified, a further ultrasound assessment by a fetal medicine specialist should be performed. If this is not available locally, tertiary referral for further assessment is recommended. *Grade 2B*
3. We recommend that women with a placenta praevia and a previous caesarean section where no features of PAS are identified on ultrasound by a skilled operator, can be managed as per usual obstetric care for women with placenta praevia. Healthcare providers should be aware of the limitations of ultrasound and that PAS cannot be completely excluded on imaging. *Best practice*
4. We recommend ultrasound reporting of the features of PAS should be standardised to ensure consistency in reporting of these features. A proforma in Appendix 3 summarises the ultrasound and MRI features which should be marked as either present or absent. *Best practice*
5. We recommend the limitations of ultrasound and MRI in definitively ruling out PAS should be considered when counselling women as to the risk of PAS based on imaging findings. *Best practice*
6. We recommend women diagnosed with PAS should have a named lead consultant obstetrician and be cared for by a multi-disciplinary team with expertise in the diagnosis and management of women with PAS. *Best practice*
7. We suggest where this is not available locally, a referral should be made to a tertiary centre. *Grade 2B*
8. We recommend the multi-disciplinary team should include, at a minimum, clinicians with expertise in diagnosis of PAS, to include fetal-maternal medicine specialists, consultant anaesthesiologist, and surgeons with expertise in complex pelvic surgery, usually a gynaecological-oncologist. *Best practice*
9. We recommend that at each MDT meeting, the following key elements should be discussed: medical, surgical, and obstetric history, all available imaging performed in the current pregnancy, most recent blood results and any relevant events in this pregnancy such as bleeding. A summary of the MDT discussion and recommendations should be clearly documented in the woman's medical file after each meeting. *Best practice*
10. We recommend that women with suspected PAS prior to 24 weeks should be reviewed by 24 weeks' gestation, while those referred after 24 weeks should be reviewed in a tertiary centre within 7 working days from referral, where possible. Some women will warrant more urgent review depending on gestation and clinical circumstances. *Best practice*
11. We recommend women with a diagnosis of PAS are usually suitable for outpatient monitoring unless other clinical factors, such as bleeding, necessitate inpatient management. *Best practice*
12. We recommend where a diagnosis of PAS is suspected, clear documentation should be made in the woman's chart describing the plan for care. *Best practice*

13. We recommend women with PAS should have a full blood count performed in line with routine antenatal care to diagnose anaemia. Women with haemoglobin measurements outside of the normal range should supplement with iron. *Best practice*
14. As there is a small risk of fetal growth restriction with placenta praevia and a clinical opinion that it is increased in PAS, we recommend these women should have regular ultrasound scans for fetal growth at 28, 32 and 34 weeks. *Best practice*
15. We recommend women with a diagnosis of PAS should be referred to physiotherapy antenatally and be reviewed postnatally both while in hospital, as well as being offered a follow up visit after discharge. *Best practice*
16. We recommend women are provided with antenatal educational resources specifically addressing PAS in a format most acceptable to them (website, video, printed information). *Best practice*
17. We recommend women should be offered review by the social work counselling team, particularly where women experience a prolonged hospital admission or delivery away from their local hospital is anticipated. *Best practice*
18. We recommend a perinatal mental health referral should be offered to all women with a diagnosis of PAS during pregnancy and again in the postnatal period. Where referral is declined, clear instructions on how to contact the service in the future should be provided. *Best practice*
19. We recommend women with PAS who have an antepartum haemorrhage should be admitted to hospital for a period of observation in a tertiary centre. Where women experience recurrent bleeding, we suggest admission until delivery is advisable. *Best practice*
20. We recommend admission criteria for women with PAS are considered on an individual basis, as these will be influenced by other factors such as distance from hospital and social circumstances and should be decided on a case-by-case basis. *Best practice*
21. We recommend where women with PAS are admitted to hospital, that cross matched blood is available for them. *Best practice*
22. When deciding to administer pharmacological thromboprophylaxis to women with PAS, we suggest a risk assessment should be made to determine the women's individual risk of VTE which will need to be carefully balanced against the risk of bleeding and timing of birth. *Best practice*
23. We suggest delivery for women with suspected PAS should be considered from 34 weeks' gestation, and not delayed beyond 36+6 weeks. Each case should be discussed at the MDT meeting to finalise the most appropriate gestation, taking into consideration individual clinical factors. *Grade 2C*
24. We recommend that in selected individual cases, an elective Caesarean birth prior to 34 weeks' gestation may be indicated. *Best practice*
25. We suggest women with PAS who will give birth prior to 34+6 weeks' gestation should have antenatal timed corticosteroids administered for fetal lung maturity. *Grade 2A*
26. We recommend specialist centres providing care to women with PAS should have 24-hour availability of a multi-disciplinary team including consultant obstetrician, anaesthesiologist, surgeon with advanced pelvic skills, haematology, and neonatology. *Best practice*
27. We recommend an anaesthesiology consultation should be arranged as early as possible following suspicion of PAS to facilitate discussion around anaesthetic options available and identify any potential challenges with anaesthesia. *Best practice*

28. We suggest suitable approaches for anaesthesia for PAS include neuraxial, neuraxial + general anaesthesia, and general anaesthesia. The most suitable approach will take into consideration individual clinical factors as well as the woman's preference. *Best practice*
29. We recommend several good practice points which units caring for women with PAS can consider intraoperatively: position woman in dorsal lithotomy, ensure adequate exposure using self-retaining retractors, incise the uterus away from the placenta. *Best practice*
30. We recommend attempts at manual removal of the placenta are avoided where intraoperative findings confirm PAS. *Grade 2C*
31. We recommend units caring for women with PAS should provide education for theatre staff regarding the preparation and intraoperative management for PAS cases. *Best practice*
32. We recommend that decisions regarding hysterectomy and uterine conservation should be made at the MDT meeting and take into consideration disease severity, the woman's preferences, and available surgical expertise. *Best practice*
33. We recommend informed consent should be obtained by a senior obstetrician who can counsel women on the possible associated risks, particularly caesarean hysterectomy, blood transfusion, damage to local organs including bladder and ureters, need for HDU/ICU admission and death. *Best practice*
34. We recommend the use of Interventional Radiology (IR) techniques in PAS should be decided on a case-by-case basis at the PAS MDT meeting. *Best practice*
35. We recommend where a decision has been made to use interventional radiology, decisions regarding which IR technique to use will be determined by the expertise available and the MDT. *Best practice*
36. We recommend the use of an aortic balloon, which has the advantage of being performed in a standard operating theatre, with no radiation exposure to the woman or staff and possible improved haemostasis over bilateral iliac artery occlusion. *Best practice*
37. We recommend that in keeping with recommendations for all postnatal women, women with PAS should have an individual VTE score calculated to determine the dose and duration of thromboprophylaxis. *Grade 2C*
38. We recommend that women who were anaemic antenatally or are diagnosed with anaemia postnatally, should be prescribed iron supplementation for at least six weeks postnatally. *Grade 2C*
39. We recommend women have a clear management for postnatal analgesia documented and charted in the woman's health record. *Best practice*
40. We recommend that women should be offered referral to physiotherapy and social work services in the postnatal period, if this has not already been done or the referral was not followed through during the antenatal period. *Best practice*
41. We recommend that women should be offered referral to perinatal mental health in the postnatal period, if this has not already been done or the referral was not followed through during the antenatal period. *Best practice*
42. We suggest a postnatal visit with the specialist care team should be arranged at six weeks postnatally for women and their support partners, where a debrief and discussion of the pregnancy is facilitated. *Best practice*

43. We recommend all relevant clinical information relating to the antenatal course and intraoperative findings should be included so that they are available to the pathologist when requesting histological assessment for PAS specimens. *Best practice*
44. We recommend specimens sent for pathological assessment of PAS should be reported according to the FIGO classification. *Best practice*
45. We recommend in order to facilitate ongoing learning and education within PAS MDTs, the final histology should be presented at the MDT meeting once available. *Best practice*

Chapter 1: Initiation

The National Clinical Effectiveness Committee (NCEC) and Health Information and Quality Authority (HIQA) define clinical guidelines as systematically developed statements, based on a thorough evaluation of the evidence, to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances, across the entire clinical spectrum.¹

1.1 Purpose

The purpose of this Guideline was to develop and provide a comprehensive, evidence-based guidance for the management of Placenta Accreta Spectrum (PAS) within the Republic of Ireland.

1.2 Scope

Target Users

The Guideline is a resource for all clinicians working in healthcare in Ireland who are involved in the care of women with suspected or confirmed PAS.

Target Population

The Guideline is a resource for all women diagnosed with PAS.

1.3 Objective

To provide evidence-based recommendations for the care of women with PAS, as well as promoting a standardised approach nationally across all maternity units.

1.4 Guideline development process

The Guideline Developers agreed to undertake this work under the direction of the Guideline Programme Team (GPT). An Expert Advisory Group (EAG) was commissioned by the GPT. Their role was to critically review the Guideline prior to submission to the National Women and Infants Health Programme (NWIHP) for final approval.

See Appendix 1 for EAG group membership and Appendix 2 for Guideline Programme Process.

The following members were involved in the development of this Guideline:

1. *Donal Brennan (Consultant Gynaecological-Oncologist)*
2. *Shane Higgins (Consultant Fetal-Maternal Medicine)*
3. *Helena Bartels (Specialist Registrar, Placenta Accreta Fellow)*

1 National Clinical Effectiveness Committee (NCEC) and Health Information and Quality Authority (HIQA) (2015) National quality assurance criteria for clinical guidelines. Version 2. Dublin: NCEC and HIQA. <https://www.hiqa.ie/sites/default/files/2017-01/National-Quality-Assurance-Criteria.pdf>

4. *Naomi Cooney (Patient Advocate, Placenta Accreta Ireland)*
5. *Roisin Ni Mhuirheartaigh (Consultant Anaesthesiologist)*
6. *John Moriarty (Consultant Interventional Radiologist)*
7. *David Brophy (Consultant Interventional Radiologist)*
8. *Paul Downey (Consultant Pathologist)*
9. *Jennifer Walsh (Consultant Fetal-Maternal Medicine)*
10. *Bridgette Byrne (Consultant Obstetrician and Gynaecologist)*
11. *Tony Geoghegan (Consultant Interventional Radiologist)*
12. *Michael O'Leary (Consultant Gynaecological Oncologist)*
13. *Jennifer Donnelly (Consultant Fetal Maternal Medicine)*
14. *Richard Greene (Consultant Fetal-Maternal Medicine)*
15. *Gabrielle Colleran (Consultant Radiologist)*
16. *Claire Thompson (Consultant Gynaecological Oncologist)*

1.5 Stakeholder involvement

Stakeholders are people who have a common interest in improving health services. This includes persons that are responsible for delivering and those who receive services related to the clinical Guideline. Guideline committee consisted of a broad group of medical practitioners with an interest in the management of women with PAS including Fetal-Maternal Medicine Specialists, Gynaecological Oncologists and Interventional Radiologists, as well as a representative from a Patient Advocacy Group for women affected by PAS.

The role of midwifery was also considered when writing this Guideline. Ms Mary Brosnan Director of Midwifery and Nursing at the National Maternity Hospital Dublin was invited to conduct a review of the Guideline during the development stages.

1.6 Disclosure of interests

Guideline developers and reviewers bring a range of experiences and perspectives to the work of the national Guideline Programme. It is likely that both Guideline developers and stakeholders/reviewers will have a variety of interests, arising from different contexts and activities done in a professional or personal capacity. These can include employment and other sources of income, speaking engagements, publications and research, and membership of professional or voluntary organisations. The involvement of individuals with relevant content expertise is essential for enhancing the value of Guideline recommendations, but these individuals may also have interests that can lead to conflicts of interest, as may peer reviewers, patient representatives and researchers.

All interests should be declared if, in the view of a reasonable person, they are relevant, or could be perceived to be relevant, to the work of the Clinical Practice Guideline in question.²Declaring an interest does not mean there is a conflict of interest.

2 NICE (2019) Policy on declaring and managing interests for NICE advisory committees <https://www.nice.org.uk/Media/Default/About/Who-we-are/Policies-and-procedures/declaration-of-interests-policy.pdf>

It is important that interests are openly declared so they can be appropriately managed. Conflicts of interest can bias recommendations and ultimately be harmful to patients and the health system. Disclosures of interests and appropriate management of conflicts of interest, when identified, are therefore essential to producing high-quality, credible health guidelines.³

The Guidelines International Network (GIN), a global network of Guideline developers that aims to promote best practices in the development of high-quality guidelines, developed a set of 9 principles to provide guidance on how financial and non-financial conflicts of interest should be both disclosed and managed. It is recommended that Guideline developers follow the GIN principles.⁴

For this National Clinical Practice Guideline, all Guideline developers are asked to complete a conflict of interest declaration form. The response to declared interests will be managed by the Guideline programme team, in accordance with GIN principles. Conflicts of interest may be reported in the published Guideline and declarations of interest can be made available.

1.7 Disclaimer

These guidelines have been prepared to promote and facilitate standardisation and consistency of good clinical practice, using a multidisciplinary approach. Information in this Guideline is current at the time of publication.

The ultimate judgement regarding a particular clinical procedure or treatment plan must be made by the Clinician in light of clinical data presented by the patient and the diagnostic and treatment options available.

Clinical material offered in this Guideline does not replace or remove clinical judgment or the professional care and duty necessary for each specific woman.

Clinical care carried out in accordance with this Guideline should be provided within the context of locally available resources and expertise.

This Guideline does not address all elements of standard practice and assumes that individual clinicians are responsible for:

- Discussing care with women in an environment that is appropriate and which enables respectful confidential discussion. This includes the use of interpreter services where necessary
- Advising women of their choices and ensure informed consent is obtained
- Provide care with professional scope of practice, meeting all legislative requirements and maintaining standards of professional conduct
- Applying standard precautions and additional precautions, as necessary, when delivering care
- Documenting all care in accordance with local and mandatory requirements

3 Traversy G, Barnieh L, Akl EA, Allan GM, Brouwers M, Ganache I, Grundy Q, Guyatt GH, Kelsall D, Leng G, Moore A, Persaud N, Schünemann HJ, Straus S, Thombs BD, Rodin R, Tonelli M. CMAJ. 2021, 193(2):E49-E54. DOI: 10.1503/cmaj.200651 <https://www.cmaj.ca/content/193/2/E49>

4 Holger J, Schünemann, Lubna A, Al-Ansary, Frode Forland, *et al.*; for the Board of Trustees of the Guidelines International Network. Guidelines International Network: Principles for disclosure of interests and management of conflicts in guidelines. Ann Intern Med. 2015;163:548-553. doi:10.7326/M14-1885 <https://www.acpjournals.org/doi/10.7326/m14-1885>

1.8 Use of language

Within this guidance we use the terms ‘woman’ and ‘women’s health’. However, it is important to acknowledge that people who do not identify as cis-gender women are excluded from this descriptor, including people who identify as transgender, gender diverse and gender non-binary⁵. We also appreciate that there are risks to desexing language when describing female reproduction^{6 7}. Services and delivery of care must be appropriate, inclusive and sensitive to the needs of people whose gender identity does not align with the sex they were assigned at birth. This includes training and education regarding diverse pathways to pregnancy and the use of practices which affirm the sexual and gender identities of all people using Obstetrics and Gynaecology services.

Language use is key to effectively communicate options, recommendations, and respectfully accept a woman’s fully informed decision⁸. With this in mind, the use of birth is preferable to the term delivery in all circumstances and is used consistently where possible throughout the guidelines. It is acknowledged that in some circumstances (e.g., in the case of a medically indicated intervention or surgery) and in some contexts, substituting with the term delivery is considered appropriate and this term may be used instead.

-
- 5 Moseson H, Zazanis N, Goldberg E, *et al.* The Imperative for Transgender and Gender Nonbinary Inclusion. *Obstet Gynecol.* 2020;135(5):1059-1068. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7170432/>
 - 6 Brotto LA, Galea LAM. Gender inclusivity in women’s health research. *BJOG: An International Journal of Obstetrics & Gynaecology.* <https://obgyn.onlinelibrary.wiley.com/doi/full/10.1111/1471-0528.17231>
 - 7 Gribble KD, Bewley S, Bartick MC, *et al.* Effective Communication About Pregnancy, Birth, Lactation, Breastfeeding and Newborn Care: The Importance of Sexed Language. *Frontiers in Global Women’s Health.* 2022;3. Accessed June 9, 2022. <https://www.frontiersin.org/article/10.3389/fgwh.2022.818856>
 - 8 <https://blogs.bmj.com/bmj/2018/02/08/humanising-birth-does-the-language-we-use-matter/>

Chapter 2: Clinical Practice Guideline

Background

Placenta Accreta Spectrum (PAS) is defined as abnormal adherence and invasion of the trophoblast into the myometrium, resulting in failure of placental separation following the birth of the fetus^{1,2}. The condition is suspected antenatally using ultrasound and magnetic resonance imaging (MRI) and confirmed on histopathological examination.

The prevalence of PAS has increased significantly over the past number of decades. The incidence of placenta accreta has increased 13-fold since the early 1900s and directly correlates with the increasing caesarean section rate¹. Studies from the 1980s reported a prevalence of 1 in 2500-4000^{1,3}, with more recent data from 2016 in the United States estimating a prevalence as high as 1 in 272⁴.

However, other studies estimate the prevalence as much as lower than that at 1 in 2000 pregnancies³. The variation in reported prevalence highlights the need for standardised definitions and reporting criteria for PAS. None the less, while absolute prevalence rates vary between studies, the literature is unanimous that there has been a substantial increase in the number of women diagnosed with PAS in the past decade⁵.

There are a number of risk factors leading to the development of PAS, the most important of which is a previous caesarean section⁶. Women have a seven-fold increased risk of developing PAS after one caesarean section⁷. While the increase in prevalence of PAS is largely attributed to an increase in caesarean section rates^{8,9}, which in Ireland rates have increased steadily from 25% in 2008 to 35% in 2020¹⁰, other factors also play a role. Any uterine surgery, such as a history of myomectomy or previous uterine curettage, advanced maternal age¹¹ and artificial reproductive techniques also increase the risk of PAS. Placenta praevia is possibly the most important risk factor for PAS, and for women who have a previous caesarean section and placenta praevia, the risk of PAS increases with each caesarean section, from 3% with one previous caesarean section to up to 67% with four or more caesarean sections¹⁴.

The significance of PAS lies in its association with maternal morbidity and mortality. Maternal morbidity is largely related to massive obstetric haemorrhage, with some studies reporting median blood loss of over 2000mL and up to 80% of women requiring a blood transfusion^{15,16}. Maternal mortality rates from early studies in the 1990s were reported to be as high as 7%¹⁷, however more recent studies have estimated much lower rates^{18,19}. The reduction in maternal morbidity and mortality is largely attributed to improvements in diagnosis and management within centres of excellence with established multi-disciplinary teams^{19,20}.

Recommendations relevant to this Guideline can also be found in the:

- National Clinical Practice Guideline: Prevention and Management of Primary Post-Partum Haemorrhage (2022)⁹
- National Clinical Practice Guideline: Diagnosis, Management and Prevention of Venous Thromboembolism in Pregnancy (due 2023)
- National Clinical Practice Guideline for the use of Antenatal Corticosteroids in Pregnancy (due 2023)
- National Clinical Practice Guideline for Preterm Labour (due 2023)

Clinical Questions; Section 1 – Diagnosis

Introduction

The following section will discuss the diagnosis of PAS. The ultrasonographic and MRI features have been previously well described in a number of key publications. The Guideline committee considered the existing literature relating to the diagnosis of PAS and using methods as described by AGREE II reviewed the existing criteria. Based on these criteria a proforma which combines the ultrasound and MRI criteria was developed (Appendix 3). Clinical questions numbered 2.1 to 2.9 will describe the most relevant literature relating to the diagnosis of PAS, with a short summary to guide clinical practice at the end of this section.

Clinical Question 2.1: What are the risk factors for developing PAS?

Evidence Statement

The major risk factors for placenta accreta spectrum include a history of accreta in a previous pregnancy, previous caesarean section especially with placenta praevia, other uterine surgery, maternal age and Artificial Reproductive Technology^{11 12 13}. This risk rises as the number of prior caesarean sections increase. Previous caesarean section and the presence of an anterior low-lying placenta or placenta praevia should alert the antenatal care team of the higher risk of placenta accreta spectrum.

Most epidemiological studies of the last 20 years show a direct association between the increase in caesarean deliveries and the incidence of placenta accreta spectrum in subsequent pregnancies^{14 21 22 23 24}. A study using the Nordic Obstetric Surveillance data found that the risk of invasive placentation increases seven-fold after one prior caesarean section²⁵.

A meta-analysis of cohorts and case-control studies reported a summary OR of 1.96 (95% CI 1.41-2.74) for placenta accreta spectrum after a caesarean section²⁶. The risk of placenta accreta spectrum increases with the number of previous caesarean sections. There is an increase in the incidence of accreta placentation from 3.3-4.0% in women with placenta praevia and no previous caesarean birth, to 50-67% in women with three or more caesarean deliveries²⁷. The OR for placenta accreta spectrum in a subsequent pregnancy ranges between 8.6 (95% CI 3.536-21.078) and 17.4 (95% CI 9.0-31.4) for two previous caesarean sections²¹ and 55.9 (95% CI 25.0-110.3) for three or more caesarean sections²⁸.

9 Byrne B, Spring A, Barrett N, Power J, McKernan J, Brophy, D, Houston C, Faryl R, McMahon E, Manning C, Murphy P, Ni Ainle F. National Clinical Practice Guideline: Prevention and Management of Primary Postpartum Haemorrhage. National Women and Infants Health Programme and The Institute of Obstetricians and Gynaecologists, December 2022

Placenta praevia is another important risk factor and a large cohort study noted that for women presenting with placenta praevia and prior caesarean section the risk of accreta placentation increases with the number of prior caesarean sections (Table 1) ²⁹.

Table 1: risk of PAS in women with placenta praevia and a previous caesarean section

Number of caesarean sections	Risk of PAS (with placenta praevia) (%)
1	3.3
2	11
3	40
4	61
5	67
>6	67
Data from RM Silver <i>et al.</i> ²⁹	

The national case-control study using the United Kingdom Obstetric Surveillance System found that the incidence of placenta accreta spectrum increases from 1.7 per 10 000 women overall to 577 per 10 000 in women with a previous caesarean section and placenta praevia ¹⁴. Similarly, another meta-analysis showed the incidence of PAS in women with a placenta praevia was 11.10% (IQR 7.65-17.35) ³⁰. In a recent study in cases with placenta praevia, the number of previous caesarean sections was the most powerful predictor for PAS [adjusted risk ratio (aRR) for one previous caesarean section 5.34, 95% confidence interval (CI) 3.70-7.71; aRR for two or more previous caesarean section 16.5, 95% CI 11.5-23.6]. Among cases without placenta praevia, previous caesarean section was not a significant predictor ³¹.

Other surgical trauma to the uterine endometrium and/or superficial myometrium, such as uterine curettage, manual removal of the placenta, postpartum endometritis or myomectomy, has been associated with PAS in subsequent pregnancies ^{32 33}. Overall, the aOR for PAS after previous uterine surgery is 3.40 (95% CI 1.30-8.91) ¹¹. The development of placenta accreta spectrum has also been reported in women with no surgical history but presenting with a uterine pathology, such as bicornuate uterus, adenomyosis, submucous fibroids and myotonic dystrophy ¹³.

Maternal age is a risk factor for PAS ^{14 25} and older women (age 35 years or more) without a previous caesarean section have an increased aOR of 1.30 (95% CI 1.13-1.50) for every 1-year increase in age ⁶.

Artificial Reproduction Technology and in particular in vitro fertilisation is associated with PAS ^{34 35}. Among cases without placenta praevia, previous caesarean section was not a significant predictor, whereas the strongest predictor was conception through ART (aRR 5.05, 95% CI 4.50-5.66) ³¹.

The evidence to support the following recommendations (page 21) relating to screening is largely derived from peer reviewed publications as well as from research exploring clinicians' knowledge and decision-making in the area of PAS.

Clinical Question 2.2: Should all women have a formal assessment of placental location carried out, and if so, when?

Evidence Statement

As a previous caesarean section is the single most frequent risk factor for PAS, all women with a history of a caesarean section should have a formal assessment of placental location at their 20-week anatomy scan. This recommendation is supported by existing international guidelines, including the FIGO consensus Guideline on PAS³⁶ and the RCOG guidelines³⁷. All women should have formal assessment of placental location documented at the time of the mid trimester fetal anatomy scan. This documentation should include whether the placenta is anterior or posterior, fundal, lateral low-lying or praevia.

The term placenta praevia should be used consistently when the placenta lies directly over and covers the internal cervical os. The placenta should be documented as low-lying when the placental edge is less than 20mm from the internal cervical os on transabdominal (TAS) or transvaginal ultrasound (TVS). Placenta praevia is not a contraindication to transvaginal sonography.

Clinical Question 2.3: Who should be referred for further assessment for PAS and by whom should this be performed?

Evidence Statement

Several risk factors for PAS have been described. The most common is the combination of a previous caesarean section and placenta praevia¹. As described above, the risk of PAS increases with each subsequent caesarean section²⁹.

Focusing screening for PAS on this cohort of women will allow for the highest diagnostic yield. As such, all women found to have a low-lying placenta or placenta praevia at the time of the mid trimester anatomy scan in the setting of a previous caesarean section should be referred for further assessment in a timely manner. This further assessment should be performed by a skilled healthcare professional experienced in the ultrasound assessment of PAS disorders. Women with other risk factors, such as prior uterine surgeries, should be risk assessed and referred based on clinical discretion.

Women who have been diagnosed with placenta praevia who have had a previous caesarean section should have an ultrasound performed by an experienced operator where features of PAS are clearly documented as being present or absent using the checklist in Appendix 3. Where no features of PAS are identified, most women will be suitable for delivery in their referring hospital. However, healthcare providers should remain cognisant of the woman's individual risk of PAS based on the number of previous caesarean sections as discussed in section 1.1, as well as the limitations of ultrasound in excluding PAS.

A meta-analysis demonstrated the diagnostic accuracy of antenatal ultrasound and found an overall sensitivity and specificity of 90.72% (95% CI, 87.2-93.6) and 96.94% (95% CI, 96.3-97.5) respectively³⁸. Hence where no features of PAS are identified by an experienced operator the overall risk of PAS is low. While the management of placenta praevia is beyond the scope of the current Guideline, existing guidelines recommend women are delivered electively where possible, blood products are available in theatre and the procedure is performed by a senior obstetrician³⁷.

In summary, the antenatal booking visit will identify women who are at risk of developing PAS based on their previous obstetric history and other risk factors as outlined. While all women should ideally have a fetal anatomy scan, it is particularly important that women with a previous caesarean section have clear documentation of placental location at this ultrasound assessment. Where features suspicious for PAS are seen, a further ultrasound scan by an experienced operator should be arranged as soon as possible.

Clinical Question 2.4: What are the ultrasound signs of PAS?

Evidence Statement

Ultrasound is the primary diagnostic modality for the antenatal detection of PAS^{36 37}. Ultrasound assessment generally includes grey-scale and colour Doppler imaging and/or 3D power Doppler sonography. Ultrasound markers of PAS include the presence of multiple vascular lacunae within the placenta, loss of the normal hypoechoic zone between the placenta and myometrium, decreased retroplacental myometrial thickness (less than 1 mm), abnormalities of the uterine serosa-bladder interface, and colour Doppler findings including turbulent lacunar flow, increased subplacental vascularity, gaps in myometrial blood flow, and vessels bridging the placenta to the uterine margin (Table 2). No ultrasound sign or combination of signs is predictive or specific for depth of myometrial invasion to allow for differentiation between adherent and invasive placentation.

Placental lacunae

The presence of placental lacunae is the most reported ultrasound sign on grey scale sonography³⁹. These often appear as multiple, large and irregular echolucences within the placental parenchyma, giving rise to a “moth-eaten” appearance to the placenta. Lacunae are a common finding in low risk pregnancies, but in the presence of risk factors for PAS they carry the highest sensitivity of all grey-scale markers³⁹. The presence of turbulent flow on colour Doppler within the lacunae, or the identification of placental lacunae feeder vessels increases the likelihood of PAS further. Notably, the absence of significant placental lacunae in pregnancies with placenta praevia and a prior caesarean section is associated with high negative predictive values for PAS ranging from 88% to 100%³⁹.

Loss of the retroplacental hypoechoic zone

Loss of the normal hypoechoic zone or “clear zone” between the placenta and myometrium is a common grey-scale finding^{39 40}. This may be associated with myometrial thinning, defined as thinning of the myometrium overlying the placenta to less than 1mm or undetectable. It is important to note that both of these markers can potentially be iatrogenically produced with undue transducer pressure^{39 40}.

Abnormalities of the uterine serosa-bladder interface

Abnormalities of the uterine serosa-bladder interface include uterovesical hypervascularity, subplacental hypervascularity, bridging vessels and focal bladder wall interruption. Bridging vessels represent neovascularity in the uterine serosa at the uterovesical interface. Bladder varicosities and hypervascularity in the lower uterine segment are often seen in the context of placenta praevia without PAS making this marker difficult to interpret. Interruption of the bladder wall is a clear marker for PAS as it represents placental tissue beyond the uterus.

Table 2: European Working group on Abnormally Invasive Placenta (EW-AIP) descriptions for ultrasound findings in placenta accreta spectrum from Collins *et al.* ⁴⁰

US finding	EW-AIP suggested standardized definition
2D grayscale	
Loss of 'clear zone'	Loss, or irregularity, of hypoechoic plane in myometrium underneath placental bed ('clear zone')
Abnormal placental lacunae	Presence of numerous lacunae including some that are large and irregular (Finberg Grade 3), often containing turbulent flow visible on grayscale imaging
Bladder wall interruption	Loss or interruption of bright bladder wall (hyperechoic band or 'line' between uterine serosa and bladder lumen)
Myometrial thinning	Thinning of myometrium overlying placenta to < 1 mm or undetectable
Placental bulge	Deviation of uterine serosa away from expected plane, caused by abnormal bulge of placental tissue into neighbouring organ, typically bladder; uterine serosa appears intact, but outline shape is distorted
Focal exophytic mass	Placental tissue seen breaking through uterine serosa and extending beyond it; most often seen inside filled urinary bladder
2D colour Doppler	
Uterovesical hypervascularity	Striking amount of colour Doppler signal seen between myometrium and posterior wall of bladder; this sign probably indicates numerous, closely packed, tortuous vessels in that region (demonstrating multidirectional flow and aliasing artifact)
Subplacental hypervascularity	Striking amount of colour Doppler signal seen in placental bed; this sign probably indicates numerous, closely packed, tortuous vessels in that region (demonstrating multidirectional flow and aliasing artifact)
Bridging vessels	Vessels appearing to extend from placenta, across myometrium and beyond serosa into bladder or other organs; often running perpendicular to myometrium
Placental lacunae feeder vessels	Vessels with high-velocity blood flow leading from myometrium into placental lacunae, causing turbulence upon entry
3D ultrasound ± power Doppler	
Intraplacental hypervascularity	Complex, irregular arrangement of numerous placental vessels, exhibiting tortuous courses and varying calibres

Reproduced from Collins SL *et al.* ⁴⁰ with permission (see Chapter 4, section 4.3)
EW AIP – European Working group on Abnormally Invasive Placenta

Clinical Question 2.5: How should ultrasound assessments for suspected PAS be reported?

Evidence Statement

In order to improve consistency and standards in reporting of suspected PAS, standardised definitions for the various PAS ultrasound markers should be specifically looked for and reported. In 2016 the European Working Group on Abnormally Invasive Placenta⁴⁰ proposed standardised descriptions of ultrasound signs which was endorsed by The International Federation of Gynaecology and Obstetrics (FIGO)³⁶. The International Abnormally Invasive Placenta Expert Group subsequently produced a proforma protocol for the ultrasound assessment which can be adapted to include MRI findings as appropriate (Appendix 3). It is recommended that all assessments in the diagnosis of PAS disorders report using this tool.

Clinical Question 2.6: What technical issues should be considered which can affect the accuracy of ultrasound in diagnosing PAS?

Evidence Statement

Ultrasound for cases of suspected PAS should be performed by a skilled healthcare professional experienced in the ultrasound assessment of PAS disorders^{39,40}. They should be aware of the technical issues which might affect the accurate diagnosis of PAS disorders. The assessment should be performed using an appropriate higher frequency (5-9MHz), linear transducer where possible with a full bladder to clearly identify to lower uterine segment.

Transvaginal ultrasound more clearly identifies the cervical canal, internal os, and bladder interface. The loss of the retroplacental “clear” zone should be assessed with light probe pressure as excessive pressure can lead to a false positive sign. Many of the colour flow Doppler findings are subjective and appropriate machine settings including the correct gain setting for the individual woman are essential to allow for optimal assessment of vasculature without artefact.

Clinical Question 2.7: What is the role for MRI in the diagnosis of PAS disorders?

Evidence Statement

MRI is often performed in adjunct with ultrasound assessment in the diagnosis of PAS⁴¹. There are a number of features which have been described on MRI in PAS, including abnormal uterine bulge, dark intraplacental bands on T2 weighted imaging and placental heterogeneity⁴². The sensitivity and specificity of MRI in the diagnosis of PAS was reported in two systematic reviews and metanalysis.

The first review included 13 studies and found the sensitivity of MRI was 82% (95% CI: 72%-90%), with a specificity of 88% (95% CI: 81%-94%)⁴³. The diagnostic odds ratio was 22.95 (95% CI: 3.19-165.11). The second review included 18 studies and 1010 PAS cases and found the diagnostic accuracy of MRI was as follows for PAS; a sensitivity of 94.4% (95% CI, 86.0-97.9%); specificity of 84.0% (95% CI, 76.0-89.8%); and a diagnostic odds ratio of 89.0 (95% CI, 22.8-348.1)⁴⁴.

There are seven MRI features which are recommended for the diagnosis of PAS disorders by the society of Abdominal Radiology (SAR) and European Society of Urogenital Radiology (ESUR), who have published a joint consensus statement for MRI in PAS⁴⁵. These features are:

1. Intraplacental dark T2 bands
2. Uterine/placental bulge
3. Loss of low T2 retroplacental line
4. Myometrial thinning/disruption
5. Bladder wall interruption
6. Focal exophytic placental mass
7. Abnormal vasculature of the placental bed

In addition to these features the diameter of intraplacental fetal vessel has been described as an additional feature which may aid in the prediction of placental invasion in PAS. A study including 160 women with suspected PAS found those with fetal vessels of greater than 3mm diameter were more likely to have placenta percreta and experience peripartum complications⁴⁶.

Hence MRI has a sensitivity and specificity for the detection of PAS disorders which is similar to ultrasound. The main benefit of MRI is the increased field of view compared to ultrasound and a higher reproducibility^{47 48}. It can be considered a complementary imaging modality in PAS, particularly to aid in surgical planning and assessment of parametrial involvement^{36 37 49}.

Clinical Question 2.8: How should MRI assessments for suspected PAS be reported?

Evidence Statement

As described above, there are a number of features which should be reported on as being present or absent on MRI when assessing for PAS. The Guideline committee considered the current available evidence and have included the seven features as described by the SAR and ESUR consensus statement in the proforma for MRI reporting in Appendix 3.

Clinical Question 2.9: What are the limitations of antenatal diagnosis of PAS disorders?

Evidence Statement

Placenta accreta spectrum disorders are ultimately a clinical and histopathological diagnosis that can only be made at the time of birth. The absence of ultrasound findings does not preclude a diagnosis of PAS, and it should be remembered that clinical risk factors remain equally important predictors. Reports on the sensitivity and specificity of ultrasound for the diagnosis of PAS may overestimate the accuracy of ultrasonography due to patient selection and many single-centre studies.

As highlighted by FIGO, small areas of abnormal invasion are reported in many asymptomatic women and are of little clinical significance³⁶. A false positive diagnosis of PAS may lead to a midline laparotomy and a fundal uterine incision, with increased operative and postoperative complications. The role of prenatal detection therefore should be to allow for the detection of PAS cases of clinical significance. A recognition of these limitations is important in when counselling women.

Clinical Practice

The diagnosis of PAS relies on antenatal imaging performed and interpreted by individuals and teams with expertise and experience with PAS. Ultrasound is the main imaging modality for diagnosing PAS, with MRI considered an adjunct which can provide additional information in certain cases, particularly to allow for surgical planning. Where a diagnosis of PAS is suspected and the expertise is not available locally, referral to a tertiary centre for a formal ultrasound assessment should be arranged.

Recommendations – Section 1, Diagnosis

1. We suggest that all women with a previous caesarean section should have placental location clearly documented at the fetal anatomy scan.
2. We suggest where features suspicious for Placenta Accreta Spectrum (PAS) are identified, a further ultrasound assessment by a fetal medicine specialist should be performed. If this is not available locally, tertiary referral for further assessment is recommended.
3. We recommend that women with a placenta praevia and a previous caesarean section where no features of PAS are identified on ultrasound by a skilled operator, can be managed as per usual obstetric care for women with placenta praevia. Healthcare providers should be aware of the limitations of ultrasound and that PAS cannot be completely excluded on imaging.
4. We recommend ultrasound reporting of the features of PAS should be standardised to ensure consistency in reporting of these features. A proforma in Appendix 3 summarises the ultrasound and MRI features which should be marked as either present or absent.
5. We recommend the limitations of ultrasound and MRI in definitively ruling out PAS should be considered when counselling women as to the risk of PAS based on imaging findings.

Clinical Questions; Section 2 – Antenatal care

MULTI-DISCIPLINARY TEAM CARE

The following section will describe the current literature relating to Multi-Disciplinary Team (MDT) care for women with PAS and make recommendations for care.

Introduction

Once a diagnosis of PAS is suspected on ultrasound and/or MRI, a suggested pathway for antenatal care is described through the following series of clinical questions.

Clinical Question 2.10: Where should women be cared for once a diagnosis of PAS is suspected?

Evidence Statement

A number of studies have demonstrated the improvement in maternal outcomes for women with PAS when managed within a multi-disciplinary team (MDT) in a centre of excellence. The management of women with PAS within MDTs is endorsed by multiple international guidelines, including The Royal College of Obstetricians and Gynaecologists, American College of Obstetricians and Gynaecologists and International Federation of Gynaecology and Obstetrics^{5 36 37}.

Eller *et al.*⁵⁰ reported on 79 women with PAS managed in an MDT compared to 62 by standard care and found women in the MDT group had lower transfusion requirements, reoperation rates for bleeding (3% versus 36%, $p < 0.001$) and were less likely to experience post-operative morbidity. Similarly, Shamshirsaz *et al.*⁵¹ reported on 57 women with PAS managed in an MDT compared to 33 receiving standard care and found a significant reduction in blood loss (median of 2.1 L (range, 0.5-18 L) vs 3 L (range, 0.8-14 L, $p = 0.025$), a reduction in emergency delivery (23% versus 64%, $p = 0.001$), and despite iatrogenic pre-term delivery in the MDT group, no difference in neonatal outcomes.

A number of other retrospective studies have found similar results, with MDT care resulting in reduced blood loss and blood transfusion requirements, increase in antenatal diagnosis and a reduction in post-operative morbidity^{52 53 54 55}. Management within an MDT also leads to improvement over time, as those working within an MDT gain experience leading to continued reductions in maternal morbidity⁵⁶.

Furthermore, a meta-analysis including 461 women found those managed as part of an MDT had significantly less blood loss (mean difference -1.1 L, 95% CI -1.9 to -0.4 , $P = .004$), were less likely to require a blood transfusion or experience a post-operative complication compared to those managed by standard obstetric care⁵⁷. A 2019 review summarising the current evidence supporting the use of MDTs in the care of women with PAS further endorsed the management of PAS within stable, experienced MDTs in high volume centres as superior to standard care⁵⁸.

In keeping with international experience, data from Ireland describing women managed within an MDT compared to standard care demonstrated an increase in antenatal diagnosis from 56.3 to 92.9% ($p < 0.0001$), a significant reduction in EBL (4150 mL (800-19500) vs 1975 (495-8500), $p < 0.0001$), and transfusion requirements (median 7 (0-30) units of RCC vs 1 (0-13), $p < 0.0001$)¹⁹.

Clinical Question 2.11: What are the minimum level of care requirements for a centre with an established MDT?

Evidence Statement

The following recommendations are based on existing guidelines addressing the management of women with PAS. As women with PAS require specialist peri-operative, intraoperative and post-operative care, a centre providing an MDT service should have a minimum level of care standards.

The RCOG and FIGO guidelines both make recommendations regarding standard of care for women with PAS, in addition to managing women within an MDT ^{36 37}. While the specialists who should make up an MDT are not clearly defined, both guidelines recommend the onsite availability of fetal maternal specialists for the diagnosis of PAS, access to surgeons with expertise in complex pelvic surgery, usually a gynaec-oncologist and senior anaesthetic staff as a minimum requirement.

The RCOG Guideline recommends women with PAS should be delivered in centres where at a minimum a level 2 critical care bed is available, with access to blood products on site, and availability of neonatal intensive care services ³⁷. In addition to these recommendations, FIGO advises access to an adult intensive care unit, capacity for massive transfusion, additional surgical expertise when required (urology, vascular surgery, general surgery) and cell saver ³⁶. A review from 2019 describing the components of MDT care in PAS further recommends the availability of an expert placental pathologist, research staff and on-site interventional radiology access ⁵⁸.

Clinical Practice

The Guideline committee considered the above recommendations from the existing guidelines by RCOG ³⁷, ACOG ⁵ and FIGO ³⁶ as described, and consensus was reached that the following represent the minimum requirements for units providing specialist care to women with PAS:

1. Multidisciplinary team available 24/7, consisting of:
 - a. Consultant Obstetrician – lead Obstetrician to co-ordinate PAS care in tertiary centre should be named at diagnosis
 - b. Consultant Anaesthesiologist
 - c. Consultant Surgeon with experience in advanced pelvic surgeon (such as a gynaecological oncologist)
 - d. Consultant Haematologist
 - e. Consultant Neonatologist
 - f. Consultant Interventional Radiologist
2. Neonatal intensive care
3. Centre should have massive transfusion protocol established and either PPH packs or POC TEG/TEM for target directed transfusion
4. On site blood bank with immediate access to PRC, plasma, fibrinogen concentrate & platelets
5. Cell salvage
6. Equipment for rapid infusion of warmed fluids/blood (see further details in Appendix 4: Theatre Equipment)

Clinical Question 2.12: What are the key elements that should be discussed and documented at an MDT meeting?

Evidence Statement

The following recommendations are based on expert opinion from healthcare providers experienced in the management of women with PAS. There is no literature specifically describing the key elements to be documented at each MDT meeting.

Clinical Practice

Appendix 5 provides a suggested template outlining key elements that should be discussed at a MDT meeting that can be placed in the woman's chart after each MDT meeting. A summary of antenatal imaging is included which outlines the features of PAS which are present and the expected depth of invasion/size of the defect. The checklist for ultrasonographic and MRI features in Appendix 3 should be used to ensure standardisation in reporting.

A clear surgical plan should be documented in the woman's chart including planned skin incision, uterine preservation or hysterectomy, and whether any additional surgical or radiological expertise should be available. Where women have been referred from another centre for assessment, the MDT report should be sent to the referring clinician in a timely manner. Any outstanding consultations or further imaging to be arranged should also be clearly documented.

Clinical Question 2.13: What consultations are recommended antenatally?

Clinical Practice

Women with PAS have complex care needs and benefit from additional expertise during pregnancy. The following are suggested antenatal consultations with members of the MDT which women and their support partners should have the opportunity to meet during the pregnancy.

1. Lead Obstetrician

PAS lead obstetrician

Once a suspicion of PAS has been made, a lead consultant obstetrician who will co-ordinate PAS care in the tertiary centre should be named. The role of the PAS lead obstetrician is to co-ordinate care relating to the diagnosis of PAS, such as ensuring referral is made to the PAS MDT, to feedback any decisions made at the MDT to the woman and her support partner, arrange additional consultations as described below and liaise with the local lead obstetrician providing regular antenatal care.

Lead obstetrician for antenatal care

As described in Section 2, theme 2 outpatient antenatal care, women with PAS should continue to attend for standard antenatal care to ensure routine investigations such as blood pressure and urine checks are performed. All women with PAS should remain under the care of a lead obstetrician in their local hospital where they will attend for standard antenatal care. The PAS lead obstetrician should ensure the local lead obstetrician is informed of the PAS MDT outcome and birth plan.

2. Lead Surgeon

PAS surgery often involves complex pelvic surgery and warrants the presence of surgeons with experience in such cases. Within an Irish maternity unit this is more than likely to be a Gynaecological Oncologist. A single centre review found the presence of a Gynaecological Oncologist at the start of PAS surgery rather than a “call as needed” approach is associated with less blood loss and transfusion requirements⁵⁹. Hence the presence of a surgeon with experience in pelvic surgery is an essential component of the MDT, and the lead surgeon should ideally meet with the woman and her support partner during the antenatal period. This allows for the opportunity to ask questions relating to the plan of care on the day of the birth.

3. Neonatology

Women with a diagnosis of PAS may require an iatrogenic preterm Caesarean birth. Various existing international guidelines advise to consider elective delivery from 34 weeks. ACOG recommends delivery from 34 weeks, RCOG from 34 weeks for high risk women and FIGO advises to consider from 34 weeks, while acknowledging the lack of high quality evidence to guide the optimum delivery gestation^{36 37} (see Part 2, theme 5, clinical question 2.33) Hence it can be anticipated that a significant number of women will have their baby admitted to the neonatal unit where a preterm delivery is performed and would benefit from antenatal review by a neonatologist to inform them of what this may involve.

4. Anaesthesiology

Women with suspected PAS should have an opportunity to meet with a consultant anaesthesiologist during pregnancy. This is further detailed in the section of peri-operative planning in Part 3 peri-operative care. In summary, any decisions around anaesthesia should be explained to the mother in the context of the surgical plan. The first pre-op meeting between the mother and anaesthesiologist should be at the earliest opportunity once a decision around surgical planning has been made.

During this meeting options available for anaesthesia are presented. Also involved is a specific discussion around events anticipated that may lead to emergent conversion to general anaesthesia and what this involves, and what to do in the event of an emergency. The mother is given the opportunity to consider what will be involved in each. This meeting will also provide an opportunity for the anaesthetist to identify specific anaesthesia issues such as airway, BMI, and any pre-existing comorbidities. Hence it is advisable to consider referring all women with suspected PAS for an antenatal consultation with an anaesthesiologist.

5. Other supports

Involvement of midwifery care throughout the antenatal period in keeping with routine antenatal care. Antenatal referral to physiotherapy, social work and mental health are discussed below within theme 4.

Clinical Question 2.14: How should the MDT monitor and audit their maternal and fetal outcomes?

Evidence Statement

Continuous monitoring and audit of maternal and fetal outcomes is essential to ensure continued improvement in clinical practice^{60 61}. There is extensive literature supporting the use of continuous audit and data collection as part of MDT care to improve outcomes in managing other conditions^{62 63 64}. Specifically, for PAS MDTs, a single centre retrospective study evaluating their maternal outcomes over time found continued improvement overtime as the MDT gained experience and learning⁵⁶.

Hence it follows that a team which collects and reviews their outcomes continuously will have identify opportunities for learning and can focus efforts on areas which require further improvement. Furthermore, audit and data collection allow comparison of outcomes between units and a standardised care approach to be implemented. Recommendations for audit outcomes are made in section 7.2, with particular focus on the use of the suggested checklists for ultrasound and MRI reporting.

Clinical Question 2.15: Within what timeframe should women be reviewed in a tertiary centre following referral?

Evidence Statement

There is no literature to report a specific timeframe within which women with suspected PAS should be reviewed in a tertiary centre following referral. The ACOG guidelines suggest that women should be reviewed “soon” so as to facilitate counselling and planning as early as possible⁵. The timeframe within which review is warranted will vary in each case, with factors such as gestational age, obstetric history and distance to tertiary unit being of particular relevance. The Guideline committee considered and discussed potential timeframes for review and agreed the following.

All women with suspected PAS prior to 24 weeks’ gestation at referral, should have been seen by or at 24 weeks. However, where women are beyond 24 weeks at the time of referral, tertiary units should aim to review women within 7 working days of referral. This facilitates timely diagnosis of PAS and allows as much time as possible to implement perioperative planning, while also minimising the time the woman is waiting, which may be associated with significant distress and anxiety.

Clinical Practice

Once a diagnosis of PAS is suspected, women should be referred to a tertiary referral centre with an established MDT with expertise in caring for women with PAS (see algorithm Referral pathway for Placenta Accreta Spectrum). Their care should be coordinated by a named senior obstetrician. Further antenatal care, such as frequency of ultrasound assessment, location of care, gestation of birth, will be determined at the MDT on a case-by-case basis. MDTs should audit their clinical outcomes and endeavour to review all women referred for assessment within a timely manner.

Recommendations – Section 2, Antenatal Care, Multidisciplinary Team Care

6. We recommend women diagnosed with PAS should have a named lead consultant obstetrician and be cared for by a multi-disciplinary team with expertise in the diagnosis and management of women with PAS.
7. We suggest where this is not available locally, a referral should be made to a tertiary centre.
8. We recommend the multi-disciplinary team should include, at a minimum, clinicians with expertise in diagnosis of PAS, to include fetal-maternal medicine specialists, senior anaesthesiologist, and surgeons with expertise in complex pelvic surgery, usually a gynaecological-oncologist.
9. We recommend that at each MDT meeting, the following key elements should be discussed: medical, surgical, and obstetric history, all available imaging performed in the current pregnancy, most recent blood results and any relevant events in this pregnancy such as bleeding. A summary of the MDT discussion and recommendations should be clearly documented in the woman's medical file after each meeting.
10. We recommend that women with suspected PAS prior to 24 weeks should be reviewed by 24 weeks' gestation, while those referred after 24 weeks should be reviewed in a tertiary centre within 7 working days from referral, where possible. Some women will warrant more urgent review depending on gestation and clinical circumstances.

OUTPATIENT ANTENATAL CARE

The following section will discuss the outpatient antenatal care for women after a diagnosis of PAS is suspected. Existing policies and recently published international documents were searched – there is very little available in the literature to guide practice. Hence the recommendations in this section are based on general guidance around antenatal care, good clinical practice, and committee consideration⁶⁵.

Clinical Question 2.16: Which women are suitable for outpatient monitoring?**Clinical Practice**

Most women with PAS are suitable for management in the outpatient setting for most of their pregnancy. However, care must be individualised, and certain clinical factors increase the need for inpatient care. Recommendations are based on good clinical practice and committee consideration.

Women who are at risk of needing an emergency delivery, such as those with recurrent bleeding, a history of preterm birth or ruptured membranes, or where additional fetal monitoring is warranted such as monitoring for fetal growth restriction etc., should be cared for in a hospital setting. Distance from the planned hospital for birth and difficulties with transport should be considered, especially in the third trimester. The challenges of childcare and prolonged separation for families should also be considered when planning location of care.

Women who are being managed in the outpatient setting should be provided with clear safeguarding instructions on when and how to contact the hospital, such as in the event of bleeding.

Tailor antenatal care, including hospitalisation, to individual woman's needs and social circumstances, such as distance between home and hospital and availability of transportation, previous bleeding episodes, haematology results and acceptance of receiving donor blood or blood products.

Where hospital admission has been decided, an assessment of risk factors for venous thromboembolism in pregnancy should be performed as outlined in the National Clinical Guideline for the diagnosis, management and prevention of Venous Thromboprophylaxis in pregnancy. <https://www.hse.ie/eng/services/publications/clinical-strategy-and-programmes/venous-thromboprophylaxis-in-pregnancy.pdf>. In addition, clinicians should refer to the Guideline on management of COVID for additional advice regarding VTE risk and COVID. This will need to balance the risk of developing a venous thromboembolism against the risk of bleeding from a placenta praevia or low-lying placenta.

Clinical Question 2.17: What is the minimum requirement for documentation in the woman's health file relating to the diagnosis of PAS?

Clinical Practice

The diagnosis or concern for PAS needs to be clearly articulated as a significant risk factor to the woman and her support partner. When giving information about the condition and the antenatal care for this pregnancy:

- Use clear language, and tailor the timing, content, and delivery of information to the needs and preferences of the woman and her stage of pregnancy
- Ensure information is evidence-based and consistent (information developed by Placenta Accreta Ireland relating to PAS aimed at women and their families can be found at: <https://www.nmh.ie/support-services/placenta-accreta-service.14585.html>)
- Information should support shared decision making between the woman and her healthcare team, and:
 - Offered on a one-to-one or couple basis and supplemented by written information in a suitable format, for example, digital, printed and be easy to read.
 - Consider offering access to support group discussions (women only or women and partners)

The plan for monitoring including bloods, scans, referrals and consultations (as appropriate) need to be clearly articulated.

Discussions and counselling events with the woman and her partner should be documented. The documentation should include a clear explanation of the condition, the risks and mitigations, including death, massive haemorrhage, bleeding, indications for blood transfusion, surgical and or pathology injuries to local structures, the need for life preserving surgery including hysterectomy, need for HDU/ICU admission and subsequent care and implications including complete sterility. Questions and concerns, queries or refusals of treatments should be addressed and documented

An appropriate birth plan should be made and documented – this should include where, when, who and how; where discussed at an MDT – the plan from the MDT can be used.

The pregnant woman and their GP should be provided with a copy of the plan which can be updated as the pregnancy progresses.

Clinical Question 2.18: How often should women attend for antenatal care?

Clinical Practice

The frequency of antenatal care will depend on the individual case. The minimum should be every 4 weeks up to 28 weeks and then twice weekly to 34 weeks. Individual circumstances such as anaemia, concerns for fetal growth may require more frequent visits.

Clinical Question 2.19: How often should women with suspected PAS have a full blood count performed?

Clinical Practice

Similar to uncomplicated pregnancies, women with placenta praevia should be screened for anaemia and investigated if their haemoglobin levels are outside the normal range (11 g/dl at first visit and 10.5 g/dl at 28 weeks of gestation). Iron supplementation should be implemented if indicated ⁶⁶

If the woman has anaemia – Haematinic (Ferritin, Vitamin B12 and Folic acid) evaluation should be considered, and supplementation provided as appropriate. Repeating the Haemoglobin at 32 weeks and prior to delivery would be good practice if the initial haemoglobins are within normal limits. More frequent checks may be needed to assess treatment response.

Clinical Question 2.20: Should women with suspected PAS who are being managed as out-patients have regular cross-match performed?

Evidence Statement

To inform this clinical questions, existing policies and recently published international documents on cross-matching and blood transfusion in pregnancy were reviewed ^{67 68 69 70}. The literature search did not return any guidance or evidence to support or recommend the practice of outpatient cross-matching for women with PAS.

Clinical Practice

For women with PAS who are suitable for outpatient management, we suggest is no need for regular cross matching of blood. However, where there are blood antigen antibodies present, women have recurrent bleeding, difficulty achieving a cross match for the woman, delayed access to availability of blood products (greater than 30 minutes), cross-matching may be indicated. These decisions will be made on a case-by-case basis at the PAS MDT meeting.

Clinical Question 2.21: **Should women with suspected PAS supplement with oral iron during pregnancy?**

Clinical Practice

Prevention and treatment of anaemia during the antenatal period is recommended for women with placenta praevia or a low-lying placenta as for any pregnant woman. Iron should be used if their haemoglobin levels are outside the normal range (11 g/dl at first visit and 10.5 g/dl at 28 weeks of gestation). However, as women with PAS are at risk of significant haemorrhage at the time of Caesarean birth, it is reasonable to offer women with PAS iron supplementation antenatally.

Clinical Question 2.22: **Should women with suspected PAS continue to attend their GP for combined antenatal care?**

Clinical Practice

As for clinical question 2.18 above – The frequency of antenatal care will depend on the individual case. The minimum should be every 4 weeks up to 28 weeks and then 2 weekly to 34 weeks. Individual circumstances such as anaemia, concerns for fetal growth may require more frequent visits. As these are complicated pregnancies, they should be attending the hospital service as outlined here, additional interval visits would be appropriate with the GP.

Clinical Question 2.23: **How often should fetal growth be monitored antenatally?**

Evidence Statement

There is a small risk of fetal growth restriction with placenta praevia and a clinical opinion that it is increased in PAS; therefore, these women should have regular scans for growth at 28, 32 and 34 weeks. Where women are identified with other risks for fetal growth restriction (*i.e.* hypertension, renal disease, diabetes mellitus, etc.), the scan schedule should be individualised.

There is very limited literature in this area, however a systematic review and meta-analysis for women with placenta praevia identified a small increased risk for fetal growth restriction ⁷¹. Most of the studies were retrospective and included 11 cohort and two case-control studies. A total of 1,593,226 singleton pregnancies were included, of which 10,575 had a placenta praevia. The incidence of growth abnormalities was 8.7/100 births in cases of placenta praevia vs. 5.8/100 births among controls. Relative to cases with alternative placental location, pregnancies with placenta praevia were associated with a mild increase in the risk of fetal growth restriction, with a pooled OR [95% confidence interval (CI)] of 1.19 (1.10-1.27). Statistical heterogeneity was high with an I² = 94%. The analysis concluded neonates from pregnancies with placenta praevia have a mild increase (20%) in the risk of fetal growth restriction. There was no specific data for women with PAS ⁷¹.

Another study involving 59,149 women, where 724 (1.2%) were diagnosed with a complete or partial praevia ⁷². After adjusting for significant confounding factors (black race, gestational diabetes, preeclampsia, and single umbilical artery), the risk of intrauterine growth restriction remained similar (adjusted odds ratio, 1.1; 95% confidence interval, 0.9-1.5). The presence of bleeding did not impact the risk of growth restriction. That study concluded placenta praevia is not associated with fetal growth restriction ⁷². Serial growth ultrasounds are not indicated in women with placenta praevia.

Clinical Practice

The recommendations made here for outpatient antenatal care for women with PAS are largely based on good clinical practice and committee consideration, as well as from guidelines relating to general antenatal care. Antenatal care should be tailored to women's specific needs and the clinical situation.

Recommendations – Section 2, Antenatal care, Outpatient Antenatal Care

11. We recommend women with a diagnosis of PAS are usually suitable for outpatient monitoring unless other clinical factors, such as bleeding, necessitate inpatient management.
12. We recommend where a diagnosis of PAS is suspected, clear documentation should be made in the woman's chart describing the plan for care.
13. We recommend women with PAS should have a full blood count performed in line with routine antenatal care to diagnose anaemia. Women with haemoglobin measurements outside of the normal range should supplement with iron.
14. As there is a small risk of fetal growth restriction with placenta praevia and a clinical opinion that it is increased in PAS, we recommend these women should have regular scans for growth at 28, 32 and 34 weeks.

ANTENATAL SUPPORTS

The following clinical questions will discuss the supports that should be offered to women during pregnancy after a suspicion of PAS has been made. The current literature summarising these recommendations is discussed through the following clinical questions in this section.

Clinical Question 2.24: What additional supports should women be offered antenatally once a diagnosis of PAS is suspected?

Evidence Statement

To inform the following recommendations, relevant existing literature was reviewed and is summarised below. Where no literature was available to inform recommendations, committee consensus from clinicians experienced in the care of women with PAS is drawn on.

Receiving a diagnosis of PAS can be a distressing event for a woman and her family. As the condition may result in a number of significant challenges for women such as a prolonged hospital stay, midline laparotomy, hysterectomy, intensive care admission and their baby being admitted to neonatal intensive care, it follows that women with PAS may benefit from additional supports during and after the pregnancy such as physiotherapy, mental health and patient advocacy groups.

Clinical Question 2.25: What specific antenatal educational resources should women be provided with?

Evidence Statement

PAS is an uncommon complication of pregnancy and hence women may be unfamiliar with or unaware of what the condition is and what the diagnosis means for their pregnancy. It is common for patients to seek information through the internet, but the availability of high-quality evidence-based information may not always be easily found or accessible. A systematic review found that 44% of pregnant women used the internet to seek health information during pregnancy, with a frequency of 1-2 times per week ⁷³, with a further study finding less than half of women discussed the information they found with their healthcare team ⁷⁴. Hence where specialist information is available women should be directed to these resources by their healthcare providers, such as resources developed by Placenta Accreta Ireland available at <https://www.nmh.ie/support-services/placenta-accreta-service.14585.html>.

Clinical Question 2.26: Should women be offered physiotherapy antenatally?

Evidence Statement

Women who experience a pregnancy complicated by PAS have specialist needs both antenatally and postnatally. Women with PAS may require prolonged hospital admission, a midline laparotomy, caesarean hysterectomy and intensive care admission, as well as the usual physical challenges of pregnancy. Hence women are likely to benefit from physiotherapy input early in pregnancy as well as during the postnatal period.

As part of the National Maternity Strategy 2016-2026 ⁷⁵, all maternity units should have access to a physiotherapy service of which women can avail during or after pregnancy.

Clinical Question 2.27: Should women be offered referral to social work antenatally?

Evidence Statement

The medical social work department within a maternity setting provides a diverse range of supports for women during and after pregnancy, including assistance mental health concerns, pregnancies complicated by medical conditions, practicalities of a hospital admission and an admission of a baby to the neonatal intensive care unit. The service is freely available to all women attending the hospital. There is limited literature exploring the impact of a medical social worker on maternal well-being. However, the provision and referral to the social work team is recommended for a variety of indications by the National Maternity Strategy 2016-2026 ⁷⁵, including for women at risk of mental health problems, those who may need assistance with accommodation or where a baby requires neonatal intensive care admission. Hence it follows that there are numerous challenges women with PAS may face antenatally and postnatally where the support of a Social Worker/Counsellor would be of value.

Clinical Question 2.28: In what circumstances should women be offered a mental health referral?

Evidence Statement

The evidence to support this recommendation is derived from a small number of studies which have examined the psychological impact of a pregnancy complicated by PAS.

A survey study including 142 women with a history of PAS compared overall quality of life at various time points after pregnancy ⁷⁶. Mental health domains were found to be lowest in the first 3 months after birth, with minimal improvements in scores seen over time up to 2 years postnatal. A further study comparing women with PAS to those who underwent a complicated caesarean section for other indications found women with PAS were significantly more likely to report anxiety/worry (OR 3.77, 95% CI 1.43-9.93), grief and depression (OR 2.45, 95% CI 0.87-6.95) and overall report decreased quality of life up to 36 months after the birth ⁷⁷.

Furthermore, a study comparing women who had an uncomplicated caesarean section, women with an antenatal diagnosis of PAS and those with an unexpected major obstetric haemorrhage, found women with an antenatal diagnosis of PAS were significantly more likely to develop post-traumatic stress disorder ⁷⁸. In a small study (N=11) exploring the impact of peripartum hysterectomy, the majority of which were performed for PAS, found all women experienced a decrease in quality of life at 6 months ⁷⁹.

Two qualitative studies have explored women's experience of a pregnancy complicated by PAS. The first included seven women who were interviewed up to two years after a diagnosis of PAS and found women experienced significant challenges with long term hospitalisation, a fear of dying and feelings of worry which persisted many months after the pregnancy ⁸⁰. The women who were interviewed all highlighted the need for mental health supports and felt they would have benefited from these. The second study included 17 women with PAS, with interviews revealing the emotional burden of the diagnosis, fear and uncertainty during the pregnancy and birth related trauma ⁸¹.

In summary, women with a diagnosis of PAS are at risk of a deterioration in quality of life and mental well-being both during and after pregnancy. While no studies to date have explored the impact of mental health supports for women with PAS, it follows that these are likely to be of benefit for this group of women who are clearly at risk during what can be an extremely challenging pregnancy.

Clinical Question 2.29: Should women be offered support from patient support and advocacy groups?

Evidence Statement

No studies to date have specifically examined the role that patient advocacy groups play in supporting women with a diagnosis of PAS. However, interviews carried out with women with a diagnosis of PAS revealed they found having a “peer” who had experienced the condition to talk to helpful⁸⁰.

Placenta Accreta Ireland is a patient support and advocacy group within Ireland which offers a range of supports for women and their families who are or have experienced a pregnancy complicated by PAS. It is reasonable to offer all women contact details for the group so that they may avail of these supports as needed.

Clinical Practice

Women with PAS have specialist care needs and warrant additional supports during the antenatal and postnatal period. Women face both physical and psychological challenges and referral to support services such as physiotherapy and mental health may be of benefit to women with a diagnosis of PAS.

In addition, directing women to high quality evidence-based information will provide them with additional tools to educate and support themselves. As there is an established patient advocacy and support group within Ireland with experience in supporting women and their families with PAS, it is important to offer all women details on how to contact Placenta Accreta Ireland as they feel is needed.

While the acceptance of these additional supports will vary for each woman, it is recommended these services are offered to all. Furthermore, as many women with PAS will have a premature infant who may require admission to a Neonatal Intensive Care Unit, women and their families should be offered support services available to those with a baby in NICU, such as from the Irish Neonatal Health Alliance (<https://www.inha.ie/>). Additional supports, such as a tour of the NICU prior to the birth, should also be offered where available.

Recommendations – Section 2, Antenatal Care, Antenatal Supports

15. We recommend women with a diagnosis of PAS should be referred to physiotherapy antenatally and be reviewed postnatally both while in hospital, as well as being offered a follow up visit after discharge.
16. We recommend women are provided with antenatal educational resources specifically addressing PAS in a format most acceptable to them (website, video, printed information).
17. We recommend women should be offered review by social work counselling team, particularly where women experience a prolonged hospital admission or delivery away from their local hospital is anticipated.
18. We recommend a perinatal mental health referral should be offered to all women with a diagnosis of PAS during pregnancy and again in the postnatal period. Where referral is declined, clear instructions on how to contact the service in the future should be provided.

INPATIENT CARE

Women with PAS will often be suitable for outpatient care and do not require hospital admission in all cases. However, in certain circumstances inpatient care will be necessary. The following section will discuss the inpatient antenatal care for women after a diagnosis of PAS is suspected.

Clinical Question 2.30: How should women admitted with antepartum haemorrhage or recurrent bleeding be managed?

Evidence Statement

The following recommendations are made based on peer reviewed publications, and where no supporting literature is available, consensus from the Guideline committee on best practice.

There is no literature which accurately reflects the incidence of antepartum haemorrhage in women with PAS. Where women present with an antepartum haemorrhage, the initial management should focus on basic resuscitation and assessment of maternal haemodynamic status as described for any women presenting with bleeding during pregnancy⁸². This should include assessing airway, breathing and circulation, establishing intra-venous access, sending blood for assessment of full blood count and for cross-matched blood, and monitoring fetal wellbeing using a cardiotocograph⁶⁷.

If a woman presents with a non-substantial antepartum haemorrhage and is found to be vitally stable, there is no further bleeding and fetal well-being is confirmed using cardiotocograph, admission for a period of observation is recommended. Review by a senior obstetrician is recommended and a member of the MDT informed of the women's admission. The hospital blood bank should be notified when a woman with PAS is admitted and kept informed of birth plans.

The duration of observation will depend on an individual case by case basis, taking into account the clinical history and other factors such as distance from hospital. Where women have had more than one bleed, admission until delivery is usually warranted. The recommended gestation for Caesarean birth where bleeding has stopped and, where there are no maternal or fetal concerns, will be determined on an individual basis by the MDT.

Women who are rhesus negative should be administered anti-D as per national guidance, 'The use of Anti-D immunoglobulin for the prevention of RHD haemolytic disease of the Newborn,' (available from <https://www.rcpi.ie/faculties/obstetricians-and-gynaecologists/national-clinical-guidelines-in-obstetrics-and-gynaecology/>) unless other circumstances exist where anti-D is not indicated such as fetal blood type is known to be rhesus-negative or woman has been previously sensitised ⁸³.

Clinical Question 2.31: Should women be cross-matched while an inpatient?

Evidence Statement

Women with PAS are at risk of significant blood loss at the time of birth, but also during the antenatal period, particularly where there have been previous episodes of antepartum haemorrhage ^{6 7}. It is recommended that all women with PAS who require hospital admission should have cross-matched blood available on site. In particular, women with red cell antibodies where there may be difficulties obtaining antibody negative blood or cross matching issues warrant readily available cross matched blood ^{83 84}.

Clinical Question 2.32: What thromboprophylaxis is recommended?

Evidence Statement

Venous thromboembolism remains a leading cause of direct maternal death ⁸⁵, and hospital admission is a significant risk factor, conferring an eighteen times higher risk ⁸⁶. Hence pregnant women admitted to hospital are often recommended to have pharmacological thromboprophylaxis for the duration of hospital admission ⁸⁷. However, each woman should have an individual risk assessment and a risk benefit analysis performed prior to commencing pharmacological thromboprophylaxis.

Where women with PAS are admitted with an antepartum haemorrhage or at risk of bleeding, or delivery is planned, pharmacological thromboprophylaxis should be avoided. In selected high-risk cases, such as women with a previous venous thromboembolism, the decision to commence pharmacological thromboprophylaxis, at what dose and for what duration should be made in conjunction with the MDT and a haematologist.

While admitted to hospital, women should be provided with anti-embolism stockings of the appropriate size to reduce the risk of thromboembolism ⁸⁸. In addition, women should be encouraged to maintain adequate hydration and encourage mobilisation ⁸⁹.

Clinical Practice

Women with PAS who have an otherwise uncomplicated antenatal course, can attend the hospital for regular appointments and have had no episodes of ante-partum haemorrhage, can receive antenatal care as an outpatient.

Some women will require inpatient care of varying duration depending on the individual clinical circumstances. Decisions regarding admission to hospital will further be influenced by social factors and distance from hospital and should be made by a senior obstetrician.

Recommendations – Section 2, Inpatient Care

19. We recommend women with PAS who have an antepartum haemorrhage should be admitted to hospital for a period of observation in a tertiary centre. Where women experience recurrent bleeding, we suggest admission until delivery is advisable.
20. We recommend admission criteria for women with PAS are considered on an individual bases, as these will be influenced by other factors such as distance from hospital and social circumstances and should be decided on a case-by-case basis.
21. We recommend where women with PAS are admitted to hospital, that cross matched blood is available for them.
22. When deciding to administer pharmacological thromboprophylaxis to women with PAS, we suggest a risk assessment should be made to determine the woman's individual risk of VTE which will need to be carefully balanced against the risk of bleeding and timing of birth.

TIMING OF BIRTH

The following section will discuss the outpatient antenatal care for women after a diagnosis of PAS is suspected.

Clinical Question 2.33: At what gestational age is delivery recommended in women with suspected PAS?

Evidence Statement

The following recommendations are based on existing guidelines and a decision tree analysis published in a peer reviewed journal.

An important factor in reducing maternal morbidity for women with PAS is to aim for an elective birth^{5 36}. A number of guidelines have made recommendations as to the optimal timing of birth for women with PAS. The RCOG Guideline advises to consider delivery between 35+0-36+6 weeks³⁷, however for those who have risk factors for pre-term birth or antepartum haemorrhage they suggest delivery from 34+0 weeks. The ACOG Guideline recommends considering delivery from 34+0 weeks, and not to delay beyond 36+0 weeks⁵. The international FIGO Guideline advise to consider delivery from 34+0 weeks, however they suggest it is reasonable to wait until 36+6 where women have not previously had ante-partum bleeding or risk factors for early delivery³⁶.

A decision tree analysis which explored birth at each gestation from 34-39 weeks and considered factors in their model such as ICU admission, perinatal mortality, infant mortality and respiratory distress syndrome, found that the preferred timing of birth was 34 weeks with the administration of antenatal corticosteroids. Beyond this gestation there was an increasing likelihood of emergency birth. The decision tree also concluded that in no scenario was there a benefit to waiting beyond 37 weeks⁹⁰.

Hence there is consensus that women with PAS warrant an elective late preterm birth, however the exact gestational timing is not clear. However, all guidelines suggest it is reasonable to consider delivery from 34 weeks and not to delay beyond 37 weeks. After reviewing current guidelines, consensus from the committee was agreed to recommend Caesarean birth between 34-36+6 weeks' gestation with the administration of timed antenatal corticosteroids.

Decisions regarding delivery and timing of birth should be made at the MDT meeting and take into consideration individual risk factors such as anticipated surgical complexity, prior antepartum haemorrhage or preterm risk factors. In selected cases, an elective delivery prior to 34 weeks may be necessary, however these decisions should be made on an individual basis in conjunction with the MDT.

Clinical Question 2.34: At what gestational age is delivery recommended for women with antepartum bleeding?

Evidence Statement

As described above, women with PAS should be recommended to have a Caesarean birth between 34-36 weeks' gestation. Individual risk factors will influence the exact timing of birth. Where women have had recurrent bleeding during pregnancy, delivery closer to 34 weeks' gestation is likely to reduce the risk of emergency birth. Women with no preterm risk factors diagnosed with PAS are less likely to have an emergency birth prior to 36 weeks⁹¹. Hence the individual clinical factors should be considered when making decisions regarding timing of birth within the suggested timeframe of 34-36+6 weeks.

Clinical Question 2.35: At what gestational age should corticosteroids be administered for fetal lung maturity?

Evidence Statement

The Guideline acknowledges that there is a separate Guideline under review which describes the current literature relating to the antenatal administration of corticosteroids, hence a detailed exploration of the literature is beyond the scope of this Guideline. However, it is briefly considered here as the recommendations made for the management of PAS include an elective preterm Caesarean section. The preterm labour Guideline is currently under development, please visit <https://www.rcpi.ie/faculties/obstetricians-and-gynaecologists/national-clinical-guidelines-in-obstetrics-and-gynaecology/> for the most up to date information.

In brief, a 2017 Cochrane review summarised the current literature and found a single dose of timed antenatal corticosteroids (betamethasone, dexamethasone or hydrocortisone) is associated with a reduction in the most serious adverse neonatal outcomes related to preterm birth, namely perinatal death (average risk ratio (RR) 0.72, 95% confidence interval (CI) 0.58 to 0.89), neonatal death (RR 0.69, 95% CI 0.59 to 0.81), respiratory distress syndrome (average RR 0.66, 95% CI 0.56 to 0.77), intraventricular haemorrhage (average RR 0.55, 95% CI 0.40 to 0.76) and necrotising enterocolitis (RR 0.50, 95% CI 0.32 to 0.78) compared to placebo or no treatment ⁹².

A randomised control trial for women at risk of late pre-term birth (34-36 weeks), found neonates in the corticosteroids group were significantly less likely to suffer respiratory complications compared to those who received no treatment ⁹³. Current guidelines recommend corticosteroids are administered 24 hours to 7 days prior to birth as they are most effective for reducing neonatal morbidity within that timeframe ^{92 94}.

For further recommendations regarding the administration on antenatal corticosteroids and magnesium sulphate, please refer to <https://www.rcpi.ie/faculties/obstetricians-and-gynaecologists/national-clinical-guidelines-in-obstetrics-and-gynaecology/>. The National Clinical Guideline for the use of Antenatal Corticosteroids in pregnancy, is currently under development within the National Maternity Guideline Programme within the National Women and Infants Health Programme (NWIHP) and the Institute of Obstetricians and Gynaecologists (IOG).

Clinical Practice

Women with PAS are best delivered in an elective setting to ensure all the necessary preparations and healthcare staff are available on the day of the surgery. In order to facilitate elective birth, an elective pre-term Caesarean section is recommended in the majority of cases with suspected PAS. This minimises the risk of an emergency section. All decisions regarding gestation at birth should be made at the MDT meetings and clearly documented in the woman's chart. Women should be informed that the clinical scenario may change during pregnancy and in certain cases the most appropriate gestation for birth will change as new clinical information becomes available. The majority of women should be planned to have a Caesarean birth from 34 weeks' gestation, with no benefit to waiting beyond 36 weeks.

Recommendations – Section 2, Delivery Timing

23. We suggest delivery for women with suspected PAS should be considered from 34 weeks' gestation, and not delayed beyond 36+6 weeks. Each case should be discussed at the MDT meeting to finalise the most appropriate gestation, taking into consideration individual clinical factors.
24. We recommend that in selected individual cases, an elective Caesarean section prior to 34 weeks' gestation may be indicated.
25. We suggest women with PAS who will give birth prior to 34+6 weeks' gestation should have antenatal timed corticosteroids administered for fetal lung maturity.

Clinical Questions; Section 3 – Peri-operative care

Introduction

The following section will discuss the peri-operative and anaesthetic management of women with PAS. The recommendations made were developed with input from neonatology and, as with each stage of the Guideline development, a patient advocate.

Clinical Question 2.36: When should the first anaesthesia consultation take place?

Clinical Practice

Anaesthesia consultation should take place when the diagnosis or a high index of suspicion is established. This allows time for the mother to be informed of the options available and for the anaesthetic team to identify any potential challenges for anaesthesia.

Clinical Question 2.37: What issues should be addressed at the anaesthesia consultations?

Clinical Practice

The following recommendations are based on expert opinion and best practice as considered by the Guideline committee. As described above, the consultation with an anaesthesiologist provides the women and her support partner with the opportunity to be informed of the various modes of anaesthesia available for PAS surgery and for any potential challenges with anaesthesia to be identified. This consultation provides an opportunity for a shared discussion between the woman and the anaesthesiologist around pain relief options.

The following summarises some of the key issues which should be addressed at this consultation:

1. Education about neuroaxial (NA), general anaesthesia (GA) and combined approach (see 4 & 5 below)
2. Identification of any co-morbidities with implications for anaesthesia in particular:
 - Suspected or known difficult airway
 - Significant systemic disease including obesity
 - Long term medications
 - Allergies including Latex

3. Strategy for optimising care in case of bleeding
 - a. Provide information regarding the probability of major haemorrhage and its management if it occurs
 - b. Identify and treat anaemia
 - c. Identify any factors complicating emergency transfusion
 - Atypical antibodies
 - Objections to any blood products for any reason, discussion documented
 - Difficult intravenous access related to prior venous access or body habitus
4. Discuss the plan for emergency presentation with bleeding
5. Consider a written copy of plan for the mother to keep in the event of emergency presentation
 - A peri and post-operative plan for pain relief should be discussed
 - A clear plan for step down pain management in the postnatal period

Clinical Question 2.38: What are the specific anaesthesia considerations in PAS surgery?

Evidence Statement

Mode of Anaesthesia

The following section describes the specific anaesthetic considerations for PAS. A number of publications have discussed the anaesthetic considerations for PAS Anaesthesia^{95 96 97 98}. The risks and benefits of the various modes of anaesthesia available are summarised in Appendix 6. Options will be defined and constrained by a clear surgical plan and contingencies and should consider the plan for placement of intravascular balloons, the extent of surgical incision and dissection anticipated before birth and the risk of rapid high volume blood loss requiring rapid delivery and maternal resuscitation. Once the surgical plan is established, the choice of anaesthetic technique should be made by the anaesthesiologist conducting the procedure in consultation with the woman prior to surgery.

Neuraxial anaesthesia can be successfully applied in many cases. The factors driving the decision are diverse and must encompass consideration of maternal preference, surgical complexity and co-morbidities rendering rapid conversion to GA hazardous.

Analgesia

Regardless of the anaesthetic technique employed, post-operative analgesia must be planned. Epidural analgesia with local anaesthetic and opioid is recommended for pain relief after open colorectal surgery and should be offered where possible, even if the plan for primary anaesthesia is general. Multimodal systemic analgesia can complement neuraxial analgesia if there are no contraindications. Alternative analgesic options include wound infusion catheters, truncal blocks and patient-controlled analgesia.

The updated National Clinical Guideline for 'The Prevention and Management of Post-partum Haemorrhage, is currently under development within the National Maternity Guideline Programme. Please see <https://www.rcpi.ie/faculties/obstetricians-and-gynaecologists/national-clinical-guidelines-in-obstetrics-and-gynaecology/> for updates.

Clinical Question 2.39: What is known about the implications for fetal outcome of spinal anaesthesia, epidural anaesthesia, general anaesthesia as a single technique and general anaesthesia as a hybrid technique with neuraxial anaesthesia?

Evidence Statement

A number of publications have described the fetal implications of maternal anaesthesia. The Paediatric Anaesthesia & NeuroDevelopment Assessment Study (**PANDA**)⁹⁹ and the Neurodevelopmental outcome at 5 years of age after general anaesthesia or awake-regional anaesthesia in infancy (**GAS**)¹⁰⁰ studies are the most important to date and are discussed below. Further supporting evidence is described in Appendix 7.

1. **PANDA**⁹⁹ – A sibling-matched cohort study (PANDA) showed that among healthy children with a single anaesthesia exposure before age 36 months, compared with healthy siblings with no anaesthesia exposure, there were no statistically significant differences in IQ scores in later childhood. No statistically significant differences in mean scores were found between sibling pairs in memory/learning, motor/processing speed, visuospatial function, attention, executive function, language, or behaviour. The authors highlighted that further study of repeated exposure, prolonged exposure, and vulnerable subgroups is needed.

2. **GAS**¹⁰⁰ – Neurodevelopmental outcome at 5 years of age after general anaesthesia or awake-regional anaesthesia in infancy (GAS): an international, multicentre, randomised, controlled equivalence trial. The study randomised 722 infants to either were randomly allocated to the awake-regional anaesthesia group and or to the general anaesthesia group in a 1:1 ratio. The primary outcome measure was a full-scale intelligence quotient (FSIQ) on the Wechsler Preschool and Primary Scale of Intelligence, third edition (WPPSI-III), at 5 years of age. The trial found just under an hour of general anaesthesia in early infancy does not alter neurodevelopmental outcome at age 5 years compared with awake-regional anaesthesia.

Hence in the GAS¹⁰⁰ and PANDA⁹⁹ studies, both of which included detailed neurodevelopmental assessments, showed that a single brief (< 1 hr) exposure to general anaesthesia in early infancy was not associated with poorer neurodevelopmental outcomes.

In summary, while there is compelling pre-clinical evidence that all anaesthetic drugs (with the possible exception of xenon, dexmedetomidine and opioids) can be harmful to the developing brain, there is no clear translation of this observation to the perinatal human brain. Prolonged anaesthetic exposure (>120 minutes) in infants is associated with a surgical condition that confounds interpretation of the neurobehavioral outcome as the child grows. There is stronger human evidence that a single brief exposure in healthy infants does not have a negative neurobehavioral impact.

Clinical Question 2.40: What approach is recommended to anaesthesia for PAS surgery?

Clinical Practice

The anaesthesia plan should be arrived at in discussion with the mother and her support partner after adequate information has been provided. Adequate education and time for consideration should be afforded to the parents prior to decision making. This should include detailed explanation of the contingencies should a departure from the primary plan be necessary. As the surgical environment during these cases is often crowded, noisy and sometimes tense, every effort should be made to talk through the experience with the parents in advance.

Specific technical requirements include:

- Large bore peripheral IV lines
- Arterial line
- TEDS and Sequential Compression Device stockings (SCDs)
- Very low threshold for elective central venous catheter (CVC) placement
- Cross matched blood and/or defrosted plasma in theatre and appropriate products (specifically Fibrinogen concentrate) available in lab onsite
- Cell salvage set up for use before commencing surgery
- If primary neuraxial anaesthesia, set up for rapid general anaesthesia conversion
- Two fluid warmers and external warming strategy (conductive warmer, forced air warmer)
- Vasopressors set up: phenylephrine, metaraminol and noradrenaline
- Neuraxial, neuraxial and general anaesthesia, and general anaesthesia only are all options
- If primary GA planned consider pre-induction neuroaxial as analgesic component of general anaesthesia, both single shot spinal, one needle CSE and two needle CSE have all been successfully used. Intrathecal catheters are an attractive option facilitating lower dose neuraxial opioids and repeated dosing but are associated with a high incidence of post-dural puncture headaches. However, they may be appropriate in some circumstances.
- Calcium and Magnesium available
- Tranexamic acid
- Consider adding 15-minute blood loss checks to theatre practice
- If general anaesthesia is either preferred or required, hypnosis may be maintained with either intravenous or volatile anaesthetic agents, ideally with neuraxial analgesia and depth of anaesthesia monitoring. While clinical evidence for harm is poor, it makes sense in light of pre-clinical studies to take practical measures to reduce the exposure of the fetus to anaesthetic drugs. Depth of anaesthesia monitoring and if possible neuraxial anaesthesia/analgesia should be in place prior to induction to avoid over-generous induction dosing and facilitate maintenance of adequate depth of anaesthesia while minimising total anaesthetic agent exposure.

Recommendations – Section 3, Peri-operative care

26. We recommend specialist centres providing care to women with PAS should have 24-hour availability of a multi-disciplinary team including consultant obstetrician, anaesthesiologist, surgeon with advanced pelvic skills, haematology and neonatology.
27. We recommend an anaesthesia consultation should be arranged as early as possible following suspicion of PAS to facilitate discussion around anaesthetic options available and identify any potential challenges with anaesthesia.
28. We suggest suitable approaches for anaesthesia for PAS include neuraxial, neuraxial + general anaesthesia, and general anaesthesia. The most suitable approach will take into consideration individual clinical factors as well as the woman's preference.

Clinical Questions; Section 4 – Intraoperative care

SURGICAL APPROACH

The following section will discuss the intraoperative care of women diagnosed with PAS.

Clinical Question 2.41: What is the recommended surgical approach for the management of women with PAS?

Evidence Statement

General Principles of Surgical Approach to PAS

There are no randomised trials comparing the ideal surgical approach for PAS, hence no recommendations can be made as to which surgical approach is best. The variation in clinical practice and surgical approach to PAS was highlighted in a 2022 publication comparing the outcomes of women with PAS managed in the UK and France ¹⁰¹. There were significant differences in the rate of caesarean hysterectomy, which was 43% in the UK and 26% in France. Furthermore, the median blood loss in the UK was significantly higher although the French cohort had a higher rate of uterine conservation (3L (IQR 1.7-6.5 L), compared with 1 L (IQR 0.5-2.5L) ¹⁰¹.

Studies have described successful outcomes with uterine conservation techniques such as leaving the placenta in situ ^{102 103 104}. An observational study compared leaving the placenta in situ with caesarean hysterectomy and, while women who underwent conservative management had less blood transfusion requirements and blood loss of >3000ml, they had a higher rate of arterial embolisation, endometritis, and readmission within 6 months postpartum ¹⁰⁵. Overall, there is no strong evidence to recommend one technique over another as this will be heavily influenced by the surgical expertise available.

Therefore, it was the opinion of the Guideline committee there is insufficient evidence to recommend one surgical technique over another. However, there are a number of general good practice points that can be applied to the surgical approach to PAS. Patient selection and local surgical expertise will obviously have a major impact on the surgical approach.

Clinical Practice

Important general principles include

1. Positioning – woman should be placed in a dorsal lithotomy position, with right sided tilt/wedge. Legs should be placed in Lloyd Davis stirrups with TED stockings and sequential compression devices.

Good practice point: Local theatre teams should be educated that women transferred to theatres for emergency delivery should be placed in dorsal lithotomy if waiting on surgical team to arrive.

2. Incision – many cases require a midline laparotomy, however the appropriate skin incision should be decided and documented at MDT meeting.
3. Exposure – a self-retaining retractor (Bookwalter or Omnitract) is required for many PAS cases and should be available in MDT centers.

Good practice point: Local theatre teams should be educated in set up and maintenance of self-retaining retractors and specific surgical instruments and devices used in PAS cases.

4. Intraoperative assessment – a careful inspection of the placenta, uterine lower segment, bladder and parametrium should be performed once adequate exposure has been obtained. We suggest intraoperative findings are clearly described and documented according to the FIGO laparotomy classification¹²⁷ to ensure for standardised, reproducible reporting.
5. Uterine incision – a uterine incision should be made away from the placenta (usually in the fundus) if the plan is to proceed directly to hysterectomy. Surgical Stapler devices may reduce blood loss¹⁰⁶, the hysterotomy site should be closed before proceeding to hysterectomy. The uterine incision in conservative uterine preserving procedures will be made at the discretion of the surgeon.
6. Removal of the placenta – attempts should not be made to remove the placenta piecemeal as this increases blood loss, if proceeding to hysterectomy the placenta should not be disturbed, in uterine conserving procedures the area of adherent myometrium should be excised en-bloc with the placenta.
7. Oxytocin administration – oxytocin should be avoided in cases where a planned caesarean hysterectomy is being performed, as this may increase the risk of bleeding due to partial placental separation. In cases where an attempt at uterine conservation is being made, oxytocin can be commenced for the third stage to facilitate placental separation. Prior to commencing oxytocin, careful intraoperative assessment of the extent of placental adherence or invasion should be made¹⁰⁷.

The following section will describe a suggested surgical approach for women with PAS. The recommendations are based on a limited number of studies which have described a surgical approach to PAS and the experience of the surgeons who were members of the Guideline committee.

The following techniques are described, with detailed explanations of each technique provided in Appendix 8:

1. Hysterectomy
2. Invasion Topography – predicting and managing difficult cases.
3. Uterine preserving surgery
 - 3.1 Leaving the placenta in situ
 - 3.2 One-step conservative surgery
 - 3.3 Triple-P procedure
4. Surgical complications

Clinical Question 2.42: What should be included in the consent process for women undergoing caesarean birth for PAS?

Evidence Statement

The individual surgical risks in PAS reported in the literature vary widely between studies, as they will depend on multiple factors such as the percentage of women with an antenatal diagnosis rate, the rate of emergency deliveries, planned surgical approach and the severity of PAS cases included, as well as the input of MDT care^{5 19 36}. Allen *et al.*¹⁰⁸ reported on the risks associated with PAS surgery using data from various studies^{109 110}. Overall, they reported a median blood loss of 2000-3000ml, with a median of 3.5-5.4 units of RCC transfused¹⁰⁸. There was wide variation in the incidence of urinary tract injuries, with the risk of bladder injury ranging from 7-48% and the ureteric injury rate from 0-18%¹⁰⁸. The risk of maternal mortality ranged from 1-7%, with more recent studies reporting a much lower incidence^{36 37}. The only reported Irish data to date of women with PAS managed with an MDT (N=28) reported a median blood loss of 1975mL (495-8500), 53% of women receiving a blood transfusion and ureteric injury rate of 3%¹⁹.

Hence the reported incidence of specific risks in the literature varies widely and may not be reflective of the risk to women depending on where they are receiving care. Hence units caring for women with PAS should, where possible, collect surgical outcome data over time and provide women with data which is reflective of the practice and risks within that unit, albeit the numbers may be small.

Clinical Practice

Women with PAS should have the opportunity to discuss their planned procedure with a senior obstetrician who will be involved in their surgery during the antenatal period. The consent process should involve an explanation of the planned surgical approach and an explanation as to why deviation from the proposed procedure may be required based on intraoperative findings. Informed consent should be obtained at the time of diagnosis and include the need for emergency Caesarean birth. Informed consent should involve discussion of specific risks relevant to PAS surgery including need for caesarean hysterectomy, injury to additional organs, particularly the bladder and the need for an indwelling catheter, major obstetric haemorrhage which may require a blood transfusion, and admission to an intensive care unit. The need for additional procedures such as interventional radiology and ureteric stenting should be outlined. General risks relating to surgery should also be considered, wound infection, pain, and the risk of venous thromboembolism. We recommend that women who are planned for uterine conserving surgery should be offered bilateral salpingectomy at the time of the birth as a contraceptive option. This should be clearly documented in the woman's chart and form part of the signed, informed consent.

Various surgical techniques and approaches for the management of PAS have been described. Ultimately the most appropriate surgical approach will depend on multiple factors such as expected disease severity, surgical experience and the woman's preferences and informed consent. Final decisions regarding the planned surgical approach should be discussed by the MDT.

There is no strong evidence to recommend a particular technique over another and hence each case should be planned based on the individual woman factors. Informed consent process should be undertaken by a senior obstetrician involved in the woman's care and provide an explanation of the planned procedure and associated risks.

Recommendations – Section 4, Surgical Approach

29. We recommend several good practice points which units caring for women with PAS can consider intraoperatively: position woman in dorsal lithotomy, ensure adequate exposure using self-retaining retractors, incise the uterus away from the placenta.
30. We recommend attempts at manual removal of the placenta are avoided where intraoperative findings confirm PAS.
31. We recommend units caring for women with PAS should provide education for theatre staff regarding the preparation and intraoperative management for PAS cases.
32. We recommend that decisions regarding hysterectomy and uterine conservation should be made at the MDT meeting and take into consideration disease severity, the woman's preferences, and available surgical expertise.
33. We recommend informed consent should be obtained by a senior obstetrician who can counsel women on the possible associated risks, particularly caesarean hysterectomy, blood transfusion, damage to local organs including bladder and ureters, need for HDU/ICU admission and death.

INTERVENTIONAL RADIOLOGY

The following section will consider the Endovascular Options in the Management PAS and the role of Interventional Radiology (IR).

Clinical Question 2.43: What is the role of interventional radiology in PAS?

Adjunctive interventional radiology (IR) approaches aimed at reducing blood loss include internal iliac artery balloon occlusion, aortic balloon occlusion, and uterine artery embolisation (UAE) ^{111 112 113 114 115}. These minimally invasive endovascular approaches have increased in availability, usage and evidence base over the last two decades, although there remains significant heterogeneity to practice patterns and care-pathways, even in high volume centres. The aims of IR techniques are to reduce massive haemorrhage, transfusion requirement, reduce requirement for hysterectomy and ultimately reduce maternal mortality.

Clinical Question 2.44: When should interventional radiology be used in PAS?

IR techniques are reserved for PAS cases where US and MRI suggest high risk for maternal haemorrhage. Imaging factors suggesting high risk include low lateral and/or posterior disease with parametrial involvement and suspected urinary bladder involvement (FIGO 3b, 3c ¹¹⁶). Uterine conservation is challenging in women with PAS and when desired and considered a possibility, prophylactic balloon occlusion should be considered to optimise the chances of success.

Clinical Question 2.45: When interventional radiology is used, which technique should be used?

Temporary intermittent intraoperative **prophylactic balloon occlusion** (PBO) techniques have been reported widely as being the favoured technique with **embolisation** reserved for postpartum haemorrhage management. PBO can be performed with fluoroscopic and/or intravascular ultrasound guidance. Whether balloon positioning is performed in the IR suite or operating theatre, is ultimately at the discretion of local clinicians. Reported balloon occlusion locations include infrarenal abdominal aorta, bilateral common iliac artery, bilateral internal iliac artery, and bilateral uterine artery.

Internal iliac artery balloon occlusion

Iliac artery occlusion balloon placement is typically performed in the interventional radiology suite prior to transfer to an operating theatre for caesarean hysterectomy. Bilateral common femoral artery vascular access is obtained with either 5-F or 6-F vascular sheaths. A 5-French catheter is then used to select the contralateral internal iliac arteries from each femoral access. Contrast material is then injected to confirm catheter location.

Occlusion balloon catheters are then advanced into the anterior division of each internal iliac artery. Dilute contrast material is slowly injected into each balloon until the balloons are inflated to the point of vessel occlusion. The balloons were then deflated, and the volume of contrast needed to inflate the balloons is recorded and marked on the syringes. The woman is then transferred to the operating theatre and the balloons are inflated during surgery at the discretion of the operating surgeon¹¹⁷. Balloons are deflated before skin closure and the catheters are removed. Haemostasis is achieved with manual compression or a closure device according to local practice.

The potential benefits of bilateral iliac artery balloon occlusion include good local haemostasis, readily available equipment and expertise in most IR departments, and the ability to rapidly convert to a uterine or iliac artery embolisation in the event of prolonged or massive haemorrhage (given that the catheters are already in place in the target locations). However, there are several downsides to this approach. Firstly, it requires management of, and transfer to and from the IR angiography suite. Secondly there is a radiation burden to the woman and fetus. Estimated average fetal radiation doses are 29.4 ± 25.0 mGy during internal iliac artery balloon occlusion¹¹⁸. Thirdly, there is a risk of balloon dislodgement during transfer. This may result in either inadequate occlusion (retrograde dislodgement) or arterial rupture (antegrade dislodgement). Finally, and perhaps most importantly, there is evidence for lack of substantial, and sustained, benefit.

With attempts at surgical ligation of uterine or internal iliac arteries, adequate control of bleeding occurs in less than 50% of cases¹¹⁹. In the gravid pelvis there are rich anastomoses with significant collateral circulation through the cervical, ovarian, rectal, femoral, lumbar, and sacral arteries. These collateral communications contribute to the relative ineffectiveness of targeted vascular ligation whether surgical or endovascular.

A case-control study compared 19 women who had intravascular (anterior iliac) balloon placement versus those who did not and there were no statistically significant differences seen in estimated blood loss, transfusion products, operative time, or postoperative hospital days¹²⁰. Furthermore, three randomised control trials have compared outcomes of women with PAS randomised to internal iliac balloon catheter insertion. A study including 27 women with PAS who were randomised to either pre-operative prophylactic balloon catheters and found no difference between groups compared by blood loss, transfusion requirements or peripartum complications, and 2 of 13 women who had a prophylactic

balloon catheter suffered reversible adverse events ¹²¹. A further randomised trial including 57 women with PAS of whom 29 were randomised to bilateral internal iliac artery ligation also found no difference in intraoperative blood loss between groups ¹²². Finally, a third randomised trial including 100 women with PAS again found no difference between transfusion requirements or blood loss between the internal iliac balloon catheter group and controls ¹²³.

Aortic Balloon Occlusion

Aortic balloon occlusion has been previously described as an emergency measure in the treatment of penetrating abdominal trauma and aortoenteric fistula. As opposed to iliac balloons, intra-aortic balloons (IABs) may decrease the morbidity associated with cases of severely abnormal placentation given that more proximal occlusion may better address the problem of collateral circulation. Also, given that the aorta is a larger calibre vessel with longer target landing zones, it would be reasonable to believe that balloons placed here may not result in some the harms found with iliac balloons. Finally, newer methods of placement of IABs under ultrasound guidance eliminate risks of fetal fluoroscopic exposure and enable placement in the same suite so that all procedures can be performed without moving the woman.

Clinical Question 2.46: What is the role for aortic balloons in PAS?

Evidence Statement

While there are conflicting data, a Bayesian network meta-analysis including over 5000 participants suggests that PBO of the abdominal aorta is not only more effective than non-occlusion intervention in reducing blood loss but also in reducing blood loss (600ml less compared to internal iliac artery occlusion), radiation dose and balloon occlusion duration when compared to other PBO techniques ¹²⁴.

In a pilot study of 16 women managed with IAB the balloon was inflated at least once in 15/16 (94%) cases. The median number of separate balloon inflations was 1 (range: 1-4). The median time of total balloon inflation was 60 mins (range: 3-156 mins). The maximum time of uninterrupted balloon inflation was 86 minutes and the median time of uninterrupted balloon inflation was 48 mins ¹¹⁵. At the termination of the procedure, the balloon is deflated and removed before skin closure, and after skin closure, the sheath removed.

A summary of complications relating to PBO procedures in PAS is provided in Table 3. Three randomised control trials describing internal iliac artery occlusion and 2 meta-analysis which include descriptions of complications relating to abdominal aortic occlusion are summarised.

Table 3: summary of complications of IR procedures in PAS

	Study description	N	Summary of outcome	Summary of IR procedure complications
Internal Iliac Arteries				
<i>Salim R et al. 2018</i> ¹²¹	RCT of prophylactic balloon catheters for PAS	27	No difference between groups in transfusion requirements, blood loss or peripartum complications	Adverse effects in N =2 (15.4%): Temporary leg pain and swelling, temporary buttock claudication
<i>Hussein et al. 2019</i> ¹²²	RCT of prophylactic internal iliac artery ligation for PAS	52	No difference between groups in blood loss, transfusion requirements	N=2: two cases of internal iliac vein injury, immediately corrected
<i>Chen M et al. 2020</i> ¹²³	RCT of internal iliac artery balloon occlusion for PAS	100	No difference between groups in units of RCCs transfused, blood loss Higher incidence of post-operative fever and cost in IR group	No severe balloon related complications Higher rate of postpartum fever in balloon group (18% versus 2%, p=0.02).
Abdominal aorta				
<i>Dai M et al. 2021</i> ¹²⁴	Metaanalysis of prophylactic balloon occlusion procedures in PAS	5105	Abdominal aortic occlusion resulted in reduced blood loss (mean reduction 600ml), reduced transfusion requirements and lower hysterectomy rates	Overall complication rate 2.2% (n=65) Artery thrombosis 1.2% (N=37)
<i>Chen L et al. 2019</i> ¹²⁵	Metanalysis of prophylactic abdominal aortic balloon occlusion in PAS	731	Abdominal aortic balloon reduced blood loss, blood transfusion requirements and hysterectomy rate	Overall balloon related morbidity rate 1.7% (N = 8): haematoma (N=3), venous thrombus (N=5)

Clinical Practice

Detailed description of prophylactic aortic balloon occlusion technique:

1. With the woman in a supine position, ultrasound guided micropuncture access is made into the right common femoral at the level of the femoral head using a single wall puncture technique. An 8Fr sheath is then positioned.
2. Intravascular ultrasound (e.g. PV035 Volcano, Phillips Volcano, San Diego, CA) localises the level of the lowest renal artery, sizes the infrarenal aorta diameter and the distance from the fully inserted sheath hub to the most inferior renal artery. A relatively compliant balloon (e.g. VACS balloon) is 1:1 sized to the diameter of the infrarenal aorta. The length of balloon catheter to be inserted is measured with distance, of maximum insertion length to avoid renal artery occlusion, marked on the catheter shaft with a Steri-Strip or equivalent.
3. Low pressure tubing is connected and passed above shoulder level for ease of access of the anaesthesiologist/interventionalist out of the way of the operators. The volume of saline required to expand the balloon to nominal size is then measured, the balloon deflated, and the sheath and occlusion balloon affixed to the skin with sutures and Tegaderm.
4. After the birth, test inflation can be performed with a pulse oximeter on either or both right and left great toes. Within seconds of inflation, flat line oximetry should be expected. Preference should be given to inflation at time of operative increased risk of bleeding or active bleeding with inflation time of up to 12-15 minutes and deflation for 1-2 minutes. After deflation, normal oximetry waveform should return to baseline within seconds. Intraoperatively, the aortic occlusion balloon is inflated with the saline at the discretion of the operating surgeon.
5. If balloon occlusion lasts longer than 40 minutes and there is no active haemorrhage, the balloon is deflated for several minutes to avoid lower-extremity ischemia.
6. Standard arterial closure device (e.g. Angioseal, Perclose) is utilised for haemostasis after over the wire removal of IVUS and sheath.

This may all be performed in a standard operating theatre, without need for angiographic equipment, lead protection for operators or women, or specialised angiographic operating tables. Hence logistically there are multiple benefits to the care plan.

Recommendations – Section 4, Interventional Radiology

34. We recommend the use of Interventional Radiology techniques in PAS should be decided on a case-by-case basis at the PAS MDT meeting.
35. We recommend where a decision has been made to use interventional radiology, decisions regarding which IR technique to use will be determined by the expertise available and the MDT.
36. We recommend the use of an aortic balloon, which has the advantage of being performed in a standard operating theatre, with no radiation exposure to the woman or staff and possible improved haemostasis over bilateral iliac artery occlusion.

Clinical Questions; Section 5 – Postnatal care

INPATIENT POST-NATAL CARE

The following section will discuss the inpatient postnatal management for women after a pregnancy complicated by PAS after surgery.

Clinical Question 2.47: Are there any special considerations for women with PAS in the postnatal period?

Women after PAS surgery have complex care needs. PAS surgery may involve midline laparotomy, caesarean hysterectomy, and major obstetric haemorrhage. There is limited evidence specific to the postnatal care of women with PAS, and hence specific recommendations cannot be made. However, general post-operative care relating to postnatal care after caesarean section and care after laparotomy can be applied.

Clinical Practice

The following is a suggested list of good-practice points for postnatal care:

1. Analgesia – women who underwent midline laparotomy and/or caesarean hysterectomy will have additional analgesic requirements compared to women who undergo routine caesarean section. Analgesia should be charted by the team providing care accordingly and administered at regular intervals. See part 3 on peri-operative care for further details.
2. Diagnosing anaemia – all women should have a full blood count performed after surgery to diagnose and treat anaemia, the timing of which should be individualised to the clinical situation. Women who were anaemic during pregnancy or those with anaemia diagnosed postnatally should be prescribed iron supplementation for at least 6 weeks postnatal ¹²⁶.
3. Thromboprophylaxis – in keeping with recommended guidelines for postnatal care, women after PAS surgery should have an individual VTE risk assessment performed to determine the mode and duration of thromboprophylaxis. All women should be provided with anti-embolism stockings of the appropriate size to reduce the risk of thromboembolism while an inpatient, and encouraged to maintain adequate hydration and encourage mobilisation, unless clinically contraindicated ^{89 127}. Current RCOG guidelines recommend all women following a caesarean section have at least 10 days of low-molecular weight heparin prescribed, however depending on the woman's individual risk score the duration may need to be increased to 6 weeks ⁸⁷. Peripartum hysterectomy is associated with a significantly higher risk of developing VTE and should be taken into consideration when calculating VTE risk scores ¹²⁸. As each PAS case will have individual clinical factors to consider, decisions regarding duration of thromboprophylaxis should be made on a case-by-case basis. Where a woman is readmitted during the postnatal period, a VTE risk assessment should be re-calculated and appropriate thromboprophylaxis prescribed.
4. Lactation support – women should be offered referral to a lactation consultant for support with breastfeeding

5. Debrief – the specialist team providing care should have the opportunity to debrief the woman and her support partner on the events of surgery, an explanation of what happened and what to expect in recovery milestones, and arrange outpatient follow up. This debrief should ideally take place within 6 weeks, with a clear plan in place to ensure this visit takes place within a timely manner, such as arranging the follow up appointment prior to the woman’s discharge.
6. Discharge information – when women are discharged from hospital care to community care, clear information of the events of pregnancy, diagnosis of PAS and details of the Caesarean birth should be communicated to the primary care team. If available, women should be provided with hand-held information providing a summary of the pregnancy so those providing community care who may not receive a discharge letter, such as the public health nurse, has the relevant information to provide appropriate follow up care. For women who have undergone uterine conserving surgery, contraceptive options should be discussed. Where there is a plan made for uterine conserving surgery, women should be offered the option of bilateral salpingectomy at the time of surgery during the antenatal period

OUTPATIENT POSTNATAL CARE

Clinical Question 2.48: What supports should women and their families be offered in the postnatal period?

As discussed in *Section 2: Antenatal Care; antenatal supports*, women with a pregnancy complicated by PAS are at risk of a deterioration in physical and mental well-being following birth. Ideally, we recommend all women should have been offered referral to physiotherapy, mental health, and social work during pregnancy. Where referral was not made or declined, the supports should be offered again in the postnatal period

1. Physiotherapy
2. Perinatal mental health
3. Advocacy and support group – offer contact details for advocacy and support group, Placenta Accreta Ireland
4. Social work – offer to all women, particularly those with babies admitted to the neonatal unit.
5. NICU support – Support services specific to families with a baby in the unit should be offered, such as the Irish Neonatal Health Alliance

Clinical Question 2.49: How should women be followed up after pregnancy?

Initial follow up should be provided by the specialist team providing antenatal care. While no evidence-based recommendations can be made regarding frequency and duration of follow for women with PAS, it is good practice that women are seen for a six-week postnatal visit¹²⁹. This visit should facilitate a discussion around what happened during the pregnancy, provide information on any outstanding results, and a physical examination. Where women have had successful uterine conserving surgery, a discussion around risk in future pregnancies should be had, as well as information provided around suitable contraceptive options. Women should be informed of the need to attend for future cervical screening. Referral to physiotherapy and mental health should be offered if not previously done so.

Some women may warrant additional follow up appointments with the specialist team, which can be arranged on a case-by-case basis. The woman's general practitioner should be provided with a summary letter of the pregnancy outcome and any additional follow up needed.

The Guideline committee considered the lack of evidence specifically relating to follow up care in women with PAS. In one qualitative study where parents who had experienced a pregnancy complicated PAS were asked to make recommendations for care (n=29), a strong theme was the need for longer term follow up care with the specialist team, with many calling for reviews up to a year postnatal¹³⁰. Given the limited literature exploring this area, consensus was agreed that all women should be offered at least a six-week postnatal visit, with additional visits arranged as indicated for each woman. The importance of community care in the postnatal period was discussed and the value of education for those providing this care, usually the woman's general practitioner. Self-initiated follow up was endorsed by the Guideline committee, whereby women are given details of who to contact to re-engage with the maternity services and their specialist team after being discharged.

Clinical Practice

There is minimal evidence specifically relating to the postnatal care of women after a pregnancy complicated by PAS, and hence no firm recommendations can be made. However, general good practice points to consider are described above. Each woman with PAS will have very individual care needs, as the type of birth, extent of surgery and blood loss will vary significantly.

Hence there is no one postnatal care pathway that will be applicable for all women. Care needs will vary based on unique clinical circumstances. Specialist care teams should ensure the most appropriate plan for each individual woman taking into consideration these factors, and that the care pathway is clearly documented, initiated, and communicated to the community care team.

Recommendations – Section 5, Postnatal care

37. We recommend that in keeping with recommendations for all postnatal women, women with PAS should have an individual VTE score calculated to determine the dose and duration of thromboprophylaxis.
38. We recommend that women who were anaemic antenatally or are diagnosed with anaemia postnatally, should be prescribed iron supplementation for at least six weeks postnatally.
39. We recommend women have a clear management for postnatal analgesia documented and charted in the woman's health record.
40. We recommend that women should be offered referral to physiotherapy and social work services in the postnatal period, if this has not already been done or the referral was not followed through during the antenatal period.
41. We recommend that women should be offered referral to perinatal mental health in the postnatal period, if this has not already been done or the referral was not followed through during the antenatal period.
42. We suggest a postnatal visit with the specialist care team should be arranged at six weeks postnatal for women and their support partners, where a debrief and discussion of the pregnancy is facilitated.

PATHOLOGY

Clinical Question 2.50: How should specimens with suspected PAS be assessed?

Evidence Statement

Traditionally, the pathologic diagnosis of placenta accreta spectrum disorder was relatively uncomplicated – adherent placentas were classified as accreta, increta or percreta and characterised by absent decidua or deficient myometrium.

Although this classification has been traditionally used, up to one third of preoperatively suspected or diagnosed accretas were not confirmed pathologically¹³¹. The FIGO system for placenta accreta spectrum offers an opportunity to standardise reporting and improve the diagnosis and management for women with placenta accreta spectrum now and into the future¹¹⁶.

Clinical Practice

It is beyond the scope of this Guideline to detail the pathologic examination of a suspected placenta accreta and practices will differ depending on the specimen received, whether the surgery was elective or an emergency, and whether accreta spectrum was suspected clinically or not¹³¹.

While the approach to elective caesarean hysterectomy can be standardised and is often uniform, an unplanned emergency caesarean or post-partum hysterectomy should come to the laboratory with appropriate clinical details and the contact details of the operating surgeon.

As these specimens may become an important part of the medical record, the condition of both the mother and baby/babies should be established before dissection of the specimen is undertaken.

The examination of a caesarean hysterectomy should not be rushed. While the histologic examination is often straightforward (albeit requiring many blocks), grossing the specimen will be difficult unless the clinical scenario is clear. It is often only in reviewing the gross findings with the operating surgeon physically or virtually prior to, that subtle abnormalities, such as vessel tears or other potential sources of bleeding, can be identified. Operative photographs and specimen photographs are useful to help target sampling and aid the review of the specimen.

After authorisation, the caesarean hysterectomy specimen should be kept for a number of weeks so that additional sections can be submitted should more information become available.

The greatest concordance of clinico-pathologic correlation for these specimens will be achieved where there is a template guide for dissection and a clear communication between pathologist and surgeon. While it is the responsibility of the pathologist to confirm or exclude the presence of a PAS disorder, it is responsibility of the surgeon to submit clear information on a request form and giving clear instruction about who to contact for more details about the specimen.

While it is tempting to focus on the uterus, a clear description of the location of the placenta should be made. Specific items to include will be a description of the presence/absence of a placenta praevia, vasa praevia and a velamentous insertion of the umbilical cord.

As the pathologic findings of a caesarean hysterectomy are rarely required for immediate patient management, within reason, the turnaround time for a caesarean hysterectomy is less important if operative details cannot be established.

Finally, these specimens should be reported in a locally agreed manner and unless there is a good alternative reason, the FIGO PAS classification system¹¹⁶ is recommended. In order to facilitate ongoing learning and education within PAS MDTs, the final histology should be presented at the MDT meeting once available.

Recommendations – Section 5, Pathology

43. We recommend all relevant clinical information relating to the antenatal course and intraoperative findings should be included so that they are available to the pathologist when requesting histological assessment for PAS specimens.
44. We recommend specimens sent for pathological assessment of PAS should be reported according to the FIGO classification.
45. We recommend in order to facilitate ongoing learning and education within PAS MDTs, the final histology should be presented at the MDT meeting once available.

Chapter 3: Development of Clinical Practice Guideline

3.1 Literature search strategy

A comprehensive literature review was undertaken which included national and international publications.

3.2 Appraisal of evidence

Following a comprehensive literature review the quality, validity and relevance of the evidence gathered were critically appraised by the Guideline developers under the following headings:

- Study design
- Relevance of primary and secondary outcomes
- Consistency of results across studies
- Magnitude of benefit versus magnitude of harm
- Applicability to practice context

A number of evidence-based recommendations for management of PAS were agreed upon. They have been adapted to reflect care in the Irish healthcare setting.

3.3 AGREE II process

While being developed, the Guideline was assessed using the AGREE II checklist (Appendix 9) as recommended by the Department of Health in the 'How to Develop a National Clinical Guideline: a manual for guideline developers'.¹⁰

The purpose of AGREE II is to provide a framework to:

1. Assess the quality of guidelines
2. Provide a methodological strategy for the development of guidelines
3. Inform what information and how information ought to be reported in guidelines

3.4 Literature review

Details of supportive evidence based literature for this Guideline are reported in chapter two. The following databases were searched as part of the literature review: The Cochrane Library (including the Cochrane Database of Systematic Reviews and the Database of Abstracts of Reviews of Effects [DARE]), EMBASE, MEDLINE and PubMed (electronic databases).

10 Department of Health (2019). How to develop a National Clinical Guideline. Available at: <https://www.gov.ie/en/collection/cd41ac-clinical-effectiveness-resources-and-learning/>

Databases were searched for the following terms “Placenta Accreta Spectrum”, and alternative terms to describe the condition including “abnormally adherent placenta”, “morbidly adherent placenta” and “abnormally invasive placenta”, as well as the “Placenta praevia” and “Low lying placenta” from September 2021 until February 2022 inclusive.

The search was restricted to studies involving humans and those published in the English language. Relevant guidelines were also comprehensively reviewed as part of the Guideline development process, with reference made to the following guidelines:

1. RCOG Placenta Praevia and Placenta Accreta: Diagnosis and Management Green-top Guideline No. 27a⁴⁴
2. FIGO consensus guidelines on placenta accreta spectrum disorders⁴³
3. Placenta accreta spectrum. Obstetric Care Consensus No. 7. American College of Obstetricians and Gynecologists⁷

The following steps were taken to ensure a comprehensive review of the literature with continuous input and discussion between committee members:

- The Guideline committee met to consider the clinical questions to be addressed; these were divided into 5 parts as described in chapter 2
- Committee members were divided into groups and performed literature reviews based on their area of expertise to address the questions for each area
 - Part 1: J Donnelly, J Walsh, S Higgins, J Moriarty, D Brophy, G Colleran, T Geoghegan, H Bartels
 - Part 2: H Bartels, R Greene, B Byrne
 - Part 3: D Brennan, M O’Leary, R Greene, C Thompson, H Bartels
 - Part 4: R Ni Mhuircheartaigh, N Cooney, H Bartels
 - Part 5: H Bartels, C Thompson, N Cooney, Donal Brennan, P Downey
- The Guideline committee met regularly to discuss the recommendations for each area
- Where there was no evidence to support certain recommendations, these were made based on group consensus and committee expertise
- The final draft of the Guideline was reviewed by all committee members, with a further meeting to discuss the final recommendations and evidence presented
- In particular to the antenatal and surgical management, these are based on group consensus and relied on the experience of the committee members in caring for women with PAS, as there is very limited literature to support firm recommendations

3.5 Grades of recommendation

GRADE¹³² offers a transparent and structured process for developing and presenting evidence summaries and for carrying out the steps involved in developing recommendations.¹¹ While we acknowledge that for this particular work an extensive GRADE approach is not possible, we have used the suggested language set out in the GRADE table when making recommendations.¹² (Appendix 10)

3.6 Future research

An important outcome of the Guideline development process is in highlighting gaps in the evidence base. The questions of relevance to this Guideline include;

1. How frequently should ultrasound assessments be performed in women with PAS?
2. What is the optimal anaesthesia for women undergoing PAS surgery?
3. What is the optimal surgical approach for women with PAS?
4. How should women with PAS be followed up in the postnatal period and who should provide this care?
5. What is the role of aortic balloons in the management of women with PAS?

11 Guyatt, Gordon, *et al.* "GRADE Guidelines: 1. Introduction – GRADE Evidence Profiles and Summary of Findings Tables." *Journal of Clinical Epidemiology*, vol. 64, no. 4, 2011, pp. 383-94, <https://doi.org/10.1016/j.jclinepi.2010.04.026>.

12 SMFM adopts GRADE (Grading of Recommendations Assessment, Development, and Evaluation) for clinical guidelines. Society for Maternal-Fetal Medicine (SMFM), Chauhan SP, Blackwell SC. *Am J Obstet Gynecol.* 2013 Sep;209(3):163-5. doi: 10.1016/j.ajog.2013.07.012. PMID: 23978245 <https://pubmed.ncbi.nlm.nih.gov/23978245/>

Chapter 4: Governance and Approval

4.1 Formal governance arrangements

This Guideline was written by the Guideline Developers under the direction of the Guideline Programme Team. An Expert Advisory Group was formed to review the Guideline prior to submission for final approval with the National Women and Infants Health Programme Clinical Advisory Group (CAG) (Appendix 11). The roles and responsibilities of the members of each group and their process were clearly outlined and agreed.

4.2 Guideline development standards

This Guideline was developed by the Guideline Developer Group (GDG) within the overall template of the HSE National Framework¹³ for developing Policies, Procedures, Protocols and Guidelines (2016) (Appendix 12) and under supervision of the Guideline Programme Team (GPT).

A review was conducted by a group of experts, specialists and advocates (the EAG) prior to approval by the Clinical Advisory Group (CAG) of the National Women and Infants Health Programme (NWIHP) with final sign off for publication by CAG Co-Chairs, the Clinical Director of NWIHP and the Chair of the IOG.

4.3 Copyright/Permission sought (if applicable)

Permission to reproduce Table 2 from the following publication:

Collins SL, Ashcroft A, Braun T, Calda P, Langhoff-Roos J, Morel O, Stefanovic V, Tutschek B, Chantraine F; European Working Group on Abnormally Invasive Placenta (EW-AIP). Proposal for standardized ultrasound descriptors of abnormally invasive placenta (AIP). Ultrasound Obstet Gynecol. 2016 Mar;47(3):271-5

This was granted for publication in this Guideline by John Wiley and Sons and Copyright Clearance Centre under the licence number 5226441207005.

13 Health Service Executive (2016). National Framework for developing Policies, Procedures, Protocols and Guidelines (PPPGs). Available from: <https://www.hse.ie/eng/about/who/qid/nationalframeworkdevelopingpolicies/>

Chapter 5: Communication and Dissemination

A communication and dissemination plan for this Guideline has been developed by the GPT and endorsed by NWIHP.

Effective ongoing clear communication is essential in explaining why the Guideline is necessary and securing continued buy-in. It provides an opportunity to instil motivation within staff, helps overcome resistance to change and gives an opportunity for feedback.¹⁴

The Clinical Guideline will be circulated and disseminated through the Guideline Programme Team as well as through the professional networks who participated in developing and reviewing the document.

Senior management within the maternity units are responsible for the appropriate dissemination of new and updated guidelines. Local hospital groups including Guideline committees are also instrumental in the circulation of new and updated guidelines and promoting their use in the relevant clinical settings.

The HSE will make this Guideline available to all employees through standards networks as well as storing it in the online PPPG repository. Electronic versions available on the NWIHP (<https://www.hse.ie/eng/about/who/acute-hospitals-division/woman-infants/clinical-guidelines/>) and RCPI websites (<https://www.rcpi.ie/faculties/obstetricians-and-gynaecologists/national-clinical-guidelines-in-obstetrics-and-gynaecology/>) and other communication means can be used to maximise distribution. The NWIHP website will also provide a training webinar introducing each Guideline and where relevant a downloadable version of the recommended algorithm will be available.

14 Department of Health (2018). NCEC Implementation Guide and Toolkit. Available at: <https://health.gov.ie/national-patient-safety-office/ncec/>

Chapter 6: Implementation

6.1 Implementation plan

Implementation was considered at the beginning, and throughout the Guideline development process. The local multidisciplinary clinical team, senior executive and clinical management in each maternity and gynaecology unit are ultimately responsible for the appropriate structured adoption and implementation of the guidelines within their area of responsibility. They must ensure that all relevant personnel under their supervision have read and understood the Guideline and monitor both its effectiveness and adoption.

Within each site, local multidisciplinary teams are responsible for the clinical implementation of Guideline recommendations and ensuring that their local clinical practices and processes reflect and are aligned with the Guideline recommendations.

The following have been put in place to help facilitate the implementation of this Guideline.

- Quick Summary Document (QSD) for clinical staff (includes key recommendations, auditable standards, algorithms and important links)
- Clinical Guideline mobile application
- Plain language summary

In the case of this Guideline it became apparent from reviewing the existing literature and consensus from the Guideline committee that a national approach to the management of PAS was needed. Hence implementation of this Guideline will involve the development of a national MDT to discuss PAS cases cared for within Ireland, with specialist centres providing the necessary clinical care.

6.2 Education plans required to implement the Guideline

It is acknowledged that this Guideline should be complemented by ongoing education, training and assessment where required.

This Guideline's education plan includes training for theatre staff who are working in centres caring for women with PAS (Appendix 4)

6.3 Barriers and facilitators

To ensure successful implementation of guidelines, it is first necessary to look at potential barriers and facilitators. Taking these into account when developing the implementation plan should improve levels of support from relevant users. (DOH 2018, 2019)

Barriers may be categorised as internal (specific to the Guideline itself) or external (specific to the clinical environment).

The Guideline Development Group has aimed to address any internal barriers during the development of this Guideline. The cost implications associated with the Guideline recommendations should be assessed locally to support its implementation.

Potential external barriers include:

- Structural factors (e.g. budget or service redesign)
- Organisational factors (e.g. lack of facilities or equipment)
- Individual factors (e.g. knowledge, skills, training)
- Patient perceptions

In the case of this Guideline, it will be necessary to examine possible barriers and consider implementation strategies to address them. By example, this may include discussion with relevant management groups with regards budgetary impact or providing training to the relevant staff.

6.4 Resources necessary to implement recommendations

The implementation of this Guideline should be undertaken as part of the quality improvement of each hospital. Hospitals should review existing service provision against this Guideline, identifying necessary resources required to implement the recommendations in this Guideline.

In the case of this Guideline, implementation will be centred around the establishment of a national PAS MDT with specialist centres providing clinical care. This will require the support of the National Women and Infant's Health Programme.

Chapter 7: Audit and Evaluation

7.1 Introduction to audit

It is important that both implementation of the Guideline and its influence on outcomes are audited to ensure that this Guideline positively impacts on patient care. Institutions and health professionals are encouraged to develop and undertake regular audits of Guideline implementation. Personnel tasked with the job of conducting the audit should be identified on receipt of the most recent version of the Guideline.

7.2 Auditable standards

Audit using the key recommendations as indicators should be undertaken to identify where improvements are required and to enable changes as necessary. Audit should also be undertaken to provide evidence of continuous quality improvement initiatives.

Auditable standards for this Guideline include:

1. Number of women with a previous caesarean section who have placental location documented at fetal anatomy scan
2. Number of women with PAS who were diagnosed antenatally
3. Number of women with PAS managed within an MDT
4. Number of women with PAS who had clear documentation of an antenatal care plan, birth plan and consent in the woman's medical notes
5. Number of women with PAS who have an elective section
6. Number of women with PAS who received a blood transfusion
7. Number of women with PAS who have histopathological confirmation of accreta

7.3 Evaluation

Evaluation is defined as a formal process to determine the extent to which the planned or desired outcomes of an intervention are achieved.¹⁵

Implementation of this Guideline will be audited periodically at national level with standards for this set by the NWIHP. Evaluation of the auditable standards should also be undertaken locally by senior hospital clinical management to support implementation.

15 Health Information Quality Authority (2012). National Standards for Safer Better Healthcare [Internet]. Available from: <https://www.hiqa.ie/reports-and-publications/standard/national-standards-safer-better-healthcare>

Chapter 8: Revision Plan

8.1 Procedure for the update of the Guideline

It may be a requirement to amend, update or revise this Guideline as new evidence emerges. This Guideline will be reviewed at national level every three years, or earlier if circumstances require it, and updated accordingly.¹⁶

The Guideline Development Group will be asked to review the literature and recent evidence to determine if changes are to be made to the existing Guideline. If the Guideline Development Group are unavailable, the GPT along with the NWIHP senior management team will select a suitable expert to replace them.

If there are no amendments required to the Guideline following the revision date, the detail on the revision tracking box must still be updated which will be a new version number and date.

The recommendations set out in this Guideline remain valid until a review has been completed.

8.2 Method for amending the Guideline

As new evidence becomes available it is inevitable that Guideline recommendations will fall behind current evidence based clinical practice. It is essential that clinical guidelines are reviewed and updated with new evidence as it becomes available.

In order to request a review of this Guideline one of the following criteria must be met:

- a. Three years since the Guideline was published
- b. Three years since last review was conducted
- c. Update required as a result of new evidence

Correspondence requesting a review of the Guideline should be submitted to the National Women and Infants Health. Any such requests should be dealt with in a timely manner.

16 Health Service Executive (2016). National Framework for developing Policies, Procedures, Protocols and Guidelines (PPPGs). Available from: <https://www.hse.ie/eng/about/who/qid/nationalframeworkdevelopingpolicies/>

Chapter 9: References

Reference list

1. Morlando M, Collins S. Placenta Accreta Spectrum Disorders: Challenges, Risks, and Management Strategies. *Int J Womens Health*. 2020;12:1033-1045. Published 2020 Nov 10. doi:10.2147/IJWH.S224191
2. Bartels HC, Postle JD, Downey P, Brennan DJ. Placenta Accreta Spectrum: A Review of Pathology, Molecular Biology, and Biomarkers. *Dis Markers*. 2018 Jul 3;2018:1507674
3. Silver RM, Branch DW. Placenta Accreta Spectrum. *N Engl J Med*. 2018 Apr 19;378(16):1529-1536 Wu S, Kocherginsky M, Hibbard JU. Abnormal placentation: twenty-year analysis. *Am J Obstet Gynecol* 2005; 192: 1458 – 61
4. Mogos MF, Salemi JL, Ashley M, Whiteman VE, Salihi HM. Recent trends in placenta accreta in the United States and its impact on maternal-fetal morbidity and healthcare-associated costs, 1998-2011. *J Matern Fetal Neonatal Med* 2016; 29: 1077 – 82
5. Placenta accreta spectrum. *Obstetric Care Consensus No. 7*. American College of Obstetricians and Gynecologists. *Obstet Gynecol* 2018;132:e259-75.
6. Piñas Carrillo A, Chandrachan E. Placenta accreta spectrum: Risk factors, diagnosis and management with special reference to the Triple P procedure. *Womens Health (Lond)*. 2019;15:1745506519878081. doi:10.1177/1745506519878081
7. Eshkoli T, Weintraub AY, Sergienko R, Sheiner E. Placenta accreta: risk factors, perinatal outcomes, and consequences for subsequent births. *Am J Obstet Gynecol* 2013;208:219.e1-7
8. MacDorman MF, Menacker F, Declercq E. cesarean birth in the United States: epidemiology, trends, and outcomes. *Clin Perinatol* 2008;35:293-307
9. Higgins MF, Monteith C, Foley M, O’Herlihy C. Real increasing incidence of hysterectomy for placenta accreta following previous caesarean section. *Eur J Obstet Gynecol Reprod Biol* 2013;171:54-6.
10. Irish Maternity Indicator System. 2020. National Report 2020. National Women and infants health Programme clinical Programme for obstetrics and Gynaecology. Available at: <https://www.hse.ie/eng/about/who/acute-hospitals-division/woman-infants/national-reports-on-womens-health/irish-maternity-indicator-system-national-report-2020.pdf>
11. Fitzpatrick KE, Sellers S, Spark P, Kurinczuk JJ, Brocklehurst P, Knight M; Incidence and risk factors for placenta accreta/increta/percreta in the UK: a national case-control study. *PLoS One*. 2012; 7(12):e52893
12. Bahram Salmanian, Karin A. Fox, Sara E. Arian, Hadi Erfani, Steven L. Clark, Kjersti M. Aagaard, Sarah E. Dettlefs, Soroush Aalipour, Jimmy Espinoza, Ahmed A. Nassr, William E. Gibbons, Amir A. Shamshirsaz, Michael A. Belfort, Alireza A. Shamshirsaz, In vitro fertilization as an independent risk factor for placenta accreta spectrum, *American Journal of Obstetrics and Gynecology*, Volume 223, Issue 4, 2020, Pages 568.e1-568.e5, ISSN 0002-9378

13. O. Ishihara, R. Araki, A. Kuwahara, A. Itakura, H. Saito, G.D. Adamson Impact of frozen-thawed single-blastocyst transfer on maternal and neonatal outcome: an analysis of 277,042 single-embryo transfer cycles from 2008 to 2010 in Japan *Fertil Steril*, 101 (2014), pp. 128-133
14. Silver RM, Landon MB, Rouse DJ, Leveno KJ, Spong CY, Thom EA, *et al.*; National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. Maternal morbidity associated with multiple repeat cesarean deliveries. *Obstet Gynecol* 2006;107:1226-32
15. Wright JD, Pri-Paz S, Herzog TJ, Shah M, Bonanno C, Lewin SN, *et al.* Predictors of massive blood loss in women with placenta accreta. *Am J Obstet Gynecol* 2011;205:38.e1-6
16. Stotler B, Padmanabhan A, Devine P, Wright J, Spitalnik SL, Schwartz J. Transfusion requirements in obstetric patients with placenta accreta. *Transfusion* 2011;51:2627-33
17. O'Brien JM, Barton JR, Donaldson ES. The management of placenta percreta: conservative and operative strategies. *Am J Obstet Gynecol* 1996;175:1632-8.
18. Shamshirsaz AA, Fox KA, Salmanian B, Diaz-Arrastia CR, Lee W, Baker BW, *et al.* Maternal morbidity in patients with morbidly adherent placenta treated with and without a standardized multidisciplinary approach. *Am J Obstet Gynecol* 2015;212:218.e1-9
19. Bartels HC, Mulligan KM, Craven S, Rogers AC, Higgins S, O'Brien DJ, McVey R, McParland P, Walsh JM, Carroll S, Corcoran S, Robson M, Mahony R, Downey P, Brophy D, Colleran G, McAuliffe FM, Brennan DJ. Maternal morbidity in placenta accreta spectrum following introduction of a multi-disciplinary service compared to standard care: an Irish perspective. *Ir J Med Sci*. 2021 Jan 15. doi: 10.1007/s11845-020-02473-3. Epub ahead of print. PMID: 33449329.
20. Einerson, B.D., Silver, R.M. Multidisciplinary Teams in the Management of Placenta Accreta Spectrum Disorders. *Curr Obstet Gynecol Rep* 8, 80-85 (2019). <https://doi.org/10.1007/s13669-019-00264-x>
21. Wu S, Kocherginsky M, Hibbard JU. Abnormal placentation: twenty-year analysis. *Am J Obstet Gynecol*. 2005 May;192(5):1458-61
22. Morlando M, Sarno L, Napolitano R, Capone A, Tessitore G, Maruotti GM, Martinelli P. Placenta accreta: incidence and risk factors in an area with a particularly high rate of cesarean section. *Acta Obstet Gynecol Scand*. 2013 Apr;92(4):457-60
23. Cook JR, Jarvis S, Knight M, Dhanjal MK. Multiple repeat caesarean section in the UK: incidence and consequences to mother and child. A national, prospective, cohort study. *BJOG*. 2013 Jan;120(1):85-91
24. Jauniaux E, Kingdom JC, Silver RM. A comparison of recent guidelines in the diagnosis and management of placenta accreta spectrum disorders. *Best Pract Res Clin Obstet Gynaecol*. 2021 Apr;72:102-116
25. Eshkoli T, Weintraub AY, Sergienko R, Sheiner E. Placenta accreta: risk factors, perinatal outcomes, and consequences for subsequent births. *Am J Obstet Gynecol*. 2013 Mar;208(3):219.e1-7
26. Marshall NE, Fu R, Guise JM. Impact of multiple cesarean deliveries on maternal morbidity: a systematic review. *Am J Obstet Gynecol*. 2011 Sep;205(3):262.e1-8
27. Klar M, Michels KB. Cesarean section and placental disorders in subsequent pregnancies--a meta-analysis. *J Perinat Med*. 2014 Sep;42(5):571-83
28. Thurn L, Lindqvist PG, Jakobsson M, Colmorn LB, Klungsoyr K, Bjarnadóttir RI, Tapper AM, Børdahl PE, Gottvall K, Petersen KB, Krebs L, Gissler M, Langhoff-Roos J, Källen K. Abnormally invasive placenta-prevalence, risk factors and antenatal suspicion: results from a large population-based pregnancy cohort study in the Nordic countries. *BJOG*. 2016 Jul;123(8):1348-55

29. Silver RM, Landon MB, Rouse DJ, Leveno KJ, Spong CY, Thom EA, Moawad AH, Caritis SN, Harper M, Wapner RJ, Sorokin Y, Miodovnik M, Carpenter M, Peaceman AM, O'Sullivan MJ, Sibai B, Langer O, Thorp JM, Ramin SM, Mercer BM; National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. Maternal morbidity associated with multiple repeat cesarean deliveries. *Obstet Gynecol*. 2006 Jun;107(6):1226-32
30. Jauniaux E, Grønbeck L, Bunce C, Langhoff-Roos J, Collins SL. Epidemiology of placenta previa accreta: a systematic review and meta-analysis. *BMJ Open*. 2019 Nov 12;9(11):e031193
31. Ogawa K, Jwa SC, Morisaki N, Sago H. Risk factors and clinical outcomes for placenta accreta spectrum with or without placenta previa. *Arch Gynecol Obstet*. 2021 Aug 26
32. Luke RK, Sharpe JW, Greene RR. Placenta accreta: the adherent or invasive placenta. *Am J Obstet Gynecol*. 1966 Jul 1;95(5):660-8
33. Jauniaux E, Jurkovic D. Placenta accreta: pathogenesis of a 20th century iatrogenic uterine disease. *Placenta*. 2012 Apr;33(4):244-51
34. Esh-Broder E, Ariel I, Abas-Bashir N, Bdolah Y, Celnikier DH. Placenta accreta is associated with IVF pregnancies: a retrospective chart review. *BJOG*. 2011 Aug;118(9):1084-9
35. Balayla J, Bondarenko HD. Placenta accreta and the risk of adverse maternal and neonatal outcomes. *J Perinat Med*. 2013 Mar;41(2):141-9
36. Jauniaux E, Bhide A, Kennedy A, Woodward P, Hubinont C, Collins S; FIGO Placenta Accreta Diagnosis and Management Expert Consensus Panel. FIGO consensus guidelines on placenta accreta spectrum disorders: Prenatal diagnosis and screening. *Int J Gynaecol Obstet*. 2018 Mar;140(3):274-280
37. Jauniaux E, Alfirevic Z, Bhide A, Belfort MA, Burton G, Collins S *et al.*: Placenta Praevia and Placenta Accreta: Diagnosis and Management: Green-top Guideline No. 27a *BJOG: An International Journal of Obstetrics & Gynaecology*, 2018/09/27 VL 126 10.1111/1471-0528.1530
38. D'Antonio F, Iacovella C, Bhide A. Prenatal identification of invasive placentation using ultrasound: Systematic review and meta-analysis. *Ultrasound Obstet Gynecol*. 2013;42:509-517.
39. Shanker SA, Coleman B, Timor-Tritsch IE, Bhide A, Bromley B, Cahill AG, Gandhi M, Hecht JL, Johnson KM, Levine D, Mastrobattista J, Phillips J, Platt LD, Shamshirsaz AA, Shipp TD, Silver RM, Simpson LL, Copel JA, Abuhamad A; Society for Maternal-Fetal Medicine. Electronic address: pubs@smfm.org. Special Report of the Society for Maternal-Fetal Medicine Placenta Accreta Spectrum Ultrasound Marker Task Force: Consensus on definition of markers and approach to the ultrasound examination in pregnancies at risk for placenta accreta spectrum. *Am J Obstet Gynecol*. 2021 Jan;224(1):B2-B14
40. Collins SL, Ashcroft A, Braun T, Calda P, Langhoff-Roos J, Morel O, Stefanovic V, Tutschek B, Chantraine F; European Working Group on Abnormally Invasive Placenta (EW-AIP). Proposal for standardized ultrasound descriptors of abnormally invasive placenta (AIP). *Ultrasound Obstet Gynecol*. 2016 Mar;47(3):271-
41. Rahaim NS, Whitby EH. The MRI features of placental adhesion disorder and their diagnostic significance: systematic review. *Clin Radiol* 2015;70:917-25
42. Kapoor H, Hanaoka M, Dawkins A, Khurana A. Review of MRI imaging for placenta accreta spectrum: Pathophysiologic insights, imaging signs, and recent developments. *Placenta*. 2021 Jan 15;104:31-39

43. Meng X, Xie L, Song W. Comparing the diagnostic value of ultrasound and magnetic resonance imaging for placenta accreta: a systematic review and meta-analysis. *Ultrasound Med Biol*. 2013 Nov;39(11):1958-65
44. D'Antonio F, Iacovella C, Palacios-Jaraquemada J, Bruno CH, Manzoli L, Bhide A. Prenatal identification of invasive placentation using magnetic resonance imaging: systematic review and meta-analysis. *Ultrasound Obstet Gynecol*. 2014 Jul;44(1):8-16
45. Jha P, Pöder L, Bourgioti C, Bharwani N, Lewis S, Kamath A, Nougaret S, Soyer P, Weston M, Castillo RP, Kido A, Forstner R, Masselli G. Society of Abdominal Radiology (SAR) and European Society of Urogenital Radiology (ESUR) joint consensus statement for MR imaging of placenta accreta spectrum disorders. *Eur Radiol*. 2020 May;30(5):2604-2615
46. Bourgioti C, Konstantinidou AE, Zafeiropoulou K, Antoniou A, Fotopoulos S, Theodora M, Daskalakis G, Nikolaidou ME, Tzavara C, Letsika A, Martzoukos EA, Mouloupoulos LA. Intraplental Fetal Vessel Diameter May Help Predict for Placental Invasiveness in Pregnant Women at High Risk for Placenta Accreta Spectrum Disorders. *Radiology*. 2021 Feb;298(2):403-412
47. Palacios Jaraquemada JM, Bruno CH. Magnetic resonance imaging in 300 cases of placenta accreta: surgical correlation of new findings. *Acta Obstet Gynecol Scand*. 2005 Aug;84(8):716-24
48. Warshak CR, Eskander R, Hull AD, Scioscia AL, Mattrey RF, Benirschke K, Resnik R. Accuracy of ultrasonography and magnetic resonance imaging in the diagnosis of placenta accreta. *Obstet Gynecol*. 2006 Sep;108(3 Pt 1):573-81
49. Bourgioti C, Zafeiropoulou K, Fotopoulos S, Nikolaidou ME, Antoniou A, Tzavara C, Mouloupoulos LA. MRI Features Predictive of Invasive Placenta With Extrauterine Spread in High-Risk Gravid Patients: A Prospective Evaluation. *AJR Am J Roentgenol*. 2018 Sep;211(3):701-711
50. Eller AG, Bennett MA, Sharshiner M, Masheter C, Soisson AP, Dodson M, *et al*. Maternal morbidity in cases of placenta accreta managed by a multidisciplinary care team compared with standard obstetric care. *Obstet Gynecol* 2011;117:331-7
51. Shamshirsaz AA, Fox KA, Salmanian B, Diaz-Arrastia CR, Lee W, Baker BW, *et al*. Maternal morbidity in patients with morbidly adherent placenta treated with and without a standardized multidisciplinary approach. *Am J Obstet Gynecol* 2015;212:218.e1-9
52. Smulian JC, Pascual AL, Hesham H, Qureshey E, Bijoy Thomas M, Depuy AM, *et al*. Invasive placental disease: the impact of a multi-disciplinary team approach to management. *J Matern Fetal Neonatal Med* 2017;30:1423-7.
53. Lee PS, Kempner S, Miller M, Dominguez J, Grotegut C, Ehrisman J, *et al*. Multidisciplinary approach to manage antenatally suspected placenta percreta: updated algorithm and patient outcomes. *Gynecol Oncol Res Pract* 2017;4:11. doi: 10.1186/s40661-017-0049-6. eCollection 2017
54. Al-Khan A, Gupta V, Illsley NP, Mannion C, Koenig C, Bogomol A, *et al*. Maternal and fetal outcomes in placenta accreta after institution of team-managed care. *Reprod Sci* 2014;21:761-71
55. Melcer Y, Jauniaux E, Maymon S, Tsviban A, Pekar-Zlotin M, Betser M, *et al*. Impact of targeted scanning protocols on perinatal outcomes in pregnancies at risk of placenta accreta spectrum or vasa previa. *Am J Obstet Gynecol* 2018;218:443.e1-8
56. Shamshirsaz AA, Fox KA, Erfani H, Clark SL, Salmanian B, Baker BW, *et al*. Multidisciplinary team learning in the management of the morbidly adherent placenta: outcome improvements over time. *Am J Obstet Gynecol*. 2017;216:612.e1-5

57. Bartels HC, Rogers AC, O'Brien D, McVey R, Walsh J, Brennan DJ. Association of Implementing a Multidisciplinary Team Approach in the Management of Morbidly Adherent Placenta With Maternal Morbidity and Mortality. *Obstet Gynecol*. 2018 Nov;132(5):1167-1176
58. Einerson, B.D., Silver, R.M. Multidisciplinary Teams in the Management of Placenta Accreta Spectrum Disorders. *Curr Obstet Gynecol Rep* 8, 80-85 (2019)
59. Brennan DJ, Schulze B, Chetty N, Crandon A, Petersen SG, Gardener G, Perrin L. Surgical management of abnormally invasive placenta: a retrospective cohort study demonstrating the benefits of a standardized operative approach. *Acta Obstet Gynecol Scand*. 2015 Dec;94(12):1380-6
60. Ivers N, Jamtvedt G, Flottorp S, *et al*. Audit and feedback: effects on professional practice and healthcare outcomes. *Cochrane Database Syst Rev* 2012;6:CD000259
61. Scrivener R, Morrell C, Baker R, *et al*. Principles for best practice in clinical audit. Abingdon: Radcliffe Medical Press Ltd, 2002
62. Janssen, A., Robinson, T., Brunner, M. *et al*. Multidisciplinary teams and ICT: a qualitative study exploring the use of technology and its impact on multidisciplinary team meetings. *BMC Health Serv Res* 18, 444 (2018)
63. O'leary KJ, Sehgal NL, Terrell G, Williams MV. Interdisciplinary teamwork in hospitals: a review and practical recommendations for improvement. *J Hosp Med*. 2012;7(1):48-54
64. Van Dijk-de Vries A, Duimel-Peeters I, Muris J, Wesseling G, Beusmans G, Vrijhoef H. Effectiveness of teamwork in an integrated care setting for patients with COPD: development and testing of a self-evaluation instrument for interprofessional teams. *Int J Integrated Care*. 2016;16(1)
65. Antenatal care NICE guideline Published: 19 August 2021: www.nice.org.uk/guidance/ng201
66. National Institute of Health and Care Excellence. Antenatal Care for Uncomplicated Pregnancies. Clinical Guideline 62: NICE; 2017
67. Blood Transfusion in Obstetrics. Green Top Guideline No 47. May 2015. Available from: <https://www.rcog.org.uk/globalassets/documents/guidelines/gtg-47.pdf>
68. White J, Qureshi H, Massey E, Needs M, Byrne G, Daniels G, Allard S; British Committee for Standards in Haematology. Guideline for blood grouping and red cell antibody testing in pregnancy. *Transfus Med*. 2016 Aug;26(4):246-63
69. Hunt BJ, Allard S, Keeling D, Norfolk D, Stanworth SJ, Pendry K; British Committee for Standards in Haematology. A practical guideline for the haematological management of major haemorrhage. *Br J Haematol*. 2015 Sep;170(6):788-803
70. Munoz JL, Kimura AM, Xenakis E, Jenkins DH, Braverman MA, Ramsey PS, Ireland KE. Whole blood transfusion reduces overall component transfusion in cases of placenta accreta spectrum: a pilot program. *J Matern Fetal Neonatal Med*. 2021 Apr 26:1-6
71. Balayla J, Desilets J, Shrem G. Placenta previa and the risk of intrauterine growth restriction (IUGR): a systematic review and meta-analysis. *J Perinat Med*. 2019 Aug 27;47(6):577-584
72. Harper LM, Odibo AO, Macones GA, Crane JP, Cahill AG. Effect of placenta previa on fetal growth. *Am J Obstet Gynecol*. 2010 Oct;203(4):330.e1-5
73. Sayakhot P, Carolan-Olah M. Internet use by pregnant women seeking pregnancy-related information: a systematic review. *BMC Pregnancy Childbirth*. 2016 Mar 28;16:65.
74. Kavlak O, Atan SU, Güleç D, Öztürk R, Atay N. Pregnant women's use of the Internet in relation to their pregnancy in Izmir, Turkey. *Inform Health Soc Care*. 2012;37(4):253-63

75. National Maternity Strategy 2016-2026, available from <https://assets.gov.ie/18835/ac61fd2b66164349a1547110d4b0003f.pdf>
76. Bartels HC, Terlizzi K, Cooney N, Kranidi A, Cronin M, Lalor JG, Brennan DJ. Quality of life and sexual function after a pregnancy complicated by placenta accreta spectrum. *Aust N Z J Obstet Gynaecol.* 2021 Oct;61(5):708-714
77. Grover B, Einerson BD, Keenan KD, Gibbins KJ, Callaway E, Lopez S, Silver RM. Patient-Reported Health Outcomes and Quality of Life after Peripartum Hysterectomy for Placenta Accreta Spectrum. *Am J Perinatol.* 2020 Aug 20
78. Tol ID, Yousif M, Collins SL. Post traumatic stress disorder (PTSD): The psychological sequelae of abnormally invasive placenta (AIP). *Placenta.* 2019 Jun;81:42-45
79. Pathiraja PDM, Jayawardane A. Evaluation of Peripartum Hysterectomy in a Tertiary Care Unit and Its Effect on Patients' Long-Term Physical and Mental Wellbeing: Quest Is Not Over When You Save the Life. *Obstet Gynecol Int.* 2021 Feb 17;2021:5720264
80. Bartels HC, Mulligan KM, Lalor JG, Higgins MF, Brennan DJ. A life changing experience: An interpretative phenomenological analysis of women's experiences of placenta accreta spectrum. *Eur J Obstet Gynecol Reprod Biol.* 2020 Nov;254:102-108
81. Einerson BD, Watt MH, Sartori B, Silver R, Rothwell E. Lived experiences of patients with placenta accreta spectrum in Utah: a qualitative study of semi-structured interviews. *BMJ Open.* 2021 Nov 3;11(11):e052766
82. Antepartum Haemorrhage; Royal College of Obstetricians and Gynaecologists Green Top Guideline No 63, November 2011
83. British Committee for Standards in Haematology Blood Transfusion Task Force, Gooch A, Parker J, Wray J, Qureshi H. Guideline for blood grouping and antibody testing in pregnancy. *Transfus Med* 2007;17:252-62
84. Sánchez-Durán, M.Á., Higuera, M.T., Halajdian-Madrid, C. *et al.* Management and outcome of pregnancies in women with red cell isoimmunization: a 15-year observational study from a tertiary care university hospital. *BMC Pregnancy Childbirth* 19, 356 (2019). <https://doi.org/10.1186/s12884-019-2525-y>
85. Centre for Maternal and Child Enquiries (CMACE). Saving Mothers' Lives: Reviewing maternal deaths to make motherhood safer: 2006-08. The Eighth Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom. *BJOG* 2011;118 Suppl 1:1-203
86. Abdul Sultan A, West J, Tata LJ, Fleming KM, Nelson-Piercy C, Grainge MJ. Risk of first venous thromboembolism in pregnant women in hospital: population based cohort study from England. *BMJ* 2013;347:f6099
87. Royal College of Obstetricians and Gynaecologists. Thromboembolic Disease in Pregnancy and the Puerperium: Acute Management. Green-top Guideline No. 37b. London: RCOG; 2015
88. Phillips SM, Gallagher M, Buchan H. Use graduated compression stockings postoperatively to prevent deep vein thrombosis. *BMJ* 2008;336:943-4
89. National Institute for Health and Care Excellence. Reducing venous thromboembolism risk in hospital patients hospital patients. November 2021.
90. Robinson BK, Grobman WA. Effectiveness of timing strategies for delivery of individuals with placenta previa and accreta. *Obstet Gynecol.* 2010 Oct;116(4):835-842

91. Perlman NC, Little SE, Thomas A, Cantonwine DE, Carusi DA. Patient selection for later delivery timing with suspected previa-accreta. *Acta Obstet Gynecol Scand.* 2017 Aug;96(8):1021-1028
92. Roberts D, Brown J, Medley N, Dalziel SR. Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth. *Cochrane Database Syst Rev.* 2017 Mar 21;3(3):CD004454
93. Gyamfi-Bannerman C, Thom EA, Blackwell SC, Tita AT, Reddy UM, Saade GR, Rouse DJ, McKenna DS, Clark EA, Thorp JM Jr, Chien EK, Peaceman AM, Gibbs RS, Swamy GK, Norton ME, Casey BM, Caritis SN, Tolosa JE, Sorokin Y, VanDorsten JP, Jain L; NICHD Maternal-Fetal Medicine Units Network. Antenatal Betamethasone for Women at Risk for Late Preterm Delivery. *N Engl J Med.* 2016 Apr 7;374(14):1311-20
94. Green Top Guideline no7. October 2010. Antenatal corticosteroids to reduce neonatal morbidity and mortality.
95. Einerson, B. & Weiniger, C. Placenta accreta spectrum disorder: updates on anesthetic and surgical management strategies. *Int J Obstet Anesth* 46, 102975 (2021)
96. Markley, J. C., Farber, M. K., Perlman, N. C. & Carusi, D. A. Neuraxial Anesthesia During Cesarean Delivery for Placenta Previa With Suspected Morbidly Adherent Placenta. *Anesthesia Analgesia* 127, 930-938 (2018).
97. Panjeton, G. D. *et al.* Neuraxial anesthesia and postoperative opioid administration for cesarean delivery in patients with placenta accreta spectrum disorder: a retrospective cohort study. *Int J Obstet Anesth* 103220 (2021)
98. Warrick CM, Markley JC, Farber MK, Balki M, Katz D, Hess PE, Padilla C, Waters JH, Weiniger CF, Butwick AJ. Placenta Accreta Spectrum Disorders: Knowledge Gaps in Anesthesia Care. *Anesth Analg.* 2022 Jan 24
99. Sun, L. S. *et al.* Association Between a Single General Anesthesia Exposure Before Age 36 Months and Neurocognitive Outcomes in Later Childhood. *JAMA* 315, 2312-2320 (2016).
100. McCann, M. E. *et al.* Neurodevelopmental outcome at 5 years of age after general anaesthesia or awake-regional anaesthesia in infancy (GAS): an international, multicentre, randomised, controlled equivalence trial. *Lancet* 393, 664-677 (2019).
101. McCall SJ, Deneux-Tharaux C, Sentilhes L, Ramakrishnan R, Collins SL, Seco A, Kurinczuk JJ, Knight M, Kayem G. Placenta accreta spectrum – variations in clinical practice and maternal morbidity between the UK and France: a population-based comparative study. *BJOG.* 2022 Apr 5
102. Sentilhes L, Ambroselli C, Kayem G, Provansal M, Fernandez H, Perrotin F, Winer N, Pierre F, Benachi A, Dreyfus M, Bauville E, Mahieu-Caputo D, Marpeau L, Descamps P, Goffinet F, Bretelle F. Maternal outcome after conservative treatment of placenta accreta. *Obstet Gynecol.* 2010 Mar;115(3):526-534
103. Miyakoshi K, Otani T, Kondoh E, Makino S, Tanaka M, Takeda S; Perinatal Research Network Group in Japan. Retrospective multicenter study of leaving the placenta in situ for patients with placenta previa on a cesarean scar. *Int J Gynaecol Obstet.* 2018 Mar;140(3):345-351.
104. Timmermans S, van Hof AC, Duvekot JJ. Conservative management of abnormally invasive placentation. *Obstet Gynecol Surv.* 2007 Aug;62(8):529-39.

105. Sentilhes L, Seco A, Azria E, Beucher G, Bonnet MP, Branger B, Carbillon L, Chiesa C, Crenn-Hebert C, Dreyfus M, Dupont C, Fresson J, Huissoud C, Langer B, Morel O, Patrier S, Perrotin F, Raynal P, Rozenberg P, Rudigoz RC, Vendittelli F, Winer N, Deneux-Tharoux C, Kayem G; PACCRETA Study Group. Conservative management or cesarean hysterectomy for placenta accreta spectrum: the PACCRETA prospective study. *Am J Obstet Gynecol.* 2021 Dec 14:S0002-9378(21)02655-7
106. Belfort MA, Shamshiraz AA, Fox K. Minimizing blood loss at cesarean-hysterectomy for placenta previa percreta. *Am J Obstet Gynecol.* 2017 Jan;216(1):78.e1-78.e2
107. Collins SL, Alemdar B, van Beekhuizen HJ, Bertholdt C, Braun T, Calda P, Delorme P, Duvekot JJ, Gronbeck L, Kayem G, Langhoff-Roos J, Marcellin L, Martinelli P, Morel O, Mhallem M, Morlando M, Noergaard LN, Nonnenmacher A, Pateisky P, Petit P, Rijken MJ, Ropacka-Lesiak M, Schlembach D, Sentilhes L, Stefanovic V, Strindfors G, Tutschek B, Vangen S, Weichert A, Weizsäcker K, Chantraine F; International Society for Abnormally Invasive Placenta (IS-AIP). Evidence-based guidelines for the management of abnormally invasive placenta: recommendations from the International Society for Abnormally Invasive Placenta. *Am J Obstet Gynecol.* 2019 Jun;220(6):511-526
108. Allen L, Jauniaux E, Hobson S, Papillon-Smith J, Belfort MA; FIGO Placenta Accreta Diagnosis and Management Expert Consensus Panel. FIGO consensus guidelines on placenta accreta spectrum disorders: Nonconservative surgical management. *Int J Gynaecol Obstet.* 2018 Mar;140(3):281-290
109. Walker MG, Allen L, Windrim RC, *et al.* Multidisciplinary management of invasive placenta previa. *J Obstet Gynaecol Can.* 2013;35:417-425.
110. Grace Tan SE, Jobling TW, Wallace EM, McNeilage LJ, Manolitsas T, Hodges RJ. Surgical management of placenta accreta: A 10-year experience. *Acta Obstet Gynecol Scand.* 2013;92:445-450.
111. M. Aoki, H. Tokue, M. Miyazaki, K. Shibuya, S. Hirasawa, K. Oshima. Primary postpartum hemorrhage: outcome of uterine artery embolization. *Br J Radiol* (2018), p. 20180132 J.S. Lee, S.M. Shepherd
112. J.S. Lee, S.M. Shepherd Endovascular treatment of postpartum hemorrhage. *Clin Obstet Gynecol*, 53 (2010), pp. 209-218
113. A.C. Picel, B. Wolford, R.L. Cochran, G.A. Ramos, A.C. Roberts Prophylactic internal iliac artery occlusion balloon placement to reduce operative blood loss in women with invasive placenta. *J Vasc Interv Radiol*, 29 (2018), pp. 219-224
114. Lee AY, Ballah D, Moreno I, Dong PR, Cochran R, Picel A, Lee EW, Moriarty J, Padgett M, Nelson K, Kohi MP. Outcomes of balloon occlusion in the University of California Morbidly Adherent Placenta Registry. *Am J Obstet Gynecol MFM.* 2020 Feb;2(1):100065. doi: 10.1016/j.ajogmf.2019.100065. Epub 2019 Nov 9
115. Blumenthal E, Rao R, Murphy A, Gornbein J, Hong R, Moriarty JM, Kahn DA, Janzen C.; Pilot Study of Intra-Aortic Balloon Occlusion to Limit Morbidity in Patients with Adherent Placentation Undergoing Cesarean Hysterectomy. *AJP Rep.* 2018 Apr;8(2):e57-e63. doi: 10.1055/s-0038-1641736. Epub 2018 Apr 11
116. Jauniaux E, Ayres-de-Campos D, Langhoff-Roos J, Fox KA, Collins S. FIGO Placenta Accreta Diagnosis and Management Expert. Consensus Panel. FIGO classification for the clinical diagnosis of placenta accreta spectrum disorders. *Int J Gynaecol Obstet* 2019; 146:20e4.
117. J. Ballas, A.D. Hull, C. Saenz, *et al.* Preoperative intravascular balloon catheters and surgical outcomes in pregnancies complicated by placenta accreta: a management paradox. *Am J Obstet Gynecol*, 207 (2012), pp. 216.e211-216.e215

118. Y. Ono, Y. Murayama, S. Era, *et al.* Study of the utility and problems of common iliac artery balloon occlusion for placenta previa with accreta
119. Clark SL, Phelan JP, Yeh SY, Bruce SR, Paul RH. Hypogastric artery ligation for obstetric hemorrhage. *Obstet Gynecol* 1985; 66 (03) 353-356
120. Shrivastava V, Nageotte M, Major C, Haydon M, Wing D. Case-control comparison of cesarean hysterectomy with and without prophylactic placement of intravascular balloon catheters for placenta accreta. *Am J Obstet Gynecol* 2007; 197 (04) 402.e1-402.e5
121. Salim R, Chulski A, Romano S, Garmi G, Rudin M, Shalev E. Precesarean Prophylactic Balloon Catheters for Suspected Placenta Accreta: A Randomized Controlled Trial. *Obstet Gynecol.* 2015 Nov;126(5):1022-1028
122. Hussein AM, Dakhly DMR, Raslan AN, Kamel A, Abdel Hafeez A, Moussa M, Hosny AS, Momtaz M. The role of prophylactic internal iliac artery ligation in abnormally invasive placenta undergoing caesarean hysterectomy: a randomized control trial. *J Matern Fetal Neonatal Med.* 2019 Oct;32(20):3386-3392
123. Chen M, Liu X, You Y, Wang X, Li T, Luo H, Qu H, Xu L. Internal Iliac Artery Balloon Occlusion for Placenta Previa and Suspected Placenta Accreta: A Randomized Controlled Trial. *Obstet Gynecol.* 2020 May;135(5):1112-1119
124. Dai M, Zhang F, Li K, Jin G, Chen Y, Zhang X. The effect of prophylactic balloon occlusion in patients with placenta accreta spectrum: a Bayesian network meta-analysis. *Eur Radiol.* 2021 Nov 30. doi: 10.1007/s00330-021-08423-6. Epub ahead of print
125. Chen L, Wang X, Wang H, Li Q, Shan N, Qi H. Clinical evaluation of prophylactic abdominal aortic balloon occlusion in patients with placenta accreta: a systematic review and meta-analysis. *BMC Pregnancy Childbirth.* 2019 Jan 15;19(1):30
126. Pavord S, Myers B, Robinson S, Allard S, Strong J, Oppenheimer C; British Committee for Standards in Haematology. UK guidelines on the management of iron deficiency in pregnancy. *Br J Haematol.* 2012 Mar;156(5):588-600
127. Phillips SM, Gallagher M, Buchan H. Use graduated compression stockings postoperatively to prevent deep vein thrombosis. *BMJ* 2008;336;943-4
128. Mauney L, Barth WH Jr, Clapp MA. Association between peripartum hysterectomy and venous thromboembolism. *Am J Obstet Gynecol.* 2021 Jul 2:S0002-9378(21)00775-4. doi: 10.1016/j.ajog.2021.06.091
129. National Institute for Health and Care Excellence. Postnatal care up to 8 weeks after birth. NICE Clinical Guideline 37. 2015
130. Bartels HC, Horsch A, Cooney N, Brennan DJ, Lalor JG. Living beyond placenta accreta spectrum: parent's experience of the postnatal journey and recommendations for an integrated care pathway. *BMC Pregnancy Childbirth.* 2022 May 10;22(1):397.
131. Hecht, J.L., Baergen, R., Ernst, L.M. *et al.* Classification and reporting guidelines for the pathology diagnosis of placenta accreta spectrum (PAS) disorders: recommendations from an expert panel. *Mod Pathol* 33, 2382-2396 (2020)
132. Guyatt, Gordon, *et al.* "GRADE Guidelines: 1. Introduction – GRADE Evidence Profiles and Summary of Findings Tables." *Journal of Clinical Epidemiology*, vol. 64, no. 4, 2011, pp. 383-94, <https://doi.org/10.1016/j.jclinepi.2010.04.026>
133. Ginosar, Y., Reynolds, F., FRCPC, S. H. M., MSc, & Weiner, C. P. Anesthesia and the Fetus. (2018) doi:10.1002/9781118477076

134. Robbins, L. S. *et al.* General anesthesia for cesarean delivery and childhood neurodevelopmental and perinatal outcomes: a secondary analysis of a randomized controlled trial. *Int J Obstet Anesth* 45, 34-40 (2021).
135. Sun, L. S. *et al.* Association Between a Single General Anesthesia Exposure Before Age 36 Months and Neurocognitive Outcomes in Later Childhood. *JAMA* 315, 2312-2320 (2016).
136. Davidson, A. J. & Sun, L. S. Clinical Evidence for Any Effect of Anesthesia on the Developing Brain. *Anesthesiology* 128, 840-853 (2018)
137. *Eller A, Porter T, Soisson P, Silver R. Optimal management strategies for placenta accreta. BJOG. 2009;116(5):648-54*
138. Pelosi MA, 3rd, Pelosi MA. Modified cesarean hysterectomy for placenta previa percreta with bladder invasion: retrovesical lower uterine segment bypass. *Obstet Gynecol.* 1999;93:830-3.
139. Fitzpatrick KE, Sellers S, Spark P, Kurinczuk JJ, Brocklehurst P, Knight M. The management and outcomes of placenta accreta, increta, and percreta in the UK: a population-based descriptive study. *BJOG.* 2014;121:62-70; discussion – 1.
140. Palacios-Jaraquemada J. One-step reconstructive surgery for placenta accreta-percreta. In: Arulkumaran PS, editor. *A textbook of Postpartum Hemorrhage.* Lankashire, United Kingdom: Sapiens Publishing; 2012.
141. Chandrharan E, Rao S, Belli AM, Arulkumaran S. The Triple-P procedure as a conservative surgical alternative to peripartum hysterectomy for placenta percreta. *Int J Gynaecol Obstet.* 2012;117:191-4.

Bibliography

Health Information Quality Authority (HIQA). National Standards for Safer Better Healthcare [Internet]. Available from: <https://www.hiqa.ie/reports-and-publications/standard/national-standards-safer-better-healthcare>

Scottish Intercollegiate Guidelines Network (SIGN). A guideline developer's handbook. Edinburgh: SIGN; 2019. (SIGN publication no. 50). [November 2019]. Available from URL: <http://www.sign.ac.uk>

Society of Maternal-Fetal Medicine. SMFM Clinical Practice Guidelines Development Process [Internet]. Available from: <https://www.smfm.org/publications>

Department of Health (2018). NCEC Implementation Guide and Toolkit. Available at: <https://health.gov.ie/national-patient-safety-office/ncec/>

Department of Health (2019). How to develop a National Clinical Guideline. Available at: <https://www.gov.ie/en/collection/cd41ac-clinical-effectiveness-resources-and-learning/>

Department of Health (2015). NCEC Standards for Clinical Practice Guidance. Available at: <https://www.nmbi.ie/NMBI/media/NMBI/Forms/standards-for-clinical-practice-guidance-ncec.pdf>

Health Service Executive (2016). National Framework for developing Policies, Procedures, Protocols and Guidelines (PPPGs). Available from: <https://www.hse.ie/eng/about/who/qid/nationalframeworkdevelopingpolicies/>

Health Service Executive (2019). National Review of Clinical Audit. Available from: <https://www.hse.ie/eng/services/publications/national-review-of-clinical-audit-report-2019.pdf>

National Clinical Effectiveness Committee (NCEC) and Health Information and Quality Authority (HIQA) (2015) National quality assurance criteria for clinical guidelines. Version 2. Dublin: NCEC and HIQA. <https://www.hiqa.ie/sites/default/files/2017-01/National-Quality-Assurance-Criteria.pdf>

Health Service Executive (2022), National Centre for Clinical Audit Nomenclature – Glossary of Terms, National Quality and Patient Safety Directorate. Available from: <https://www.hse.ie/eng/about/who/nqpsd/ncca/>

Supporting Evidence

GRADE: <http://www.gradeworkinggroup.org/>

AGREE: <http://www.agreetrust.org/agree-ii/>

HSE: <https://www.hse.ie/eng/about/who/qid/nationalframeworkdevelopingpolicies/>

Glossary

(for the Purpose of this Guideline)

- ACOG** American College of Obstetricians and Gynaecologists
- AGREE** Appraisal of Guidelines for Research and Evaluation
- CVC** Central Venous Catheter
- CAG** Clinical Advisory Group
- CSE** Combined Spinal Epidural
- SCD** Compression Device Stockings
- ESUR** European Society of Urogenital Radiology
- EAG** Expert Advisory Group
- FSIQ** Full-scale intelligence quotient
- GA** General Anaesthesia
- GAS** General anaesthesia or awake regional anaesthesia in infancy
- GRADE** Grading of Recommendations, Assessments, Developments and Evaluations
- GPT** Guideline Programme Team
- HIQA** Health Information and Quality Authority
- HSE** Health Service Executive
- HDU** High Dependency Unit
- IOG** Institute of Obstetricians and Gynaecologists
- ICU** Intensive Care Unit
- FIGO** International Federation of Gynaecology and Obstetrics
- IR** Interventional Radiology
- IABs** Intra-Aortic Balloons
- IVUS** Intravascular Ultrasound
- MRI** Magnetic Resonance Imaging
- MDT** Multi-Disciplinary team
- NCEC** National Clinical Effectiveness Committee
- NWIHP** National Women and Infants Health Programme
- NA** Neuroaxial
- PANDA** Paediatric Anaesthesia and Neuro-Development Assessment Study
- PAS** Placenta Accreta Spectrum

PPPG Policy, Procedures, Protocols and Guidelines

PBO Prophylactic Balloon Occlusion

RCOG Royal College of Obstetricians and Gynaecologists

RCPI Royal College of Physicians of Ireland

SAR Society of Abdominal Radiology

NICE The National Institute for Health and Care Excellence

TVS Trans Vaginal Scan

UAE Uterine Artery Embolisation

VTE Venous thromboembolism

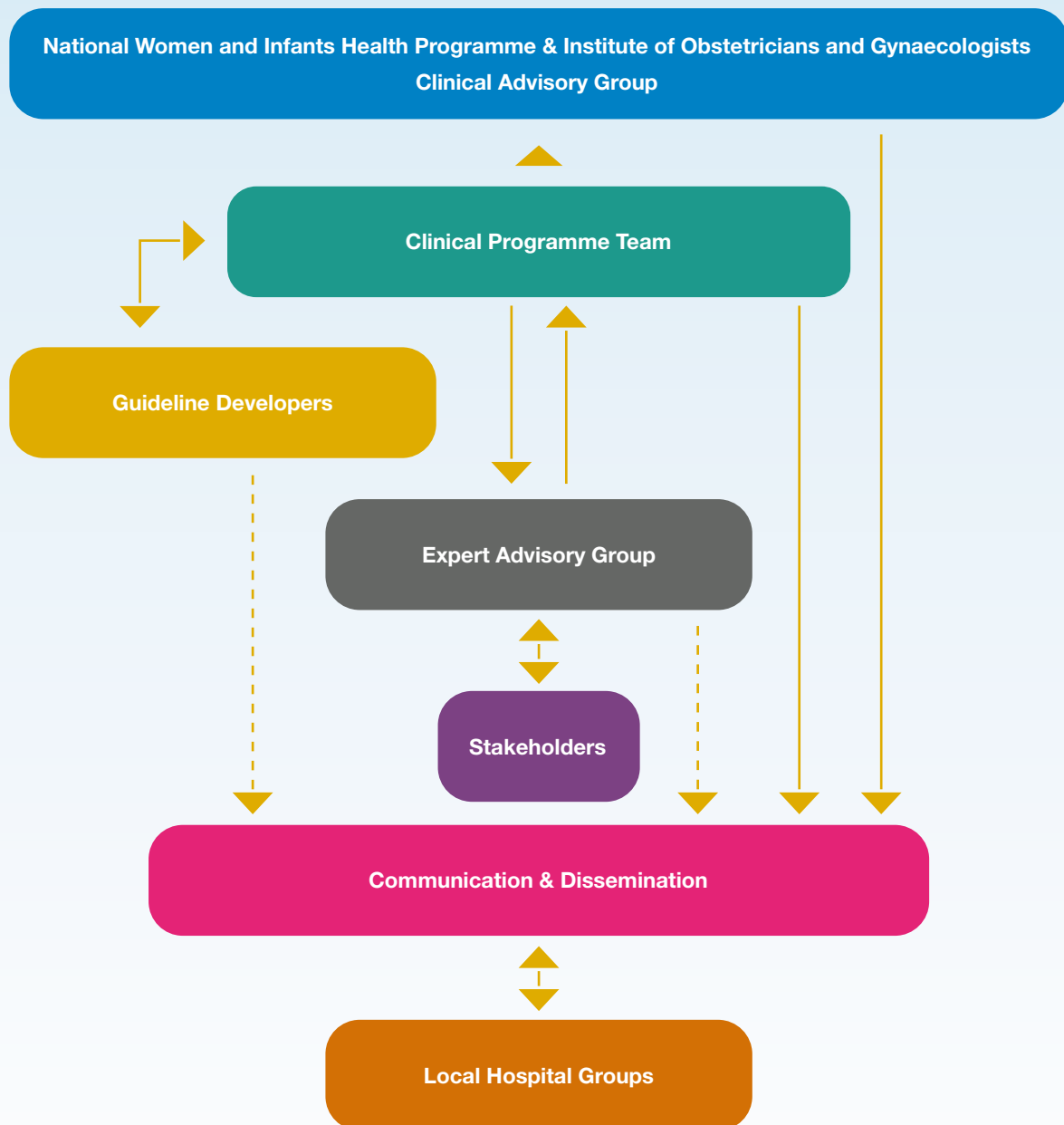
Appendix 1: Expert Advisory Group Members 2021-

Name	Profession	Location (2021)
Dr Fergus McCarthy	Consultant Obstetrician, Gynaecologist, Senior Lecturer and Maternal-Fetal Medicine Sub-specialist	Cork University Maternity Hospital, University College Cork
Dr Mairead Butler	Consultant Obstetrician and Gynaecologist	University Hospital Waterford
Prof Declan Keane	Professor of Obstetrics and Gynaecology	National Maternity Hospital Dublin, Royal College of Surgeons in Ireland
Dr Katherine Astbury	Consultant Obstetrician and Gynaecologist Gynaecology Oncology Sub-specialist	University Hospital Galway
Dr Sarah Petch	Specialist Registrar, Obstetrics and Gynaecology	National Maternity Hospital Dublin
Dr Orla Donohoe	Specialist Registrar, Obstetrics and Gynaecology	Sligo University Hospital
Prof John Murphy	Consultant Neonatologist and Clinical Lead for the National Clinical Programme for Paediatrics and Neonatology	National Women and Infants Health Programme
Ms Siobhan Canny	Group Director of Midwifery	Saolta University Health Care Group
Ms Fiona Hanrahan	Director of Midwifery and Nursing	Rotunda Hospital Dublin
Ms Margaret Quigley	National Lead for Midwifery	Office of Nursing and Midwifery Services Director
Prof Valerie Smith	Professor of Midwifery	School of Nursing and Midwifery, Trinity College Dublin
Ms Triona Cowman	Director of the Centre for Midwifery Education	Centre for Midwifery Education, Coombe Women & Infants University Hospital
Ms Janet Murphy	Advanced Midwifery Practitioner	University Hospital Waterford

Attendee	Profession	Location (2021)
Dr Ciara McCarthy	General Practitioner and ICGP Women's Health Lead	Irish College of General Practitioners
Mr Fergal O' Shaughnessy <i>And</i> Dr Brian Cleary <i>(Shared nomination)</i>	Senior Pharmacist, Honorary Lecturer <i>And</i> Chief Pharmacist, Honorary Clinical Associate Professor and Medications Lead, Maternal & Newborn Clinical Management System	Rotunda Hospital Dublin Royal College of Surgeons in Ireland
Ms Marie Finn	Medical Social Work Counsellor	Saolta University Health Care Group
Ms Marie Culliton	Lab Manager/Chief Medical Scientist	National Maternity Hospital Dublin
Ms Marita Hennessy	Post-Doctoral Researcher	Pregnancy Loss Research Group, INFANT Centre, University College Cork
Ms Niamh Connolly-Coyne <i>And</i> Ms Mandy Daly <i>(Shared nomination)</i>	Board of Directors	Irish Neonatal Health Alliance
Ms Caroline Joyce	Principal Clinical Biochemist PhD Candidate	Cork University Hospital University College Cork
Dr Richard Duffy	Consultant Perinatal Psychiatrist	Rotunda Hospital Dublin
Ms Clare Farrell	Physiotherapy Manager	Coombe Women & Infants University Hospital
Ms Fiona Dunlevy <i>And</i> Ms Sinéad Curran <i>(Shared nomination)</i>	Dietician Manager	Coombe Women & Infants University Hospital National Maternity Hospital
Dr Nicholas Barrett	Lead for Obstetric Anaesthesiology services	Limerick University Hospital
Dr Brendan Fitzgerald	Consultant Perinatal Pathologist	Cork University Hospital
Dr Niamh Conlon	Consultant Histopathologist	Cork University Hospital

Appendix 2: Guideline Programme Process

Guideline Programme Process



Appendix 3: Proforma of ultrasound and MRI signs in PAS

Suspected Placenta Accreta Spectrum: imaging reporting template

Date of examination	__/__/__
Gestational Age	__weeks__days

Demographics and Risk Factors			
Parity			
Number of previous CS			
Number of previous surgical evacuations (including TOP)			
	Yes	No	Not known
Previous uterine surgery (e.g. myomectomy, endometrial ablation)?			
History of PAS?			
Was CS scar pregnancy suspected first trimester?			
Placenta praevia on US?			

Ultrasound Signs 'x' as appropriate	Yes	No	Unsure	MRI Signs 'x' as appropriate	Yes	No	Unsure
Loss of clear zone				Loss of retroplacental low T2 line			
Myometrial thinning				Myometrial thinning (<1mm)			
Uterine bulge				Uterine bulge			
Focal exophytic placental mass – through serosa, parametrium				Focal exophytic placental mass – through serosa, parametrium			
Bladder wall interruption				Bladder wall interruption			
Lacunae				Low T2 placental bands			

Colour Doppler				Heterogeneity			
Placenta lacunae feeder vessels				Intraplacental fetal vessels (>3mm)			
Abnormal vasculature at plac-myometrial interface, serosa, bladder				Abnormal vasculature at plac-myometrial interface, serosa, bladder			

Clinical Significance of Imaging Findings	High	Intermediate	Low
Extent of PAS	Focal	Diffuse	

Appendix 4: Placenta Accreta Syndrome (PAS) & Caesarean Hysterectomy: A Practical Pathway for Theatre Nurses

Supplementary appendix, available to view at:

<https://www.hse.ie/eng/about/who/acute-hospitals-division/woman-infants/clinical-guidelines/>

<https://www.rcpi.ie/faculties/obstetricians-and-gynaecologists/national-clinical-guidelines-in-obstetrics-and-gynaecology/>

Appendix 5: Template for documentation of MDT outcome

Name:	Hospital number:	DOB:
Age:	Parity:	BMI:
EDD:	Previous CS/uterine surgery:	
Referral source:		
Local lead obstetrician:		
PAS lead obstetrician:		
MDT Date		
Gestation		
Hb	Document current +/- optimisation required	
Antenatal corticosteroids	Document gestation given	
Estimated fetal weight (centile)		
Imaging findings	US: MRI:	
Expected depth of invasion		
	FIGO grade 1/2/3	
Location of defect		
	Anterior inferior/anterior superior/right lateral/left lateral/posterior	
Size of defect		
Recommendation of MDT		
Elective delivery location		
Elective delivery gestation		
Elective delivery admission		

Planned surgical approach	Abdominal incision: Midline/pfannenstiel Attempt uterine conservation/BTL/hysterectomy Urology required: Yes/No Interventional radiology required: Yes/No
	Further imaging
Anaesthetic review	Date Completed
Neonatology review	Date completed
Gynaecology review	Date completed
Social work review	Date completed
Additional consultations	Date completed

Appendix 6: Mode of anaesthesia

	Benefits	Risks
General Anaesthesia	<p>Maximum maternal comfort for prolonged surgical exposure</p> <p>Controlled elective management of airway</p> <p>Control of physiology in the event of major haemorrhage</p> <p>Reduced sympatholysis which can exacerbate hypotension in major haemorrhage</p>	<p>Failed intubation or aspiration</p> <p>Need for neonatal resuscitation/recovery from anaesthesia</p> <p>Reduced cardiac output</p> <p>For mother – not awake for birth of baby</p>
Spinal/ subarachnoid anaesthesia	<p>Excellent surgical anaesthesia for delivery</p> <p>Mother awake for birth of baby</p>	<p>Sympathectomy reducing mean arterial pressure and cardiac output</p> <p>Inadequate duration or extent of anaesthesia for prolonged procedures including IR prior to laparotomy or extensive dissection</p> <p>Post dural puncture headache</p> <p>Co-morbidities may contraindicate</p>
Epidural or Combined Spinal Epidural (CSE) anaesthesia	<p>Adequate surgical anaesthesia with the capacity to extend the duration as needed</p> <p>Excellent post-operative analgesia</p> <p>Effective reduction in anaesthetic dose requirement when combined with general anaesthesia</p> <p>Less haemodynamic compromise than SAB alone</p>	<p>Block failure/inadequacy with unplanned or uncontrolled conversion to GA with suboptimal positioning</p> <p>Post dural puncture headache</p> <p>Co-morbidities may contraindicate</p> <p>Neuraxial catheter potentially in situ during coagulopathy associated with major haemorrhage</p>

Appendix 7: Supporting evidence for the implications of maternal anaesthesia for fetal and childhood outcomes

1. Experimental evidence in infant animals (both rodents and non-human primates) shows that neuroapoptosis is induced by exposure to NMDA antagonists (Ketamine), GABAA agonists (benzodiazepines) and drugs with mixed activity (Ethanol) ^{133 134}
 - Combining an anaesthetic drug with GABAergic activity with one which has NMDA antagonism results in marked neuroapoptotic potentiation
 - Drug combinations or drugs like alcohol with both GABAergic and NMDA-antagonistic effects are especially damaging to the developing animal brain
 - Drug combinations appear to be synergistic rather than additive in their capacity to trigger neuroapoptosis
 - Apoptotic cell death affects the primate brain on the same time course as the rodent brain.
 - Studies in neonatal Rhesus monkeys show severe damage with:
 - 5-8 hours exposure to isoflurane
 - 5-9 hours of ketamine infusion
 - The findings of particular sensitivity to damage in the basal ganglia and thalamus has been shown in children exposed to alcohol and anti-convulsants *in utero*
 - Human epidemiological studies show:
 - Some evidence for increased risk of developmental behavioural disorders and learning disabilities in children exposed to anaesthesia
 - Most increase seen in children exposed to >120 mins of anaesthesia or >1 episode of anaesthesia
 - Retrospective studies have significant limitations including heterogeneity of general anaesthetic techniques which can be outdated by the time of neurological assessment

2. Animal studies describe a dose dependent increase in apoptosis after every anaesthetic agent in use. The significance of these findings for neonatal humans has not yet been established. It is of concern and warrants ongoing investigation. It is noted that the concentrations of hypnotic drugs studied may not be those commonly administered in a 'balanced anaesthesia'. There is uncertainty over how these findings in animal models translate to clinically relevant human scenarios.

3. General anaesthesia is associated with higher proportions of Apgar's @5 mins <7. This effect is brief and reversible. This is not the context in which Apgar scores are meaningful, being a measure of neonatal overall health rather than the response of a neonate after exposure to anaesthesia. This finding is temporary and of questionable clinical significance beyond the first minutes after birth.
4. In a secondary analysis of an RCT (Mg and CP), anaesthesia was not associated with overall neurodevelopmental delay at 2 years ¹³⁵
5. A sibling-matched cohort study (**PANDA**) ⁹⁹ showed that among healthy children with a single anaesthesia exposure before age 36 months, compared with healthy siblings with no anaesthesia exposure, there were no statistically significant differences in IQ scores in later childhood. No statistically significant differences in mean scores were found between sibling pairs in memory/learning, motor/processing speed, visuospatial function, attention, executive function, language, or behaviour. The authors highlighted that further study of repeated exposure, prolonged exposure, and vulnerable subgroups is needed.
6. The FDA labelling regarding the safe use of anaesthetic and sedatives drugs was changed in 2017 to state "repeated or lengthy use of general anaesthetic and sedation drugs during surgeries or procedures in children younger than 3 years or in pregnant women during their third trimester may affect the development of children's brains." ¹³⁶
 - The warning goes on to state that brief exposure is probably safe. Most but not all studies have found a greater impact with repeated exposures.
 - The FDA warning is driven by the compelling pre-clinical evidence. In contrast, there is stronger human evidence that a single brief exposure in a healthy infant is not associated with poorer neurodevelopmental outcome.
 - The **GAS** ¹⁰⁰ and **PANDA** ⁹⁹ studies both of which included detailed neurodevelopmental assessments, showed that a single brief (< 1 hr) exposure to general anaesthesia in early infancy was not associated with poorer neurodevelopmental outcomes.

In summary, while there is compelling pre-clinical evidence that all anaesthetic drugs (with the possible exception of xenon, dexmedetomidine and opioids) can be harmful to the developing brain, there is no clear translation of this observation to the perinatal human brain. Prolonged anaesthetic exposure (>120 minutes) in infants is by definition associated with a surgical condition that confounds interpretation of the neurobehavioral outcome as the child grows. There is stronger human evidence that a single brief exposure in healthy infants does not have a negative neurobehavioral impact

Appendix 8: Detailed description of surgical techniques

Detailed description of surgical techniques: clinical practice

1. Hysterectomy

Hysterectomy is considered the gold standard for management of anterior PAS, however additional uterine conserving procedures are increasing in popularity¹³⁷. Specific attention should be paid to rarer cases that involve posterior or lateral disease extending into the parametrium.

In the experience of the guideline developers all women are placed in dorsal lithotomy position have a vertical midline incision. Careful inspection of the abdomen and pelvis is then undertaken to assess the clinical severity of the disease with particular emphasis on vascularity over the lower uterine segment, the bladder dome and the pelvic sidewall. Prior to delivery of the fetus, the round ligaments are ligated bilaterally and the pelvic sidewalls are opened if there is any suggestion of parametrial involvement which can be demonstrated by the presence of newly formed vessels from the ureter or pelvic branches of the internal iliac arteries. In this situation, if high proximal vascular control (aorta-bilateral common iliac) is not available, the dissection should be stopped and the baby delivered via a fundal incision without disturbing the placenta (discussed below).

Once parametrial involvement has been excluded the key part of the procedure is mobilisation of the bladder. Dissection of the vesico-uterine peritoneum allows ligation of vesico-uterine neovasculature which is almost pathognomonic of PAS (Figure 2). Occasionally this area can be difficult to dissect due to fibrosis and it is possible place a finger in the cervical-vesical space (Pelosi maneuver¹³⁸) and elevate to facilitate the dissection. If frank invasion of the bladder is present demonstrated by vascular invasion into the bladder encountered during dissection, a cystotomy is performed; the ureteric orifices are identified, and ureteric catheters are placed bilaterally. This procedure is safe in most cases as the dome of the bladder is involved, however in rare cases of placenta percreta that arise from caesarean scar pregnancies that involve the trigone special care must be taken (discussed below).

The fetus is delivered via a uterine incision avoiding the placenta. Blood loss can be reduced by using a linear stapler to open the uterus if it is available. In this situation, two stay sutures are placed in the uterine fundus and the myometrium is opened down to the amnion using electrocautery, the membranes are digitally separated from the decidua and the linear stapler (4.8mm) is inserted and fired inferiorly and superiorly. The membranes can then be ruptured, and the baby delivered¹⁰⁶.

After delivery, the cord is clamped and cut close to the placental insertion site. If spontaneous separation of the placenta does not occur no attempt should be made to manually remove the placenta¹³⁹ and the uterus should be closed. Hysterectomy and bilateral salpingectomy are then initiated by ligation of the ovarian ligaments and uterine arteries. Following ligation of the uterine arteries and division of the cardinal ligaments a narrow Deever retractor or sponge on a stick was placed in the vagina to identify the anterior vaginal fornix. The anterior vagina is opened and the hysterectomy is completed in a retrograde fashion, clamps should be placed on all vaginal pedicles to minimise blood loss from vaginal arterial branches. The vaginal vault is closed using interrupted 0 vicryl sutures.

2. Invasion Topography – predicting and managing difficult cases

An improved surgical classification of PAS using objective elements is required to improve understanding and planning of difficult cases. An understanding of the anatomical invasive margin (invasion topography) either by MRI or intraoperative assessment is helpful to prevent complications, as they are often related to a specific vascular pedicle. Approximately 80% of PAS invasions occur close to the bladder dome and these are often on the benign side of the spectrum as this area is only supplied by the uterine and superior vesical arteries which are easily accessible. These cases may be suitable for uterine conserving approaches and one-step conservative surgery.

Lower anterior invasions are much more complicated and are often the result of cervical scar pregnancies. Gaining vascular control in this area can be very difficult as multiple vessels including the inferior vesical, cervical and vaginal pedicles. These vascular pedicles originate from the internal pudendal artery and are located in a very narrow space, close to the bladder trigone and are often surrounded by the fibrous anterior parametrium. As a result, this is an extremely dangerous area in terms of bleeding and technical difficulty and inferior vesical invasion is associated with increased risk of complications and maternal death.

It may often be necessary to leave residual adherent placental tissue in this area. If necessary, a retrograde or subtotal hysterectomy may be performed. It is possible to perform a retrograde hysterectomy by accessing the posterior vaginal fornix using a swab on a stick or a narrow deever retractor. In these situations, it may be necessary to insert ureteric catheters or stents at the start of the procedure as dissection of the ureteric tunnel in the anterior parametrium can lead to massive haemorrhage. Ureteric stents allow easy identification of the ureters so that the uterosacral ligaments can be safely ligated, which allows for elevation of the uterus and the ureters can be gently pushed laterally.

Once the posterior vaginal fornix has been opened, the lateral vaginal vessels can be controlled using heavy clamps incorporating the full thickness of the vaginal cuff, as you move anteriorly it is usually possible to identify the anterior vagina from the bladder. Extreme care must be taken at the bladder pillars to avoid ureteric damage and brisk bleeding can be encountered at the bladder base. Each vaginal pedicle should be individually ligated using a 1.0 vicryl suture and the vaginal vault is closed using interrupted sutures. Bleeding at the bladder base can be controlled by careful placement of figure-of-eight 2.0 sutures. Bladder repair, if necessary, is performed as outlined below. These cases have a high risk of vesico-vaginal fistula and it is the authors practice to place an omental flap over the bladder, leave a urinary catheter in-situ for up to 10 days and perform a cystogram prior to removal.

The third area of invasive topography is invasion to the lateral parametrium. Although rare, lateral parametrial invasions are often associated with illegal abortions, manual removal of the placenta and repeated curettage. There are two types of lateral invasions, one in which the placenta protrudes through a lateral defect, similar to a hernia, and the another, in which primary lateral embryo implantation occurs leading to extensive neo-angiogenesis. This location is extremely dangerous, due to the close proximity of the ureter and major pelvic vessels and also because the newly formed vessels habitually arise from the ureter and the internal iliac vessels. Traumatic detachment of a lower parametrial placental invasion, particularly from the internal iliac vein can rapidly lead to life-threatening bleeding. Extensive parametrial invasion is an indication to consider earlier delivery or leave the placenta in situ.

The fourth and final area of topographic invasion is posterior lower uterine body invasions, which are much more difficult to diagnose antenatally and can cause massive bleeding, even with a major proximal vascular control. This is because, an invasive placenta in the lower posterior uterus, leads to the enlargement of a poorly described vascular bundle arising from the superior rectal artery. As this artery arises from the inferior mesenteric artery, it can lead to extensive bleeding even in the presence with aortic occlusion. This anastomotic vessel is simple to manage with a figure-of-eight stitch, once correctly identified It is easy to see once the uterus has been exteriorised.

All of these features demonstrate different approaches that may be needed when performing a hysterectomy for PAS. Characterisation of the topographic invasion via pre-operative imaging and accurate intra-operative stratification are extremely important so that the surgeon can identify the appropriate surgical approach and also consider non-operative alternatives.

3. Uterine preserving surgery

3.1 *Leaving the placenta in situ*

Conservative management involves delivery of the fetus through a uterine incision that does not involve the placenta – normally in the uterine fundus. The uterus is closed, and the placenta is left in situ and spontaneously resorbed¹⁰². The main advantage of this procedure is reduced blood loss and minimal risk of iatrogenic damage to adjacent organs. This procedure is particularly indicated when an unanticipated PAS is detected during cesarean section for fetal indications and it may not be possible to delay the delivery or in the absence of hospital resources such as a trained surgical team, a blood bank or intensive care unit.

After delivery, the woman must receive antibiotics (amoxicillin and clavulonic acid or clindamycin in penicillin allergy) and agree to close monitoring. The septic morbidity associated with this approach is not insignificant and a significant proportion (at least 10%) will need a delayed hysterectomy which can be a very difficult procedure¹⁴⁰. At present, there is no role for methotrexate or uterine artery embolisation to promote placental resorption or delivery. As many women may present to alternative institutions for management of late complications, the morbidity associated with conservative management may be under-reported.

3.2 *One-step conservative surgery*

This technique uses a modified Pfannenstiel incision and the development of dermo-cutaneous flap by dissecting over the anterior rectus fascia up to the umbilicus¹⁴⁰. A midline incision of the rectus sheath is then performed from the umbilicus to the pubic symphysis. The bladder is then mobilised and all the newly formed vessels between the bladder and placenta are ligated down to the upper vagina or cervix as previously described. A horizontal hysterotomy is performed in the upper uterine segment using the previously described Ward technique. After delivery of the baby, the uterus is exteriorised without touching the placenta. Bladder dissection is completed if necessary and the individual vessels supplying the invaded area are ligated. The placenta is then removed en bloc with all myometrium at the site of invasion using a scalpel. After cleaning the cavity, the uterus is sutured in two layers using healthy tissues. This procedure does not require ligation or embolisation of the uterine artery. To date 200 subsequent pregnancies have been reported without recurrence, postpartum hemorrhage, or placenta praevia⁸. The vast majority of cases included in this series had a high anterior insertion. It is estimated that 2 to 3cm of normal lower segment myometrium below the incision are required for adequate healing to occur.

3.3 *Triple P Procedure*

This technique was introduced in the United Kingdom to reduce a risk of obstetric hysterectomy in PAS¹⁴¹. The main steps of this procedure include: (1) perioperative placental ultrasound localisation of the superior edge of the placenta; (2) pelvic devascularisation involving pre-operative placement of intra-arterial balloon catheters (anterior division of the internal iliac arteries); and (3) no attempt to remove the entire placenta with large myometrial excision and uterine repair. If the posterior wall of the bladder is involved, the placental tissue invading the bladder is left in situ to avoid cystotomy. The authors do not recommend subsequent pregnancies. Larger studies of this technique are awaited.

4. Surgical complications

The most common intra-operative complications encountered in surgical management of PAS are bleeding and bladder injury. Intraoperative management of severe unexpected bleeding should include aortic occlusion and pressure at the bleeding point. Vascular injuries can be controlled using a 4.0 Prolene suture, although venous injuries can be more difficult to control. A large venous injury requires careful mobilisation a distal and proximal control of the injury can be obtained using two small sponges on a stick before closing the defect using a 4.0 or 5.0 Prolene. Once proximal and distal control has been achieved it is always possible to wait for vascular surgical assistance if available.

Careful mobilisation of the bladder adds additional operative time in PAS cases but results in reduced urologic morbidity. Bladder repair is a necessary skill for obstetricians who operate on PAS and generally it is best to freshen the edges of a cystotomy before repairing the defect in two layers using an absorbable suture. If the defect is close to the ureteric orifices, infant feeding tubes or JJ-stents can be placed to avoid incorporating the ureter into the bladder repair. Bladder integrity can be confirmed by infusing a solution of methylene blue. A urinary catheter is placed for 7 to 10 days and a cystogram should be performed prior to removal, if possible.

Post-operative complications include infectious complications particularly pelvic collections, which can often be managed by ultrasound guided drainage and antibiotics. Careful assessment of VTE risk should be performed in all PAS cases and low molecular weight heparin commenced once the woman is hemodynamically stable with no evidence of ongoing bleeding – usually 12 hours post operatively.

Appendix 4 includes a suggested theatre pack which units caring for women with PAS should have readily available at a minimum.

Appendix 9: AGREE II Checklist¹⁷

AGREE Reporting Checklist 2016

This checklist is intended to guide the reporting of Clinical Practice Guidelines.

CHECKLIST ITEM AND DESCRIPTION	REPORTING CRITERIA	Page #
DOMAIN 1: SCOPE AND PURPOSE		
<p>1. OBJECTIVES <i>Report the overall objective(s) of the guideline. The expected health benefits from the guideline are to be specific to the clinical problem or health topic.</i></p>	<input type="checkbox"/> Health intent(s) (i.e., prevention, screening, diagnosis, treatment, etc.) <input type="checkbox"/> Expected benefit(s) or outcome(s) <input type="checkbox"/> Target(s) (e.g., patient population, society)	
<p>2. QUESTIONS <i>Report the health question(s) covered by the guideline, particularly for the key recommendations.</i></p>	<input type="checkbox"/> Target population <input type="checkbox"/> Intervention(s) or exposure(s) <input type="checkbox"/> Comparisons (if appropriate) <input type="checkbox"/> Outcome(s) <input type="checkbox"/> Health care setting or context	
<p>3. POPULATION <i>Describe the population (i.e., patients, public, etc.) to whom the guideline is meant to apply.</i></p>	<input type="checkbox"/> Target population, sex and age <input type="checkbox"/> Clinical condition (if relevant) <input type="checkbox"/> Severity/stage of disease (if relevant) <input type="checkbox"/> Comorbidities (if relevant) <input type="checkbox"/> Excluded populations (if relevant)	
DOMAIN 2: STAKEHOLDER INVOLVEMENT		
<p>4. GROUP MEMBERSHIP <i>Report all individuals who were involved in the development process. This may include members of the steering group, the research team involved in selecting and reviewing/rating the evidence and individuals involved in formulating the final recommendations.</i></p>	<input type="checkbox"/> Name of participant <input type="checkbox"/> Discipline/content expertise (e.g., neurosurgeon, methodologist) <input type="checkbox"/> Institution (e.g., St. Peter's hospital) <input type="checkbox"/> Geographical location (e.g., Seattle, WA) <input type="checkbox"/> A description of the member's role in the guideline development group	

17 AGREE Reporting Checklist is available on the AGREE Enterprise website, a free and open access resource to support the practice guideline field (www.agreetrust.org)

CHECKLIST ITEM AND DESCRIPTION	REPORTING CRITERIA	Page #
<p>5. TARGET POPULATION PREFERENCES AND VIEWS <i>Report how the views and preferences of the target population were sought/considered and what the resulting outcomes were.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Statement of type of strategy used to capture patients'/publics' views and preferences (e.g., participation in the guideline development group, literature review of values and preferences) <input type="checkbox"/> Methods by which preferences and views were sought (e.g., evidence from literature, surveys, focus groups) <input type="checkbox"/> Outcomes/information gathered on patient/public information <input type="checkbox"/> How the information gathered was used to inform the guideline development process and/or formation of the recommendations 	
<p>6. TARGET USERS <i>Report the target (or intended) users of the guideline.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> The intended guideline audience (e.g. specialists, family physicians, patients, clinical or institutional leaders/administrators) <input type="checkbox"/> How the guideline may be used by its target audience (e.g., to inform clinical decisions, to inform policy, to inform standards of care) 	
DOMAIN 3: RIGOUR OF DEVELOPMENT		
<p>7. SEARCH METHODS <i>Report details of the strategy used to search for evidence.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Named electronic database(s) or evidence source(s) where the search was performed (e.g., MEDLINE, EMBASE, PsychINFO, CINAHL) <input type="checkbox"/> Time periods searched (e.g., January 1, 2004 to March 31, 2008) <input type="checkbox"/> Search terms used (e.g., text words, indexing terms, subheadings) <input type="checkbox"/> Full search strategy included (e.g., possibly located in appendix) 	
<p>8. EVIDENCE SELECTION CRITERIA <i>Report the criteria used to select (i.e., include and exclude) the evidence. Provide rationale, where appropriate.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Target population (patient, public, etc.) characteristics <input type="checkbox"/> Study design <input type="checkbox"/> Comparisons (if relevant) <input type="checkbox"/> Outcomes <input type="checkbox"/> Language (if relevant) <input type="checkbox"/> Context (if relevant) 	

CHECKLIST ITEM AND DESCRIPTION	REPORTING CRITERIA	Page #
<p>9. STRENGTHS & LIMITATIONS OF THE EVIDENCE</p> <p><i>Describe the strengths and limitations of the evidence. Consider from the perspective of the individual studies and the body of evidence aggregated across all the studies. Tools exist that can facilitate the reporting of this concept.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Study design(s) included in body of evidence <input type="checkbox"/> Study methodology limitations (sampling, blinding, allocation concealment, analytical methods) <input type="checkbox"/> Appropriateness/relevance of primary and secondary outcomes considered <input type="checkbox"/> Consistency of results across studies <input type="checkbox"/> Direction of results across studies <input type="checkbox"/> Magnitude of benefit versus magnitude of harm <input type="checkbox"/> Applicability to practice context 	
<p>10. FORMULATION OF RECOMMENDATIONS</p> <p><i>Describe the methods used to formulate the recommendations and how final decisions were reached. Specify any areas of disagreement and the methods used to resolve them.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Recommendation development process (e.g., steps used in modified Delphi technique, voting procedures that were considered) <input type="checkbox"/> Outcomes of the recommendation development process (e.g., extent to which consensus was reached using modified Delphi technique, outcome of voting procedures) <input type="checkbox"/> How the process influenced the recommendations (e.g., results of Delphi technique influence final recommendation, alignment with recommendations and the final vote) 	
<p>11. CONSIDERATION OF BENEFITS AND HARMS</p> <p><i>Report the health benefits, side effects, and risks that were considered when formulating the recommendations.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Supporting data and report of benefits <input type="checkbox"/> Supporting data and report of harms/side effects/risks <input type="checkbox"/> Reporting of the balance/trade-off between benefits and harms/side effects/risks <input type="checkbox"/> Recommendations reflect considerations of both benefits and harms/side effects/risks 	
<p>12. LINK BETWEEN RECOMMENDATIONS AND EVIDENCE</p> <p><i>Describe the explicit link between the recommendations and the evidence on which they are based.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> How the guideline development group linked and used the evidence to inform recommendations <input type="checkbox"/> Link between each recommendation and key evidence (text description and/or reference list) <input type="checkbox"/> Link between recommendations and evidence summaries and/or evidence tables in the results section of the guideline 	

CHECKLIST ITEM AND DESCRIPTION	REPORTING CRITERIA	Page #
<p>13. EXTERNAL REVIEW <i>Report the methodology used to conduct the external review.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Purpose and intent of the external review (e.g., to improve quality, gather feedback on draft recommendations, assess applicability and feasibility, disseminate evidence) <input type="checkbox"/> Methods taken to undertake the external review (e.g., rating scale, open-ended questions) <input type="checkbox"/> Description of the external reviewers (e.g., number, type of reviewers, affiliations) <input type="checkbox"/> Outcomes/information gathered from the external review (e.g., summary of key findings) <input type="checkbox"/> How the information gathered was used to inform the guideline development process and/or formation of the recommendations (e.g., guideline panel considered results of review in forming final recommendations) 	
<p>14. UPDATING PROCEDURE <i>Describe the procedure for updating the guideline.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> A statement that the guideline will be updated <input type="checkbox"/> Explicit time interval or explicit criteria to guide decisions about when an update will occur <input type="checkbox"/> Methodology for the updating procedure 	
DOMAIN 4: CLARITY OF PRESENTATION		
<p>15. SPECIFIC AND UNAMBIGUOUS RECOMMENDATIONS <i>Describe which options are appropriate in which situations and in which population groups, as informed by the body of evidence.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> A statement of the recommended action <input type="checkbox"/> Intent or purpose of the recommended action (e.g., to improve quality of life, to decrease side effects) <input type="checkbox"/> Relevant population (e.g., patients, public) <input type="checkbox"/> Caveats or qualifying statements, if relevant (e.g., patients or conditions for whom the recommendations would not apply) <input type="checkbox"/> If there is uncertainty about the best care option(s), the uncertainty should be stated in the guideline 	
<p>16. MANAGEMENT OPTIONS <i>Describe the different options for managing the condition or health issue.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Description of management options <input type="checkbox"/> Population or clinical situation most appropriate to each option 	

CHECKLIST ITEM AND DESCRIPTION	REPORTING CRITERIA	Page #
<p>17. IDENTIFIABLE KEY RECOMMENDATIONS <i>Present the key recommendations so that they are easy to identify.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Recommendations in a summarized box, typed in bold, underlined, or presented as flow charts or algorithms <input type="checkbox"/> Specific recommendations grouped together in one section 	
DOMAIN 5: APPLICABILITY		
<p>18. FACILITATORS AND BARRIERS TO APPLICATION <i>Describe the facilitators and barriers to the guideline's application.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Types of facilitators and barriers that were considered <input type="checkbox"/> Methods by which information regarding the facilitators and barriers to implementing recommendations were sought (e.g., feedback from key stakeholders, pilot testing of guidelines before widespread implementation) <input type="checkbox"/> Information/description of the types of facilitators and barriers that emerged from the inquiry (e.g., practitioners have the skills to deliver the recommended care, sufficient equipment is not available to ensure all eligible members of the population receive mammography) <input type="checkbox"/> How the information influenced the guideline development process and/or formation of the recommendations 	
<p>19. IMPLEMENTATION ADVICE/TOOLS <i>Provide advice and/or tools on how the recommendations can be applied in practice.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Additional materials to support the implementation of the guideline in practice. For example: <ul style="list-style-type: none"> • Guideline summary documents • Links to check lists, algorithms • Links to how-to manuals • Solutions linked to barrier analysis (see Item 18) • Tools to capitalize on guideline facilitators (see Item 18) • Outcome of pilot test and lessons learned 	

CHECKLIST ITEM AND DESCRIPTION	REPORTING CRITERIA	Page #
<p>20. RESOURCE IMPLICATIONS <i>Describe any potential resource implications of applying the recommendations.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Types of cost information that were considered (e.g., economic evaluations, drug acquisition costs) <input type="checkbox"/> Methods by which the cost information was sought (e.g., a health economist was part of the guideline development panel, use of health technology assessments for specific drugs, etc.) <input type="checkbox"/> Information/description of the cost information that emerged from the inquiry (e.g., specific drug acquisition costs per treatment course) <input type="checkbox"/> How the information gathered was used to inform the guideline development process and/or formation of the recommendations 	
<p>21. MONITORING/ AUDITING CRITERIA <i>Provide monitoring and/or auditing criteria to measure the application of guideline recommendations.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Criteria to assess guideline implementation or adherence to recommendations <input type="checkbox"/> Criteria for assessing impact of implementing the recommendations <input type="checkbox"/> Advice on the frequency and interval of measurement <input type="checkbox"/> Operational definitions of how the criteria should be measured 	
DOMAIN 6: EDITORIAL INDEPENDENCE		
<p>22. FUNDING BODY <i>Report the funding body's influence on the content of the guideline.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> The name of the funding body or source of funding (or explicit statement of no funding) <input type="checkbox"/> A statement that the funding body did not influence the content of the guideline 	
<p>23. COMPETING INTERESTS <i>Provide an explicit statement that all group members have declared whether they have any competing interests.</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> Types of competing interests considered <input type="checkbox"/> Methods by which potential competing interests were sought <input type="checkbox"/> A description of the competing interests <input type="checkbox"/> How the competing interests influenced the guideline process and development of recommendations 	

From: Brouwers MC, Kerkvliet K, Spithoff K, on behalf of the AGREE Next Steps Consortium. The AGREE Reporting Checklist: a tool to improve reporting of clinical practice guidelines. *BMJ* 2016;352:i1152. doi: 10.1136/bmj.i1152.

For more information about the AGREE Reporting Checklist, please visit the AGREE Enterprise website at <http://www.agreetrust.org>.

Appendix 10: Grades of Recommendation¹⁸

Grade of recommendation	Clarity of risk/benefit	Quality of supporting evidence	Implications	Suggested Language
1 A. Strong recommendation, high-quality evidence	Benefits clearly outweigh risk and burdens, or vice versa	Consistent evidence from well-performed randomised, controlled trials or overwhelming evidence of some other form. Further research is unlikely to change our confidence in the estimate of benefit and risk	Strong recommendations can apply to most patients in most circumstances without reservation. Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present	<p>We strongly recommend...</p> <p>We recommend that ...should be performed/ administered...</p> <p>We recommend that ... is indicated/ beneficial/ effective....</p>
1 B. Strong recommendation, moderate-quality evidence	Benefits clearly outweigh risk and burdens, or vice versa	Evidence from randomised, controlled trials with important limitations (inconsistent results, methodologic flaws, indirect or imprecise), or very strong evidence of some other research design. Further research (if performed) is likely to have an impact on our confidence in the estimate of benefit and risk and may change the estimate	Strong recommendation and applies to most patients. Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present	<p>We recommend...</p> <p>We recommend that ... should be performed/ administered...</p> <p>We recommend that ... is (usually) indicated/ beneficial/ effective...</p>

18 SMFM adopts GRADE (Grading of Recommendations Assessment, Development, and Evaluation) for clinical guidelines. Society for Maternal-Fetal Medicine (SMFM), Chauhan SP, Blackwell SC. Am J Obstet Gynecol. 2013 Sep;209(3):163-5. doi: 10.1016/j.ajog.2013.07.012. PMID: 23978245

Grade of recommendation	Clarity of risk/benefit	Quality of supporting evidence	Implications	Suggested Language
1 C. Strong recommendation, low-quality evidence	Benefits appear to outweigh risk and burdens, or vice versa	Evidence from observational studies, unsystematic clinical experience, or from randomised, controlled trials with serious flaws. Any estimate of effect is uncertain	Strong recommendation that applies to most patients. Some of the evidence base supporting the recommendation is, however, of low quality	We recommend... We recommend that ... should be performed/ administered... We recommend that ... Is (maybe) indicated/ beneficial/ effective...
2A. Weak recommendation, high-quality evidence	Benefits closely balanced with risks and burdens	Consistent evidence from well-performed randomised, controlled trials or overwhelming evidence of some other form. Further research is unlikely to change our confidence in the estimate of benefit and risk	Weak recommendation: best action may differ depending on circumstances or patients or societal values	We suggest... We suggest that ... may/might be reasonable...
2B. Weak recommendation, moderate-quality evidence	Benefits closely balanced with risks and burdens, some uncertainty in the estimates of benefits, risks and burdens	Evidence from randomised, controlled trials with important limitations (inconsistent results, methodologic flaws, indirect or imprecise), or very strong evidence of some other research design. Further research (if performed) is likely to have an impact on our confidence in the estimate of benefit and risk and may change the estimate	Weak recommendation; alternative approaches likely to be better for some patients under some circumstances	We suggest... We suggest that ... may/might be reasonable...

Grade of recommendation	Clarity of risk/benefit	Quality of supporting evidence	Implications	Suggested Language
2C. Weak recommendation, low-quality evidence	Uncertainty in the estimates of benefits, risks, and burdens; benefits may be closely balanced with risks and burdens	Evidence from observational studies, unsystematic clinical experience, or from randomised, controlled trials with serious flaws. Any estimate of effect is uncertain	Very weak recommendation: other alternatives may be equally reasonable.	We suggest... is an option We suggest that ... may/might be reasonable.
Best practice	A recommendation that is sufficiently obvious that the desirable effects outweigh undesirable effects, despite the absence of direct evidence, such that the grading of evidence is unnecessary			We recommend... We recommend that ... should be performed/ administered... We recommend that ... is usually indicated/ beneficial/effective

Appendix 11: NWIHP/IOG CAG Membership 2022

Dr Cliona Murphy (Chair). Consultant Obstetrician and Gynaecologist, Coombe Women and Infants University Hospital. Clinical Director, National Women and Infants Health Programme.

Dr Sam Coulter-Smith. Consultant Obstetrician and Gynaecologist, Rotunda Hospital. Chair, Institute of Obstetricians and Gynaecologists.

Angela Dunne. Director of Midwifery, National Women and Infants Health Programme.

Kilian McGrane. Director, National Women and Infants Health Programme.

Dr Peter McKenna. Clinical Lead, Obstetric Event Support Team, National Women and Infants Health Programme.

Prof John Murphy. Clinical Lead Neonatology, National Women and Infants Health Programme.

Prof Maeve Eogan. Consultant Obstetrician and Gynaecologist, Rotunda Hospital. Clinical Lead, Sexual Assault Treatment Units, National Women and Infants Health Programme.

Dr Aoife Mullaly. Consultant Obstetrician and Gynaecologist, Coombe Women and Infants University Hospital. Clinical Lead, Termination of Pregnancy Services, National Women and Infants Health Programme.

Prof Keelin O'Donoghue. Consultant Obstetrician and Gynaecologist, Cork University Maternity Hospital. Clinical Lead, National Guidelines, National Women and Infants Health Programme.

Prof Nóirín Russell. Consultant Obstetrician and Gynaecologist, Cork University Maternity Hospital. Clinical Director, Cervical Check.

Prof Richard Greene. Consultant Obstetrician and Gynaecologist, Cork University Maternity Hospital. Clinical Director, National Perinatal Epidemiology Centre, University College Cork.

Prof John Morrison. Consultant Obstetrician and Gynaecologist, University Hospital Galway. Clinical Director, Saolta Maternity Directorate.

Dr Suzanne O'Sullivan. Consultant Obstetrician and Gynaecologist, Cork University Maternity Hospital. Director of Education and Training, Obstetrics and Gynaecology, Institute of Obstetricians and Gynaecologists.

Prof Fergal Malone. Master, Consultant Obstetrician and Gynaecologist, Rotunda Hospital.

Prof John Higgins. Cork University Maternity Hospital, Consultant Obstetrician and Gynaecologist, Clinical Director, Ireland South Women and Infants Directorate.

Dr Mendinaro Imcha. Clinical Director, Consultant Obstetrician and Gynaecologist, University Maternity Hospital Limerick.

Prof Shane Higgins. Master, Consultant Obstetrician and Gynaecologist, National Maternity Hospital.

Prof Mike O'Connell. Master, Consultant Obstetrician and Gynaecologist, Coombe Women and Infants University Hospital.

Dr Brian Cleary. Chief Pharmacist, Rotunda Hospital. Medications Lead, Maternal and Newborn Clinical Management System Project.

Appendix 12: Policies, Procedures, Protocols and Guidelines Checklist

The PPPG Checklists were developed to assist staff to meet standards when developing Clinical PPPGs.

Standards for developing clinical PPPG	
Stage 1 initiation	Checklist
The decision making approach relating to the type of PPPG guidance required (policy, procedure, protocol, guideline), coverage of the PPPG (national, regional, local) and applicable settings are described.	<input type="checkbox"/>
Synergies/co-operations are maximised across departments/organisations (Hospitals/ Hospital Groups/Community Healthcare Organisations (CHO)/National Ambulance Service (NAS)), to avoid duplication and to optimise value for money and use of staff time and expertise.	<input type="checkbox"/>
The scope of the PPPG is clearly described, specifying what is included and what lies outside the scope of the PPPG.	<input type="checkbox"/>
The target users and the population/patient group to whom the PPPG is meant to apply are specifically described.	<input type="checkbox"/>
The views and preferences of the target population have been sought and taken into consideration (as required).	<input type="checkbox"/>
The overall objective(s) of the PPPGs are specifically described.	<input type="checkbox"/>
The potential for improved health is described (e.g. clinical effectiveness, patient safety, quality improvement, health outcomes, quality of life, quality of care).	<input type="checkbox"/>
Stakeholder identification and involvement: The PPPG Development Group includes individuals from all relevant stakeholders, staff and professional groups.	<input type="checkbox"/>
Conflict of interest statements from all members of the PPPG Development Group are documented, with a description of mitigating actions if relevant.	<input type="checkbox"/>
The PPPG is informed by the identified needs and priorities of service users and stakeholders.	<input type="checkbox"/>
There is service user/lay representation on PPPG Development Group (as required).	<input type="checkbox"/>
Information and support is available for staff on the development of evidence-based clinical practice guidance.	<input type="checkbox"/>

Stage 2 development	Checklist
The clinical question(s) covered by the PPPG are specifically described.	<input type="checkbox"/>
Systematic methods used to search for evidence are documented (for PPPGs which are adapted/ adopted from international guidance, their methodology is appraised and documented).	<input type="checkbox"/>
Critical appraisal/analysis of evidence using validated tools is documented (the strengths, limitations and methodological quality of the body of evidence are clearly described).	<input type="checkbox"/>
The health benefits, side effects and risks have been considered and documented in formulating the PPPG.	<input type="checkbox"/>
There is an explicit link between the PPPG and the supporting evidence.	<input type="checkbox"/>
PPPG guidance/recommendations are specific and unambiguous.	<input type="checkbox"/>
The potential resource implications of developing and implementing the PPPG are identified e.g. equipment, education/training, staff time and research.	<input type="checkbox"/>
There is collaboration across all stakeholders in the planning and implementation phases to optimise patient flow and integrated care.	<input type="checkbox"/>
Budget impact is documented (resources required).	<input type="checkbox"/>
Education and training is provided for staff on the development and implementation of evidence- based clinical practice guidance (as appropriate).	<input type="checkbox"/>
Three additional standards are applicable for a small number of more complex PPPGs:	<input type="checkbox"/>
Cost effectiveness analysis is documented.	<input type="checkbox"/>
A systematic literature review has been undertaken.	<input type="checkbox"/>
Health Technology Assessment (HTA) has been undertaken.	<input type="checkbox"/>
Stage 3 governance and approval	Checklist
Formal governance arrangements for PPPGs at local, regional and national level are established and documented.	<input type="checkbox"/>
The PPPG has been reviewed by independent experts prior to publication (as required).	<input type="checkbox"/>
Copyright and permissions are sought and documented.	<input type="checkbox"/>
Stage 4 communication and dissemination	Checklist
A communication plan is developed to ensure effective communication and collaboration with all stakeholders throughout all stages.	<input type="checkbox"/>
Plan and procedure for dissemination of the PPPG is described.	<input type="checkbox"/>
The PPPG is easily accessible by all users e.g. PPPG repository.	<input type="checkbox"/>

Stage 5 implementation	Checklist
Written implementation plan is provided with timelines, identification of responsible persons/ units and integration into service planning process.	<input type="checkbox"/>
Barriers and facilitators for implementation are identified, and aligned with implementation levers.	<input type="checkbox"/>
Education and training is provided for staff on the development and implementation of evidence- based PPPG (as required).	<input type="checkbox"/>
There is collaboration across all stakeholders in the planning and implementation phases to optimise patient flow and integrated care.	<input type="checkbox"/>
Stage 6 monitoring, audit, evaluation	Checklist
Process for monitoring and continuous improvement is documented.	<input type="checkbox"/>
Audit criteria and audit process/plan are specified.	<input type="checkbox"/>
Process for evaluation of implementation and (clinical) effectiveness is specified.	<input type="checkbox"/>
Stage 7 revision/update	Checklist
Documented process for revisions/updating and review, including timeframe is provided.	<input type="checkbox"/>
Documented process for version control is provided.	<input type="checkbox"/>

To view in full refer to website: <https://www.hse.ie/eng/about/who/qid/nationalframeworkdevelopingpolicies/>



the fact that the number of variables is large, the number of observations is small, and the number of parameters to be estimated is large. The model is therefore over-parameterized, and the estimates of the parameters are likely to be biased and inefficient.

The second problem is that the model is misspecified. The model assumes that the relationship between the variables is linear, but the true relationship is likely to be non-linear. This can lead to biased estimates of the parameters and a poor fit to the data.

The third problem is that the model is over-fitted. The model is too closely tailored to the specific data set, and therefore it is likely to perform poorly on new data. This is a common problem in machine learning, and it can be avoided by using cross-validation and regularization techniques.

The fourth problem is that the model is not interpretable. The model is too complex, and it is difficult to understand the relationship between the variables and the outcome. This is a common problem in machine learning, and it can be avoided by using simpler models and interpretability techniques.

The fifth problem is that the model is not robust. The model is sensitive to small changes in the data, and it is likely to perform poorly on new data. This is a common problem in machine learning, and it can be avoided by using robust regression and regularization techniques.

The sixth problem is that the model is not generalizable. The model is only valid for the specific data set, and it is likely to perform poorly on new data. This is a common problem in machine learning, and it can be avoided by using cross-validation and regularization techniques.

The seventh problem is that the model is not stable. The model is sensitive to small changes in the data, and it is likely to perform poorly on new data. This is a common problem in machine learning, and it can be avoided by using cross-validation and regularization techniques.

The eighth problem is that the model is not accurate. The model is likely to produce biased estimates of the parameters and a poor fit to the data. This is a common problem in machine learning, and it can be avoided by using cross-validation and regularization techniques.

The ninth problem is that the model is not efficient. The model is likely to require a large amount of data to estimate the parameters accurately. This is a common problem in machine learning, and it can be avoided by using regularization techniques.

The tenth problem is that the model is not computationally intensive. The model is likely to require a large amount of computational resources to estimate the parameters accurately. This is a common problem in machine learning, and it can be avoided by using regularization techniques.

The eleventh problem is that the model is not scalable. The model is likely to require a large amount of data to estimate the parameters accurately. This is a common problem in machine learning, and it can be avoided by using regularization techniques.

The twelfth problem is that the model is not robust to outliers. The model is likely to be biased by a few extreme observations. This is a common problem in machine learning, and it can be avoided by using robust regression techniques.

The thirteenth problem is that the model is not interpretable. The model is too complex, and it is difficult to understand the relationship between the variables and the outcome. This is a common problem in machine learning, and it can be avoided by using simpler models and interpretability techniques.