



# 5th Biennial Report

2020-2021



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## Annex

Management of major obstetric hemorrhage prior to peripartum hysterectomy and outcomes across nine European countries



## 1. Introduction.

In obstetric medicine we know several diseases and complications that can result in so-called near-miss events: severe life-threatening obstetric complications necessitating urgent medical intervention in order to prevent likely death of the mother. Many of these obstetric complications cannot be anticipated by risk factors or tests. Obstetricians will be challenged by these complications at the most a few times along their clinical career, therefore individual expertise is scarce. It is challenging to investigate rare diseases and severe complications to find robust evidence on incidence, risk factors and pathophysiology as basis for evidence-based guidelines on prevention and management.

The United Kingdom was a pioneer when developing the UK Obstetric Surveillance System (UKOSS) in 2006, a nationwide survey to identify and study 'near-miss' events and rare diseases of pregnancy. Collaboration of all maternities nationwide to collect data enables identification of a relatively small number of women. This allows to conduct descriptive epidemiologic studies, case-control and parallel cohort studies (<https://www.npeu.ox.ac.uk/ukoss/completed-surveillance>). Gathering experience and knowledge on incidence, risk factors, pathophysiology and management, results in better understanding, better patient information and care by practical improvements in prevention and treatment of these uncommon conditions.

Similar surveillance systems have been set up in other countries and the International Network of Obstetric Surveillance Systems (INOSS) was constituted in July 2010. Current member countries of INOSS include Australia, Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Italy, the Netherlands, New Zealand, Norway, Portugal, Slovakia, Spain, Sweden and the United Kingdom. The mission of INOSS is to co-operate, share information and enable cross-national comparisons and analyses (<https://www.npeu.ox.ac.uk/inoss>).

The Belgian Obstetric Surveillance System was constituted in 2011 supported by the College of physicians for the Mother and Newborn, a consultative body of the Federal Public Service of Health. B.OSS started its first registrations in almost all Belgian maternity units in January 2012. Meanwhile B.OSS has proven to be successful in monitoring severe maternal morbidity. Belgian gynaecologists are willing to participate in order to receive advice based on own data, because practice in Belgium and certainly the organization of medical care differs from neighbouring countries. Whereas Peristat (<http://www.europeristat.com>) develops valid and reliable indicators that can be used for monitoring and evaluating perinatal health in the EU, the purpose of B.OSS in Belgium and of INOSS internationally is trying to analyse and explain the figures obtained. These analyses may lead to recommendations for practical improvements to better prevent and treat these diseases and complications, trying to avoid maternal near misses and maternal deaths in the future.

## 2. Objective.

The objective of B.OSS is at first, to get an accurate picture of the obstetric complications under investigation in Belgium and secondly, to improve the quality and safety of obstetric care in Belgium by practical recommendations based on the results.

The first objective is achieved through descriptive epidemiological studies on rare obstetric disorders. Based on B.OSS data we are able to define the incidence in Belgium, to identify risk-factors, to describe and evaluate management and compare with international studies and guidelines.

The secondary objective can be achieved by recommendations for prevention: primary prevention (based on risk-factors) and secondary prevention (based on management and substandard care) formulated in national guidelines.

Aim is a high-quality performance of the Belgian Obstetric Surveillance System (B.OSS) to be a respectable partner of INOSS, capable to co-operate and compare with other international obstetric surveillance systems.

## 3. Organisation and methods.

### Institute

B.OSS was launched as an initiative of the College of Physicians for the Mother and Newborn in 2011. The College operated as the steering committee and B.OSS was endorsed by the two professional associations for gynaecologists, VVOG and CRGOLFB, and by the perinatal registries, SPE and CEpiP.

At start, daily reporting and data collection tasks were carried out by two cooperating teams: in Flanders coordinated by a research team from the Ghent University Hospital, and in Brussels/Wallonia coordinated by the CEpiP research team.

In 2017, a formal scientific board was constituted with representatives of SPE, CEpiP, the Belgian Health Care Knowledge Centre (KCE), the Scientific Institute of Public Health (Sciensano), the College of Mother and Newborn, and since 2021 the VVOG and CRGOLFB. From January 2020 onward the B.OSS project is supported financially by the Federal Public Service of Health in a pilot project. Mrs Karolien Benoit was introduced as B.OSS officer, through a B4- contract via the Ghent University Hospital. Karolien takes up most of the daily reporting and data collection tasks, in close cooperation with CEpiP and SPE. For daily follow-up of the B.OSS studies, B.OSS also trust on medical students and registrars in Obstetrics and Gynaecology at the different Belgian Universities, who perform this scientific work as part of their (Advanced Master) Master thesis.

## Ethics approval

The B.OSS methodology was approved by the Medical Ethics Committee of Ghent University Hospital (EC UZG 2012/734; B670201215359) and by the Medical Ethics Committee of the Erasme University Hospital, Brussels (EC ULB 2012/111; B406201213660) at the beginning in 2012. The Medical Ethics Committee of the Ghent University Hospital became central Ethics Committee in 2015 (EC UZG 2015/1470; B670201526875) and Ethics Committees of the participating maternities were informed and included in this multicentre study following approval.

Initially, the women eligible for inclusion were informed by their gynaecologists and offered an information letter enabling them to opt-out. Since the General Data Protection Regulation (GDPR) introduced in May 2018, women are obliged to sign an informed consent. Informed consents are guarded in the proper hospitals by the local B.OSS investigator, so that cases remain anonymous for the B.OSS research team.

Every newly set up B.OSS study needs EC approval from the central EC. Once approved, the central EC will inform the EC of all participating maternity units that are officially included in the multicentre study.

## Methods

B.OSS has adopted the methodology for case reporting of severe obstetric morbidity, developed by the UKOSS. Briefly, an appointed contact person (a gynaecologist, senior-midwife or administrative support) in each participating maternity unit is invited by monthly mailing to report a selected number of rare obstetric complications that may have occurred in the preceding month. In the event a case was reported in reply, the contact person is asked to complete an extensive data collection form. In case of incomplete reporting, the appointed contact person is encouraged repeatedly by email and phone to provide missing data.

Initially, data on reported cases were obtained through the use of a standardized form, filled out electronically or on hard copy according to preference of the local responsible. Web-based data-collection was gradually introduced following the launch of the B.OSS website in August 2013, facilitating monthly reporting and completion of data collection forms online. In 2020 the website has been renewed ([www.b-oss.be](http://www.b-oss.be)). Monthly emails are generated automatically calling to report for the previous month with reminders for missing reporting forms and incomplete data collection forms. Restricted access to the website is provided to the appointed B.OSS-contact person, who has access to the reporting forms and data collection forms of his/her maternity unit. Data protection is secured by the use of hash codes, replacing person-identifiable information such as the woman's name, date of birth or hospital number.

Person-identifiable information is eliminated from data-analysis. Confidentiality is guaranteed for mother, provider and hospital during data processing, data analysis and disclosure of results.

## Registered variables.

Data collection forms question maternal characteristics, medical history and obstetrical history, details on the index pregnancy, circumstances of the event, the management and the outcome for mother and the foetus or new born.

## 4. Participation.

### Number of participating maternities

At the beginning in 2012, 97.3 % (110/113) of the Belgian maternities formally agreed to participate in B.OSS: 2 centres have refused explicitly and 1 centre never replied.

The number of Belgian maternities dropped from 113 to 107 in 2018, to 105 in April 2020 and to 101 in 2022, as a result of merging and closure of centres. Currently, all maternities are willing to participate in B.OSS.

Demands of Ethical Committees are only getting stricter. Therefore increased efforts were done by Karolien Benoit, to renew Ethical Committee approvals according to the current requirements. Ethical Committee approval for the B.OSS study is now confirmed for 96 maternities of the 101 units.

Further, in response to stricter GDPR requirements and the increase in Internet security threats, we modified the access to the 'reporting' part of the website <https://forms.b-oss.be/> with increased security measures. Currently, 91 of 101 maternity units have access to the reporting website based on authorized hospital IP-addresses.

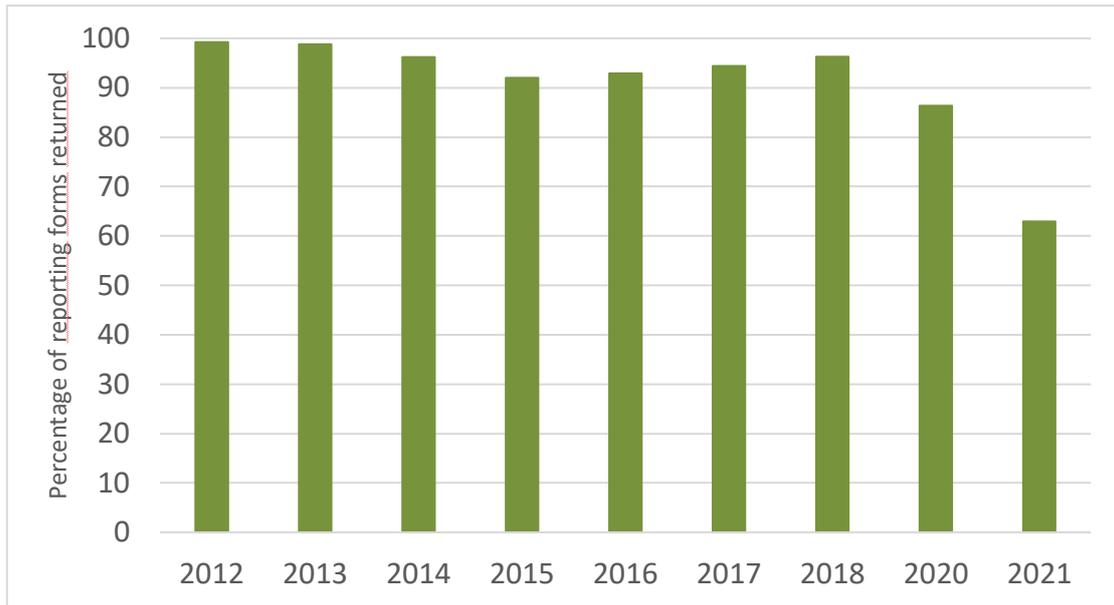
### The overall case reporting response rate

82% of the monthly reporting forms that were sent between January 2020 and December 2021, have been completed and returned. Reporting forms asked about cases of intermediate or severe intrahepatic cholestasis of pregnancy, COVID-19, surgical complications of bariatric surgery and maternal death.

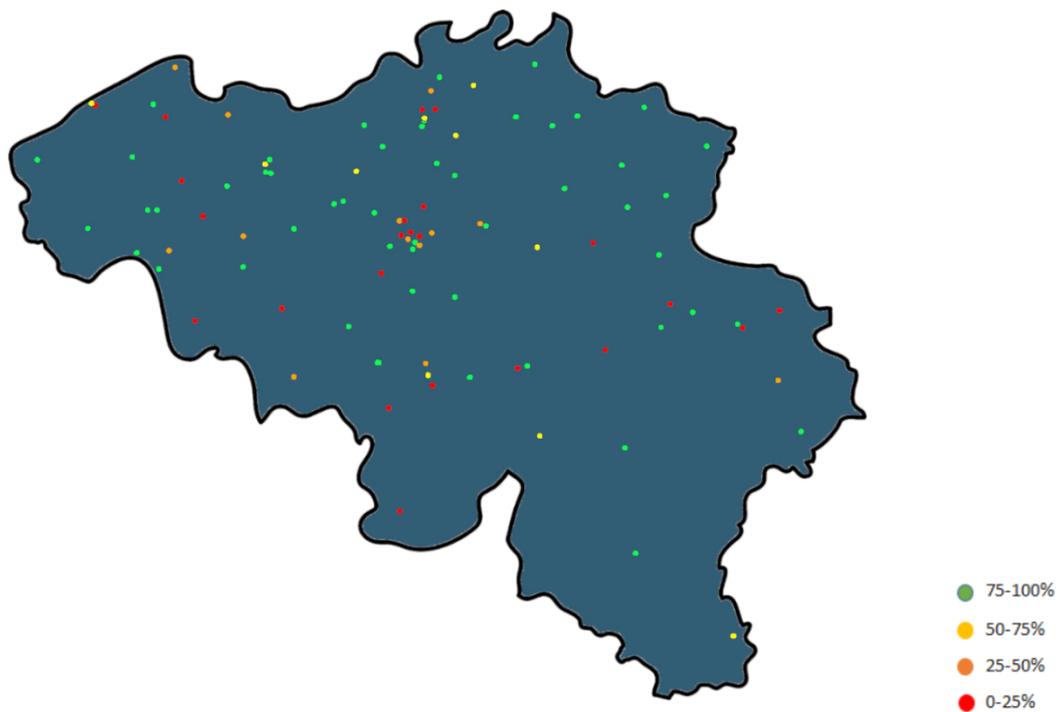
We can say that these two years were rather particular due to the COVID-19 pandemic, which may have influenced the response rate in two directions.

Firstly, there was an increase in participation and response because there was interest and a need to know more about COVID-19 and pregnancy. An important motivation to participate in the COVID-19 registration by B.OSS.

On the other hand, there was more clinical, logistic and administrative work due to the COVID-19 pandemic and pregnant women presenting with symptomatic COVID-19 or being COVID positive when giving birth. Making our busy clinicians even less able to make time to report and complete questionnaires.



**Figure 1: Monthly response rate in % of all Belgian maternity units since start of B.OSS**



**Figure 2: Monthly response rate per maternity unit since start of B.OSS**

## 5. B.OSS studies.

### 5.1. Studies completed in 2020-2021.

#### 5.1.1. COVID-19.

##### Definition

Any pregnant woman or postpartum up till 42 days after the end of pregnancy with diagnosis of COVID-19 infection, admitted to hospital.

##### Surveillance period

March 2020 – March 2021

##### Results

*Dr Anneke Vercoutere processed and analysed the data of the registration, as part of her PhD project at the Université Libre de Bruxelles (ULB). We present the first general results of this study below.*

Shortly after the COVID-19 pandemic started in Belgium in March 2020, the B.OSS system launched the registration of COVID-19 infection in pregnant women.

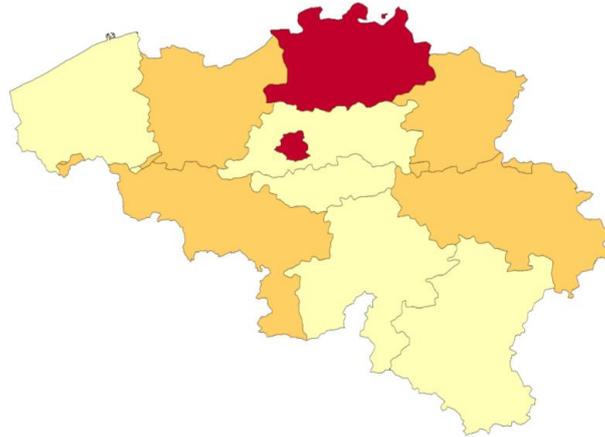
All 102 maternity units in Belgium were contacted on a monthly basis, asking to report their cases of pregnant women with COVID-19 in the previous month. 80% of these maternity units reported on a regular basis.

To interpret these results, it is important to bear in mind two important things:

- None of these women was vaccinated. The study occurred before start of the vaccination campaign.
- This cohort cannot demonstrate the impact of the alpha, delta or omicron variant. It is known from international studies, that alpha and delta may have had a more serious impact on the mother, the pregnancy outcome and the neonate.

Every pregnant woman admitted in hospital – regardless of the reason why she was admitted – who tested positive for COVID-19 was eligible to be included in this database.

We could withhold 983 women in this registry when strictly applying the inclusion criteria. A majority of these women were reported in the province of Antwerp and Brussels Capital region.



**Figure 3: map of Belgium showing the number of reported women with COVID-19 per region. Red > 150 women. Orange 80-150 women. Yellow < 80 women.**

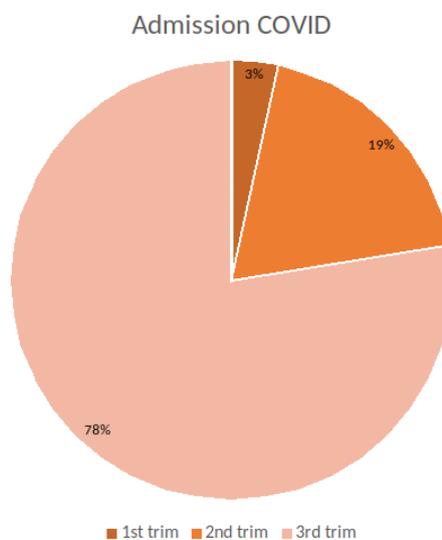
75,5% of the women were admitted because they were about to give birth, and they tested positive because of symptoms or because of routine screening at admission. Screening policy differed in between hospitals and changed throughout the one year registration period.

9,2% of the women were admitted because of a severe COVID-19 infection.

In this cohort of pregnant women with COVID-19, even more obvious in the women with severe infection, we notified a tendency of a more advanced maternal age (>35year) when compared to the overall pregnant population in Belgium. The same tendency was seen for overweight and obesitas: women in the cohort were more likely to be overweight / obese compared to the overall pregnant population.

If symptomatic, most pregnant women presented with cough and fever.

The majority of patients with severe COVID-19 infection were in their 3rd trimester of pregnancy (see figure 4). The duration of stay in hospital varied between one and maximum 77 days.



**Figure 4: Pregnant women with COVID-19 infection, admitted because of more severe infection, presented per trimester of pregnancy at the moment of admission.**

The mode of delivery in these women with COVID-19 did not differ greatly compared to the general pregnant population. The number of caesarean sections (21%) was not increased, when compared to the number of CS in a non-COVID-19 period. In the group of severe COVID-19 infection the CS rate was slightly increased (24,4%)

We do see an increase in pregnant women in whom labour was induced, in the total cohort and in the more severe covid-19 group. There may be a slight increase in preterm birth (<37 weeks) in the total cohort and in the severe covid-19 group, however, this should be interpreted with caution as other confounding factors may have played a role in this result.

2,5% of the total cohort of women was admitted to an Intensive Care Unit. This was about 20% of the women with severe COVID-19 infection. The mean duration of stay at the ICU was 4 – 10 days, with maximum 59 days.

No pregnant woman with COVID-119 died during this first year of COVID-19. The BAMB system (*Belgian Analysis system for Maternal Mortality*) was launched from January 2021, so was not active yet during the first 10 months of this COVID-19 registration period.

We decided to finalise the registration period after 12 months of registration. Mainly due to the extra workload that this registration brings for clinicians, that are already over-burdened due to the extra clinical and organisational work that COVID-19 entailed.

Based on the registration of the surrounding countries within INOSS we noticed that the new COVID variants (alpha, delta) had more impact on the course of pregnancy, compared to the first wave captured in our registration.

### **5.1.2. CONSIGN study**

The study was initiated by Prof Kitty Bloemenkamp, UMC Utrecht, The Netherlands, and supported by the International Network of Obstetric Survey Systems (INOSS). Participating countries were Italy, the Netherlands, United Kingdom, Denmark, Finland, Iceland, Norway, Sweden and Belgium. Funding was received from the EMA (European Medicines Agency).

#### **Definition**

Pregnant women admitted to hospital with a positive SARS-CoV-2 PCR test  $\leq 7$  days prior to or during admission, up to 2 days after birth.

#### **Surveillance period**

March 2020 – March 2021

#### **Preliminary results of the first wave (Feb 25, 2020 to Aug 31, 2020)**

The rate of hospitalization due to COVID-19 ranged from 0.4 to 1.8 per 1000 maternities across countries. Of the women admitted due to COVID-19, 79 (9%) [8% - 17% across countries] were admitted to intensive care, 42 ((10%) [5% - 13% across countries] needed mechanical

ventilation, 18% [3% - 20% across countries] gave birth preterm and 45% [24% - 49% across countries] had a caesarean section. Overall use of medicines was low and varied across countries. Among 877 births of women admitted due to COVID-19, 5 stillbirths (0.6%) [0% - 0.9% across countries] and 159 (18%) [14% - 27% across countries] neonatal ward admissions were reported.

Conclusions: There is a large variation in hospitalization, medication use, obstetric management and maternal and neonatal outcomes among pregnant women with COVID-19 across European countries. Only a few pregnant women received medical treatment.

## 5.2. Studies in progress since 2020.

### 5.2.1. Intrahepatic cholestasis of pregnancy (ICP).

#### Definition

Every pregnant woman identified as having intermediate (bile acids 40-99micmol/L) or severe (bile acids  $\geq$  100micmol/L) Intrahepatic Cholestasis of Pregnancy,

Defined as:

- Pruritus without rash associated with elevated serum bile acid levels  $\geq$  40 micmol/L
- At any stage of the pregnancy,
- Not explained by other pathologies,
- Disappearing after the delivery.

Exclusion criteria:

- Serum bile acid levels less than 40 micmol/L
- Other hepatic/infectious/dermatologic/pregnancy disease, which could explain the symptoms

#### Surveillance period

January 2020 – December 2023

#### Interim results (January 2020 – June 2022)

*Dr Audrey Francinetti from the Antwerp University Hospital performed an interim analysis as part of her master thesis to successfully complete her Advanced Master of Specialist Medicine in Obstetrics and Gynaecology.*

*You can read a brief summary below, the full text is added in the annex.*

*Based on this interim results the questionnaire, which is very extensive and a burden to complete, has been reduced by removing a number of items and by a stronger motivation to upload the lab-results instead of inserting the numbers.*

From January 2020 until June 2022, 171 cases of intrahepatic cholestasis of pregnancy (ICP) were reported. **66 cases** of the 171 cases reported at that time, were included for this interim analysis.

From the 66 cases, 14 (21.2%) pregnancies were also complicated by gestational diabetes, 3 (4.5%) with pre-eclampsia and one (1.5%) with pregnancy induced hypertension.

During pregnancy most patients suffered from pruritus (59/66 – 89.4%). The median gestational age when reporting pruritus was 33 (min 24 – max 38) weeks of pregnancy. Three (4.5%) patients suffered of vomitus, 4 (6.1%) reported abdominal pain, 5 (7.6%) had insomnia and 1 (1.5%) patient had steatorrhea. No one reported jaundice or hypoglycaemia. The diagnosis of ICP was made at a mean gestational age of 33.6 (SD 3.1) weeks of pregnancy. 37 patients (57.1%) had severe ICP.

Further investigation with abdominal ultrasound was performed in 25 (37.9%) cases. The results were all normal except for some nonspecific gallbladder sludge in 3 (12%) cases. There were no other imaging investigation performed nor any liver biopsy.

Treatment with UDCA was started in 54 (81.8%) cases with a mean dose of 15.4 mg/kg (SD 5.4) or a median dose of 1000mg (750-1250mg). Other treatments such as Vitamin K was started in 3 (4.5%) cases and anti-histaminic in 13 (19.7%) cases. The treatment did improve the symptoms in most (37 (68.5%)) cases.

Once the diagnosis of cholestasis was made, the pregnancy was carefully monitored. Fetal ultrasound was performed more than once a week in 13 (19.7%) cases, every week in 32 (48.5%) cases, every 2 weeks in 15 (22.7%) cases and less than every 2 weeks in 6 (9.1%) cases. Cardiotocography (CTG) was performed more than daily in 16 (24.2%) cases, daily in 4 cases (6.1%), more than weekly in 26 (39.4%) cases, weekly in 14 (21.2%) cases, less than once a week in 4 cases (6.1%) and only one (1.5%) patient there was no CTG performed. 21 (31.8%) patients were admitted to the hospital for fetal monitoring because of ICP, 13 (61.9%) of these patients had severe ICP.

The median gestational age at the end of the pregnancy was 37.4 (min 30 – max 40) weeks of pregnancy. Thirty (45.5%) patients delivered preterm (gestational age < 37 weeks). The planned mode of delivery was a vaginal delivery in 49 (74.2%) cases. Of the planned vaginal deliveries only 8 (16.3%) were not induced, 40 (81.6%) patients were induced because of ICP and 1 (2.0%) patient was induced because of simultaneous pre-eclampsia. Nineteen (47.5%) patients who were induced had intermediate ICP and 21 (52.5%) patients had severe ICP. Of the planned vaginal deliveries 9 (18.4%) ended in a secondary caesarean section and 4 (8.2%) in an instrumental vaginal delivery. The planned mode of delivery was a primary caesarean section in 17 (25.8%) cases, it is unclear in which extend ICP was responsible for this decision making. Meconium stained amniotic fluid, placenta or membranes was reported in 9 (13.6%) cases.

A major postpartum maternal morbidity occurred in 7 (10.6%) cases. Four (6.1%) patients developed a postpartum haemorrhage, 2 (28.6%) developed a severe pre-eclampsia

postpartum and 1 (14.3%) patient was admitted to the intensive care unit. There was no maternal death reported.

There was no case of stillbirth. Of the 74 neonates (8 twin pregnancies and 58 singleton pregnancies) 33 (44.6%) was admitted to a neonatal unit. The main reason was prematurity, this was the case in 28 neonates (84.8%).

### **5.2.2. Surgical complications of bariatric surgery in pregnancy.**

#### **Definition**

Every pregnant woman known with bariatric surgery prior to conception presenting with a surgical complication (Internal herniation, Intussusception, Volvulus, Gastric ulcer, Staple line stricture(s), Erosion of the gastric band, Migration of the gastric band).

#### **Surveillance period**

January 2021 – December 2022

#### **Interim results**

Until June 2022 32 cases are reported. Three cases are excluded (no surgical complication), 17 complete questionnaires were retrieved and 12 questionnaires are still incomplete. Most cases were recruited from the provinces Limburg, East- and West-Flanders. Only two cases were reported by hospitals of Brussels and Wallonia.

The majority of these cases are internal herniations (n=16), there is one stricture of an anastomosis, 2 bowel obstructions and 1 abscess due to a gastric perforation. Information about the complication is still missing for the other 9 cases.

Since a surgical complication in an early pregnancy may not always be reported to the gynaecologists, it may be of great help to inform the abdominal surgeons in your centre about the study. We provided a text (available in [Dutch](#) and [French](#) on the website) that can be used to send to your colleagues.

### **5.3. Future studies.**

#### **Re-exploration after Caesarean Section**

##### **Background**

Caesarean section (CS) is one of the most common procedures carried out in obstetrics. Although the safety of CS is increasing, complications such as bleeding, wound infection and visceral injury occur. At times these complications might warrant a return to theatre for

wound re-exploration or laparotomy. Re-exploration after CS can increase risk of infection, risk of blood transfusion, intensive care admission and increased length of hospital stay for women, as well as a repeat anaesthetic risk, which can affect the physical, emotional and mental wellbeing of the mother. It can also have a negative impact on the woman's ability to bond with or breastfeed her baby. The incidence of re-exploration after CS has been estimated to be around 0.12 - 0.13% with very wide estimates of associated maternal mortality.

The study is part of an INOSS study and was initiated by UKOSS (<https://www.npeu.ox.ac.uk/ukoss/completed-surveillance/re-exploration-after-caesarean-section>).

With this study we want to describe the incidence, the main risk factors, the management and the outcome associated with re-exploration after CS for women in Belgium.

The results will give important information for clinicians to help them counselling pregnant women.

### **Surveillance period**

January 2023 – December 2024

## **6. Belgian Analysis system for Maternal Mortality.**

The Belgian Analysis system for Maternal Mortality (BAMM) was successfully launched in January 2021.

Medical directors, quality coordinators, heads of departments of obstetrics/gynaecology, and senior midwives were informed of the launch of BAMM.

Since the launch of BAMM, we obtained Ethics Committee approval from 73 of 101 maternity units. We are awaiting approval from 13 maternity units who submitted the project to their EC, and 15 still need to submit to their EC.

### **Aim**

The aim of the BAMM system is to improve the accurateness of the Maternal Mortality Ratio in Belgium, which is now based on the work of STATBEL based on the information of the death certificates.

More importantly, the aim of BAMM is to take lessons of the rare cases of maternal death in Belgium. The identification of contributing factors through in-depth analysis, can lead to recommendations for the hospital itself, and by extension to the organisation of (obstetric) care in Belgium.

### **Definition**

All women in Belgium who died during pregnancy or within 1 year after the end of the pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related

to or aggravated by the pregnancy or its management, but not from accidental or incidental causes. [https://apps.who.int/iris/bitstream/handle/10665/70929/9789241548458\\_eng.pdf](https://apps.who.int/iris/bitstream/handle/10665/70929/9789241548458_eng.pdf)

## Methodology

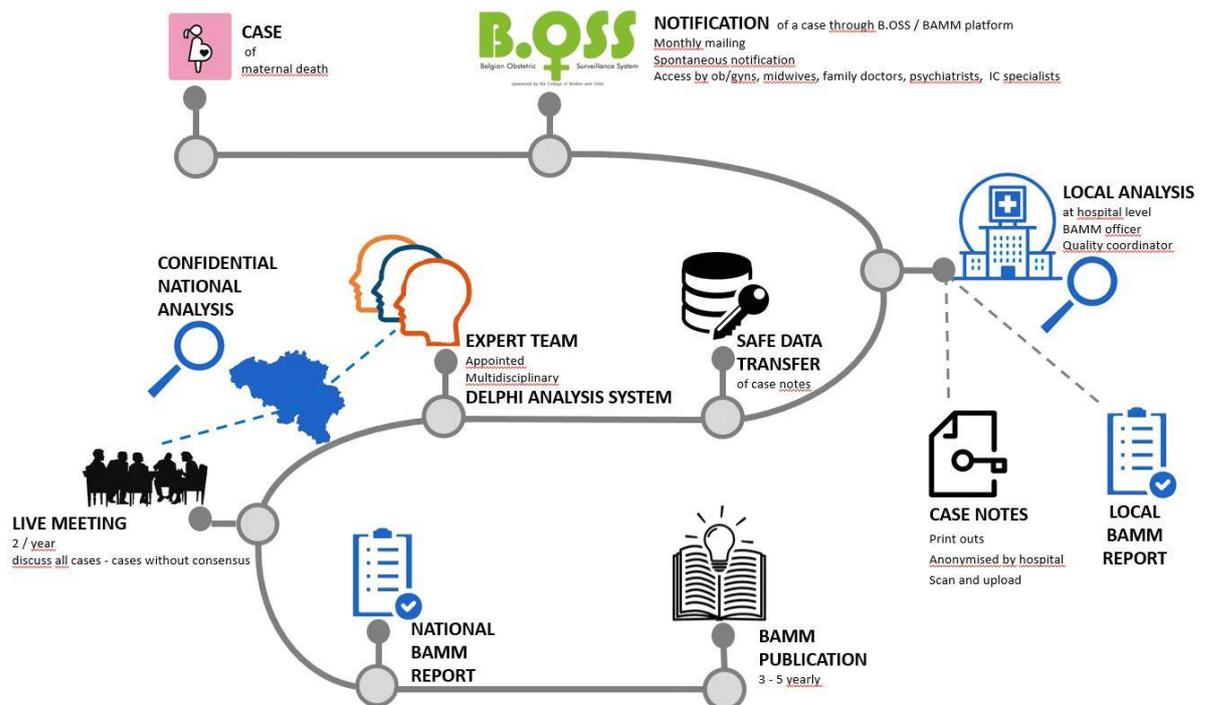
The timeline in Figure 5 demonstrates the 'flow' of the BAMB system in case of a maternal death.

The methodology of BAMB can be summarised in 5 core-ideas.

- 1) cases will be reported using the existing **platform of B.OSS**,
- 2) cases will be analysed **in 2 levels**:  
**locally** in the hospital by the care givers involved supported by the quality coordinator and BAMB officer,  
secondly **on a national level** by a multidisciplinary team of experts,
- 3) during the national analysis an unbiased opinion of the individual experts will be obtained. Experts can review the case and respond, unrestricted by time and by location. Consensus will be sought in the answers of the experts by using **the Delphi methodology**.
- 4) a **sensitisation campaign** is needed at the start to inform family doctors, psychiatrists, intensive care specialists, and other specialists, besides gynaecologists and midwives. This campaign should be repeated on a regular basis, at least yearly.
- 5) a **system of triangulation** (linkage) of 3 existing federal databases must be developed parallel to the BAMB system, to capture all late and less-evident maternal deaths and to control for missing cases.

**Confidentiality and a NO-BLAME approach are of major importance for the BAMB system to succeed.**

A more detailed description of the methodology can be found on the website (<https://www.b-oss.be/bamm/protocol>).



**Figure 5 – Timeline of the Belgian Analysis system for Maternal Mortality**

### Interim results

In 2021, the first year of BAMB, 18 maternal deaths were reported through the system. Twelve of these women died in the peripartum period (around delivery up to 6 weeks postpartum), while three deaths occurred in the 1st trimester, two were late deaths (6 weeks to 1 year postpartum).

Based on the available information, two can be regarded as direct maternal deaths (due to an obstetrical cause) and 11 as indirect deaths (due to an underlying condition that deteriorated in pregnancy). In at least 5 cases, the mother was COVID-19 positive at the time of death.

The process of collecting data, followed by a local and national analysis, is intensive and time-consuming. The first cases took 6-8 weeks per case to complete the analysis.

This thorough analysis is necessary to bring to light the small ‘gaps’ in the healthcare chain that finally resulted in the maternal death. These gaps are contributing factors from different categories (see Table 1).

	Code	Category	Definition		
<b>Technical</b>	T-EX	External	Technical failures beyond the control and responsibility of the investigating organisation.		
	TD	Design	Failures due to poor design of equipment, software, labels or forms.		
	TC	Construction	Correct design, which was not constructed properly or was set up in inaccessible areas.		
	TM	Materials	Material defects not classified under TD or TC.		
<b>Organisational</b>	O-EX	External	Failures at an organisational level beyond the control and responsibility of the investigating organisation, such as in another department or area (address by collaborative systems).		
	OK	Transfer of knowledge	Failures resulting from inadequate measures taken to ensure that situational or domain-specific knowledge or information is transferred to all new or inexperienced staff.		
	OP	Protocols	Failures relating to the quality and availability of the protocols within the department (too complicated, inaccurate, unrealistic, absent, or poorly presented).		
	OM	Management priorities	Internal management decisions in which safety is relegated to an inferior position when faced with conflicting demands or objectives. This is a conflict between production needs and safety. An example of this category is decisions that are made about staffing levels.		
	OC	Culture	Failures resulting from collective approach and its attendant modes of behaviour to risks in the investigating organisation.		
<b>Human</b>	<b>Rule-based behaviour</b>	H-EX	External	Human failures originating beyond the control and responsibility of the investigating organisation. This could apply to individuals in another department.	
		HKK	Knowledge-based behaviour	The inability of an individual to apply their existing knowledge to a novel situation. Example: a trained blood bank technologist who is unable to solve a complex antibody identification problem.	
		HRQ	Qualifications	The incorrect fit between an individual's training or education and a particular task. Example: expecting a technician to solve the same type of difficult problems as a technologist.	
		HRC	Coordination	A lack of task coordination within a health care team in an organisation. Example: an essential task not being performed because everyone thought that someone else had completed the task.	
		HRV	Verification	The correct and complete assessment of a situation including related conditions of the patient and materials to be used before starting the intervention. Example: failure to correctly identify a patient by checking the wristband.	
		HRI	Intervention	Failures that result from faulty task planning and execution. Example: washing red cells by the same protocol as platelets.	
		HRM	Monitoring	Monitoring a process or patient status. Example: a trained technologist operating an automated instrument and not realizing that a pipette that dispenses reagents is clogged.	
		<b>Skill-based behaviour</b>	HSS	Slips	Failures in performance of highly developed skills. Example: a technologist adding drops of reagents to a row of test tubes and then missing the tube or a computer entry error.
			HST	Tripping	Failures in whole body movements. These errors are often referred to as "slipping, tripping, or falling". Examples: a blood bag slipping out of one's hands and breaking or tripping over a loose tile on the floor.
		<b>Other factors</b>	PRF	Patient related factor	Failures related to patient characteristics or conditions, which are beyond the control of staff and influence treatment.
X	Unclassifiable		Failures that cannot be classified in any other category.		

**Table 1 – Categories of the Eindhoven Classification Model: medical version (MERS TM, 2001; Van Vuuren et al., 1997)**

The causes of the maternal death as a chain of event with the identified root causes or contributing factors is then represented in a causal tree. A fictitious example of a causal tree is shown in Figure 6.

Figure 7 is pie chart demonstrating for what percentage the different categories of contributing factors (technical, organisational, patient-related, human) contributed in the event.



Both figures demonstrate that the adverse outcome is caused by a combination of different contributing factors.

Following identification of these contributing factors or root causes, the multidisciplinary team will formulate (for every contributing factor) a recommendation for actions that may improve the quality of care for similar cases in the future. These recommendations will be primarily applicable for the hospital itself, but often these recommendations can be extrapolated to other maternity units and to the organisation of obstetric care in general.

When the years pass, and BAMM continues its thorough work in the same matter, we will be able to detect trends and recurring factors in similar cases. The aim is to bring out the 'lessons learned from BAMM' after a number of years: the recommendations of the experts based on recurring causal factors. The next step is then turning the recommendations into actions.

## **Evaluation of BAMM**

### **The difficulties that BAMM encounters are**

- The time-consuming process of the analysis. However, we believe that this is the only way to come to valuable results.
- The delay in reporting cases: we trust that this will improve with increasing recognition of the BAMM system
- Legal prosecution that causes prohibition to further participate in the BAMM analysis – a missed opportunity
- The availability of qualified local quality coordinators.

### **BAMM has many positive elements:**

- BAMM is successfully launched. Maternity units are willing to cooperate and care-givers find their way to report a case.
- The number of maternal deaths reported in this first year already exceeded the expected number of deaths based on the vital statistics. We trust that most cases in a hospital environment are reported. However, underreporting of early and late cases of maternal mortality is very likely.
- The feedback from care-givers is positive. Most care-givers are grateful that they can trust on the system for a structured detailed analysis of a dramatic case, that they can inform the family that a thorough analysis is taking place, that the decease of the patient can be used to take lessons from, and that they can receive feedback from the system following the national analysis.
- BAMM is a pioneering project that contributes to a changing culture of open disclosure and no-blame in Belgium.

## 7. B.OSS within INOSS.

The International Network of Obstetric Survey Systems (INOSS) is a multi-country collaboration which was formed to promote and facilitate studies of uncommon and severe complications in pregnancy and childbirth.

More information on INOSS, aims and members can be found on <https://www.npeu.ox.ac.uk/inoss>.

Since its start in 2012, B.OSS was represented at the annual INOSS meetings: in France (Paris) in 2012, in Germany (Munich) in 2013, in Sweden (Finnhamn) in 2014, in Canada (Vancouver) in 2015, in Italy (Rome) in 2016, in Copenhagen (Denmark) in 2017, in Belgium in 2018, in Bratislava in 2019.

For obvious reasons, the annual INOSS meetings in 2020, 2021, 2022 were organised online and the subject of the meetings was mainly about COVID-19 and side-effects.

We are looking forward to a live INOSS meeting in Oxford in 2023.

B.OSS participated prospectively in a number of INOSS studies:

Spontaneous Hemoperitoneum of Pregnancy (SHiP), Anaphylaxis in Pregnancy, the Global Maternal Sepsis Study and the CONSIGN study.

And B.OSS provided data to a number of retrospective multi-country studies: the international studies of uterine rupture, of peripartum hysterectomy and upcoming the international study of eclampsia.

## 8. Publications.

### List of authors

For future publications based on B.OSS data, one B.OSS contact person per hospital will be mentioned as a co-author of the 'B.OSS research group'.

Please contact us if you have questions about this list, if you did not have the chance to check or change your name.

### Previous publications

A list of publications until 2019 is provided on the website.

### Publications in 2020-2021

Frequency and management of maternal infection in health facilities in 52 countries (GLOSS): a 1-week inception cohort study.

*The Lancet Global Health* 2020 May, [https://doi.org/10.1016/s2214-109X\(20\)30109-1](https://doi.org/10.1016/s2214-109X(20)30109-1)

Anaphylaxis in pregnancy: a population-based multinational European study.  
S. J. McCall et al, on behalf of the INOSS collaboration.  
*Anaesthesia* 2020 May; 75; 1469-1475.

Epidemiological analysis of peripartum hysterectomy across nine European countries.  
Athanasios F. Kallianidis et al, on behalf of INOSS (the International Network of Obstetric Survey Systems)  
*Acta Obstetrica et Gynecologica Scandinavica* 2020 May; 99; 1364-1373.

Management of major obstetric hemorrhage prior to peripartum hysterectomy and outcomes across nine European countries.  
Kallianidis AF et al , on behalf of INOSS (the International Network of Obstetric Survey Systems)  
*Acta Obstetrica et Gynecologica Scandinavica* 2021 Jul; 100; 1345-1354.

Availability of facility resources and services and infection-related maternal outcomes in the WHO Global Maternal Sepsis Study: a cross-sectional study.  
Brizuela V et al, on behalf of the WHO GLOSS Research Group.  
*Lancet Glob Health*. 2021 Sep, [https://doi.org/10.1016/S2214-109X\(21\)00248-5](https://doi.org/10.1016/S2214-109X(21)00248-5)

Perinatal outcomes among births to women with infection during pregnancy.  
Baguiya A et al, on behalf of the WHO Global Maternal Sepsis Study (GLOSS) Research Group; GLOSS research group.  
*Arch Dis Child*. 2021 Oct;106(10):946-953. Epub 2021 Sep 2. PMID: 34475107  
<https://doi.org/10.1136/archdischild-2021-321865>

### **Upcoming publications in 2022**

Rare cases of uterine rupture: a descriptive INOSS population-based study.  
On behalf of INOSS (the International Network of Obstetrics Survey Systems)  
*Will be submitted to BJOG September 2022*

Nationwide population-based cohort study of eclampsia in Belgium: results from the Belgian Obstetric Surveillance System  
On behalf of the B.OSS research group  
*Will be submitted to BMJ Open October-December 2022*

Antenatal pulmonary embolism in Belgium: results from the Belgian Obstetric Surveillance System  
On behalf of the B.OSS research group  
*Will be submitted to BMJ Open October-December 2022*

Late miscarriage and stillbirth cases in asymptomatic and symptomatic hospitalized pregnant women in Belgium during the first and second waves of COVID-19. A prospective nationwide population-based cohort study.

*Will be submitted October-December 2022*

Obstetrical habits & COVID during pregnancy.

*Will be submitted December 2022*

Lessons learned taking charge of patients with COVID infection during pregnancy. Quality of care.

*Will be submitted December 2022*

## 9. Results turned into actions.



**Figure 8 – Circle diagram representing the objectives of B.OSS  
Inspired by the circle diagram of the ITOSS**

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0250373>

Ten years of B.OSS resulted into a number of reports, master theses, national and international publications. This written output is easily accessible for care-givers (gynaecologists and midwives, family doctors and other specialists) and for patients and their family. In this way B.OSS fulfilled its primary objective (to get an accurate picture of the obstetric complications under investigation in Belgium; see 2. Objective)

The second objective of B.OSS (to improve the quality and safety of obstetric care in Belgium by practical recommendations based on the results) is a greater challenge to achieve.

Recommendations need to be turned into actions. These actions can be national guidelines, organising trainings for care-givers, further research...

B.OSS is building up connections with strong Belgian organisations and associations to be able to address this demand together: KCE, Sciensano, VVOG, CRGOLFB and others.

## 10. SYMPOSIUM 10 YEARS B.OSS.

On the 5<sup>th</sup> of May 2022 B.OSS celebrated its 10<sup>th</sup> birthday with an evening symposium.

### **Program:**

BAMM is launched: the methodology and first findings

Karolien Benoit, B.OSS-BAMM-officer

Le prestataire de soins, deuxième victime de la mortalité maternelle

Dr Lamyae Benzakour, psychiatrist at the Geneva University Hospitals

COVID pandemic; the advantage of international obstetric surveillance systems

Prof dr. Kitty Bloemenkamp, Maternal Fetal Medicine Specialist at UMC Utrecht & chairman of INOSS

B.OSS: what can we learn from the completed studies

Dr Griet Vandenberghe, B.OSS & BAMM, gynaecologist at UZ Gent

We thank all live and online attendees for their participation.

We thank the speakers for their time and effort to turn the symposium into a fruitful interesting evening.

For those who missed it, for this interested: the presentations can be consulted on the website (<https://www.b-oss.be/evening-symposium-boss>).

## 11. Acknowledgements.

Ten years since its start in 2012, B.OSS evolved to the current firm and performant system of today.

B.OSS can continue providing information on rare and severe conditions of pregnancy, thanks to the contribution of busy clinicians:

- the B.OSS contact persons,
- the gynaecologists/obstetricians
- the registrars
- the midwives

who help reminding to report to B.OSS, who notify cases and complete the extensive data collection forms. Who persevere even when COVID-19 is overwhelming our clinical work.

We would like to thank all these important persons throughout Belgium who have contributed in one or another way to B.OSS, without whom this work would not have been possible.

We wish to thank our funders (see below) sincerely for their believe in the B.OSS and BAMM projects.

## 12. Funding.

B.OSS received its first funding from the College of Physicians for the Mother and the Newborn, section Mother, who continued until 2020.

Thanks to the efforts and support of Mieke Walraevens, Margareta Haelterman and currently Isabelle Van Der Brempt and Annemie Vlayen, further financing was provided directly through the Federal Public Service. We started with a pilot-project from January 2021 for 18 months, which was extended until December 2022.

This funding enabled the recruitment of Mrs. Karolien Benoit, who was crucial for the launch of BAMM and the daily B.OSS and BAMM activities.

In May 2022, we had a meeting with Mrs. Evelyne Hens, a representative of the Cabinet of the Minister of Public Health. We presented the current achievements, the usefulness and necessity of B.OSS and BAMM, our future plans and the financial and other needs to achieve our goals.

Installing a long-term continuation of B.OSS and BAMM has proven to be a lengthy process.

Currently we are in contact with relevant associations and organisations in Belgium, investigating our mutual interest, aiming to empower the structure of B.OSS within a larger and steady entity.

### **13. Future.**

B.OSS continues in 2022 with ongoing studies (intrahepatic cholestasis of pregnancy, surgical complications of bariatric surgery in pregnancy) and new studies (re-exploration after C-section).

B.OSS will try to re-recruit the few maternities that are not reporting currently.

B.OSS will increase its (scientific) output by a greater focus on bringing out results, hopefully by increasing the funding > the helping hands > the time.

B.OSS will build up connections with other parties that can turn recommendations into actions.

BAMM continues in 2022 with the analysis of maternal deaths, increasing experience and improving the in-depth methodology. A second live meeting with the team of experts will be planned in the autumn.

BAMM will repeat the sensibilisation campaign, increasing the awareness of care-givers for the project.

Therefore we will rely on your further enthusiasm and participation.

## 14. Tribute to Prof Myriam Hanssens.

Our beloved Prof Myriam Hanssens passed away the 18<sup>h</sup> of June 2022.

She was the creator and motivator of B.OSS at its early beginnings in 2011-2012. Thanks to Prof Myriam Hanssens, we were able to develop this performant and valuable system to investigate severe maternal morbidity. We are sure she would be very proud to see that B.OSS now has been extended with BAMM, a system for maternal mortality in Belgium.

We would like to thank her for sharing her passion.

## Annex.

1. Management of major obstetric hemorrhage prior to peripartum hysterectomy and outcomes across nine European countries.

# Management of major obstetric hemorrhage prior to peripartum hysterectomy and outcomes across nine European countries

Athanasios F. Kallianidis<sup>1</sup>  | Alice Maraschini<sup>2</sup>  | Jakub Danis<sup>3</sup> | Lotte B. Colmorn<sup>4</sup> | Catherine Deneux-Tharaux<sup>5</sup> | Serena Donati<sup>2</sup>  | Mika Gissler<sup>6,7</sup> | Maija Jakobsson<sup>8</sup> | Marian Knight<sup>9</sup> | Alexandra Kristufkova<sup>3</sup> | Pelle G. Lindqvist<sup>10</sup>  | Griet Vandenberghe<sup>11</sup> | Thomas van den Akker<sup>1,9,12</sup>  | On behalf of INOSS (the International Network of Obstetric Survey Systems)

<sup>1</sup>Department of Obstetrics and Gynecology, Leiden University Medical Center, Leiden, the Netherlands

<sup>2</sup>National Center for Disease Prevention and Health Promotion, Italian National Institute of Health, Rome, Italy

<sup>3</sup>1st Department of Obstetrics and Gynecology, Faculty of Medicine, Comenius University, Bratislava, Slovakia

<sup>4</sup>Department of Obstetrics, Rigshospitalet University Hospital, Copenhagen, Denmark

<sup>5</sup>Obstetric, Perinatal and Pediatric Epidemiology Research Team, Center for Epidemiology and Statistics Sorbonne Paris Cite, Inserm U1153, Paris Descartes University, Paris, France

<sup>6</sup>Information Services Department, THL Finnish Institute for Health and Welfare, Helsinki, Finland

<sup>7</sup>Department of Neurobiology, Care Sciences and Society, Karolinska Institute, Stockholm, Sweden

<sup>8</sup>Department of Obstetrics and Gynecology, Hyvinkää Hospital HUCH, University of Helsinki, Helsinki, Finland

<sup>9</sup>National Perinatal Epidemiology Unit, Nuffield Department of Population Health, University of Oxford, Oxford, UK

<sup>10</sup>Clinical Science and Education, Karolinska Institute, Department of Obstetrics and Gynecology, Sodersjukhuset Hospital, Stockholm, Sweden

## Abstract

**Introduction:** Peripartum hysterectomy is applied as a surgical intervention of last resort for major obstetric hemorrhage. It is performed in an emergency setting except for women with a strong suspicion of placenta accreta spectrum (PAS), where it may be anticipated before cesarean section. The aim of this study was to compare management strategies in the case of obstetric hemorrhage leading to hysterectomy, between nine European countries participating in the International Network of Obstetric Survey Systems (INOSS), and to describe pooled maternal and neonatal outcomes following peripartum hysterectomy.

**Material and methods:** We merged data from nine nationwide or multi-regional obstetric surveillance studies performed in Belgium, Denmark, Finland, France, Italy, the Netherlands, Slovakia, Sweden and the UK collected between 2004 and 2016. Hysterectomies performed from 22 gestational weeks up to 48 h postpartum due to obstetric hemorrhage were included. Stratifying women with and without PAS, procedures performed in the management of obstetric hemorrhage prior to hysterectomy between countries were counted and compared. Prevalence of maternal mortality, complications after hysterectomy and neonatal adverse events (stillbirth or neonatal mortality) were calculated.

**Results:** A total of 1302 women with peripartum hysterectomy were included. In women without PAS who had major obstetric hemorrhage leading to hysterectomy, uterotonics administration was lowest in Slovakia (48/73, 66%) and highest in Denmark (25/27, 93%), intrauterine balloon use was lowest in Slovakia (1/72, 1%) and highest in Denmark (11/27, 41%), and interventional radiology varied between 0/27

**Abbreviations:** ICU, Intensive Care Unit; INOSS, International Network of Obstetric Survey Systems; IQR, interquartile range; PAS, placenta accreta spectrum.

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<sup>11</sup>Department of Obstetrics and Gynecology, Ghent University Hospital, Ghent, Belgium

<sup>12</sup>Athena Institute, VU, Amsterdam, the Netherlands

#### Correspondence

Athanasios F. Kallianidis, Leiden University Medical Center, K6-35, PO Box 9600, Leiden 2300 RC, the Netherlands.  
Email: a.f.kallianidis@lumc.nl

in Denmark and Slovakia to 11/59 (79%) in Belgium. In women with PAS, uterotonic administration was lowest in Finland (5/16, 31%) and highest in the UK (84/103, 82%), intrauterine balloon use varied between 0/14 in Belgium and Slovakia to 29/103 (28%) in the UK. Interventional radiology was lowest in Denmark (0/16) and highest in Finland (9/15, 60%). Maternal mortality occurred in 14/1226 (1%), the most common complications were hematologic (95/1202, 8%) and respiratory (81/1101, 7%). Adverse neonatal events were observed in 79/1259 (6%) births.

**Conclusions:** Management of obstetric hemorrhage in women who eventually underwent peripartum hysterectomy varied greatly between these nine European countries. This potentially life-saving procedure is associated with substantial adverse maternal and neonatal outcome.

#### KEYWORDS

hysterectomy, peripartum period, placenta accreta, postpartum hemorrhage, pregnancy complications

## 1 | INTRODUCTION

Being the most invasive surgical procedure peripartum and non-reversible in terms of fertility, peripartum hysterectomy is applied as an intervention of last resort in the course of major obstetric hemorrhage. When all other management interventions such as uterotonics, surgical or interventional radiology procedures have failed, peripartum hysterectomy can be a life-saving procedure. It has therefore been included as a maternal near-miss event by the World Health Organization (WHO).<sup>1</sup> However, the optimal timing of peripartum hysterectomy in the course of hemorrhage and its order in the chain of interventions, remain subject of discussion.

Prevalence of peripartum hysterectomy differs considerably between countries, but little is known as to whether similar differences are present in terms of management strategies applied during major obstetric hemorrhage prior to resorting to hysterectomy.<sup>2,3</sup> After unsuccessful medical management, proceeding to surgical interventions starting with the least invasive and most readily accessible intervention is a common strategy. However, data comparing effectiveness of different medical and surgical interventions are scarce and hampered by differences in timing and clinical setting resulting in low quality evidence.<sup>4,5</sup> Relating management strategies in major obstetric hemorrhage to prevalence of hysterectomy and maternal outcomes may provide new insights into which strategies are most successful in preventing both maternal mortality and potentially preventable hysterectomies. We postulated that management of major obstetric hemorrhage would vary considerably between countries, given the lack of international clinical guidance and controlled trials comparing management interventions.

Peripartum hysterectomy, in most women, will be unplanned, taking place in an emergency setting of severe obstetric hemorrhage. However, in women with antenatally suspected placenta accreta spectrum (PAS), planned cesarean hysterectomy can be anticipated management.<sup>6,7</sup> PAS was found to be the second most

#### Key message

There is a lack of evidence concerning optimal management and use of peripartum hysterectomy in the case of life-threatening obstetric hemorrhage. Management strategies differ substantially between nine high-income countries. Peripartum hysterectomy is associated with considerable adverse maternal and neonatal outcome.

common indication for peripartum hysterectomy in European countries, occurring in 34.8% women who underwent hysterectomy.<sup>3</sup> The diagnosis of PAS, however, is notoriously difficult, with up to 70% of PAS remaining undiagnosed antenatally.<sup>8</sup>

The primary aim of this study was to compare management interventions performed in the course of major obstetric hemorrhage ultimately leading to peripartum hysterectomy in nine European countries. Additionally, we aimed to pool a large dataset of peripartum hysterectomies to obtain more robust calculations of prevalence of maternal mortality and complications, as well as neonatal adverse events.

## 2 | MATERIAL AND METHODS

We performed a multi-country, population-based study combining data from nine countries of the International Network of Obstetric Survey Systems (INOSS).<sup>9-16</sup> INOSS is an international collaboration of national survey systems, aiming to improve management of uncommon obstetric complications.<sup>17</sup> Data from obstetric surveillance studies on peripartum hysterectomy were collected from: the Belgian Obstetric Surveillance System (B. OSS), *Epidemiologie de la Morbidite Maternelle Severe* (EPIMOMS) in France, the Italian

Obstetric Surveillance System (ItOSS), *Landelijke studie naar Etnische determinanten van Maternale Morbiditeit* (LEMMoN) in The Netherlands, the Nordic Obstetric Surveillance System (NOSS) from Denmark, Finland and Sweden, the Slovak Obstetric Survey System (SOSS) and the UK Obstetric Surveillance System (UKOSS). All studies were nationwide except for EPIMOMS which included six regions of France (Alsace, Auvergne, Basse-Normandie, Île-de-France, Lorraine and Rhône-Alpes), covering 20% of national births, and ItOSS, which encompassed six regions in Italy (Campania, Emilia-Romagna, Lazio, Piedmont, Sicily and Tuscany), representing 49% of national births.

Methods of data collection for all individual survey studies have previously been described more extensively.<sup>18-23</sup> In short, all countries performed prospective national or multi-regional obstetric survey studies on peripartum hysterectomy, except for Slovakia, where data were collected retrospectively. Duration of studies varied between 12 and 36 months over different periods between 2004 and 2016. In Belgium, Sweden, Italy and the UK, monthly mailing to an appointed clinician was used to identify women who underwent peripartum hysterectomy. Further details were requested through a case report form and a “nothing to report” response was requested when there was no reported case. In Denmark and Finland, appointed clinicians in each maternity unit reported peripartum hysterectomies by means of electronic or paper data collection forms. In Sweden, Denmark and Finland, who jointly performed a previous NOSS hysterectomy study, validation and identification of additional cases was performed after cross-checking health registers and hospital databases (Hospital Discharge Register, Medical Birth Register and delivery logbooks). In The Netherlands and France, registration studies identified women with severe maternal morbidity in a similar manner and, within those, women who had a peripartum hysterectomy. In Slovakia, women who underwent peripartum hysterectomy the year before were identified after correspondence with all maternity units. Except for France and Slovakia, all countries have previously published national data on peripartum hysterectomies.<sup>9,10,14-16,19</sup>

To overcome differences in case selection between studies, we included women who underwent hysterectomy performed from the 22nd week of gestation up to 48 hours postpartum performed due to obstetric hemorrhage. This was the broadest overlapping definition between all studies. A more detailed description of methods used for case selection and background characteristics of women was described previously.<sup>3</sup>

The main outcome of this study was to describe the frequency of management interventions performed in the train of events leading to peripartum hysterectomy in the nine countries. These were: administration of uterotonics, performance of arterial ligation, manual removal of the placenta, vaginal or uterine packing, balloon tamponade, uterine compression sutures, curettage, suturing the placental bed, leaving the placenta in situ in women with PAS and interventional radiology. Interventional radiology was not always available in hospitals where hysterectomies were performed. In addition, transfusion of blood products and counts were described. For women with PAS, information was not available as to whether the hysterectomy was

anticipated prior to cesarean section or took place in an emergency setting. Therefore, we decided to stratify outcomes according to the indication of hysterectomy into women with and women without PAS.

Secondary outcomes were maternal mortality and complication rates after hysterectomy, and adverse neonatal outcome. Complications were coded by the lead investigators of each study according to the following options: hematologic, febrile/infection, genitourinary, wound, respiratory, renal, gastrointestinal, thromboembolic, cardiovascular, psychological, neurologic, endocrinologic. Adverse neonatal outcome was defined as stillbirth or neonatal mortality, including deaths up to 28 days postpartum.

After receiving all nine de-identified national datasets, these were merged and analyzed at Leiden University Medical Center, The Netherlands. If data for a specific variable were not available for a country or had more than 50% missing values, data were presented as “not reported”, since the quality of the data for that variable was then considered unreliable. Variables are presented descriptively as numbers with corresponding percentages. In the calculation of percentages, missing values are subtracted from the denominator, since it was impossible to identify them as positive or negative, which would have led to considerable under- or overestimation. Cumulative percentages were calculated using a fixed-effects model to take into account differences in study sample size. Analyses were performed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA) and R for Statistics (<https://www.r-project.org/>).

## 2.1 | Ethical approval

All national and multiregional studies were previously approved by their national or local Ethics Committees (see Table S1 for details).

## 3 | RESULTS

A total of 1302 peripartum hysterectomies were identified among 2 498 013 births (5.2/10 000 births).

### 3.1 | Variation in management of women without PAS between countries

Of 849 women who underwent peripartum hysterectomy for an indication other than PAS, 671/849 (79%) received uterotonics. In Belgium, Italy and Slovakia, fewer than 80% received uterotonics. In Slovakia, use of oxytocin and prostaglandins was lower than in other countries, but the proportion of women receiving ergometrin was the highest (42/73, 59%). The most frequently performed surgical procedure was suturing the placental bed in the case of placenta previa (44/157, 28%), varying from 0/59 (0%) in the Netherlands to 22/27 (82%) in Denmark. Vaginal and/or uterine packing was performed in 102/301 (34%) women in Italy and 5/40 (13%) women in Belgium. Intrauterine balloon tamponade varied considerably,

ranging from 1/71 (1%) in Slovakia to 11/27 (41%) in Denmark, with a proportion of 116/528 (22%) overall. Arterial ligation was applied much more frequently in France (35/75, 47%) than in the other countries. Use of uterine compression sutures was highest in Denmark (10/27, 37%) and lowest in Slovakia (0/71, 0%). Interventional radiology procedures were not performed in Denmark and Slovakia, whereas in the Netherlands and Belgium these were performed in 7/59 (12%) and 11/59 women (19%), respectively. Curettage was performed in 89/301 (30%) women in Italy but in only one other woman in the Netherlands (Table 1). The number of women in whom no surgical interventions were performed before peripartum hysterectomy varied between 70/73 (96%) in Slovakia to 2/27 (7%) in Denmark (Table 2).

Erythrocytes were administered to 752/837 (90%) women, ranging from 38/55 (69%) in Belgium to 100% in Finland and Sweden. Number of erythrocyte units transfused varied greatly, with women in the Netherlands receiving a median of 16 units (interquartile range [IQR] 11–24) vs four in both Belgium (IQR 0–8) and Italy (IQR 2–6). (Table 3).

### 3.2 | Variation in management of women with PAS between countries

In 453 women, the indication for hysterectomy was PAS, diagnosed either before or during surgery; 58/453 (13%) women had a vaginal birth. Uterotonics were administered to 265/453 (59%) women. Proportions of women in Italy and Finland receiving uterotonics were 71/188 (38%) and 5/16 (31%), respectively, much lower than in other countries. Interventional radiology procedures were performed in 79/451 (17.5%) women overall, but were not performed at all in Denmark compared with 9/15 (60%) women in Finland. Intrauterine balloon tamponade was applied in 39/446 (9%) women overall, again with great variance between countries: none in Belgium and Slovakia vs. 29/103 (28%) in the UK. Leaving the placenta in situ was commonly performed in France (10/23, 44%), unlike other countries (only performed in one other woman, in Belgium). Manual removal of the placenta occurred in 10/13 (77%) women in Belgium and 6/16 (38%) women in Denmark, vs none in Finland and Sweden (Table 4). The number of women in whom no surgical interventions were performed

**TABLE 1** Management of women with obstetric hemorrhage for indications other than placenta accreta spectrum. Presented as n (%). Percentages calculated after excluding missing data

Country	BE n = 59	DK n = 27	FI n = 56	FR n = 75	UK n = 173	IT n = 301	NL n = 59	SK n = 73	SE n = 26	Total n = 849
Uterotonics	42 (71)	25 (93)	49 (88)	63 (84)	156 (90)	219 (73)	48 (81)	48 (66)	21 (81)	671 (79)
Oxytocin	38 (78)	25 (96)	49 (88)	40 (53)	151 (89)	207 (69)	43 (73)	46 (65)	21 (81)	620 (74)
Missing	10 (17)	1 (4)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)	0 (0)	0 (0)	16 (2)
Prostaglandins	31 (65)	22 (85)	36 (67)	58 (77)	110 (65)	153 (51)	45 (76)	14 (20)	11 (42)	480 (58)
Missing	11 (19)	1 (4)	2 (4)	0 (0)	3 (2)	0 (0)	0 (0)	2 (3)	0 (0)	19 (2)
Ergometrin	16 (35)	N/R <sup>a</sup>	N/R	N/R	91 (54)	N/R	9 (15)	42 (59)	5 (19)	163 (44)
Missing	13 (22.0)				3 (2)		0 (0)	0 (0)	0 (0)	16 (4)
Surgical intervention										
Suturing placental bed	14 (31)	22 (82)	N/R	N/R	N/R	N/R	0 (0)	N/R	8 (31)	44 (28)
Missing	14 (23.7)	0 (0)					0 (0)		0 (0)	14 (8)
Vaginal/uterine packing	5 (13)	N/R	18 (32)	11 (15)	22 (13)	102 (34)	8 (14)	N/R	6 (23)	172 (24)
Missing	19 (32)		0 (0)	0 (0)	3 (2)	0 (0)	0 (0)		0 (0)	22 (3)
Balloon tamponade	8 (18)	11 (41)	17 (30)	18 (24)	44 (26)	N/R <sup>a</sup>	13 (22)	1 (1)	4 (15)	116 (22)
Missing	15 (25)	0 (0)	0 (0)	0 (0)	3 (2)		0 (0)	2 (3)	0 (0)	20 (4)
Curettage	N/R	N/R	N/R	N/R	0 (0)	89 (30)	1 (2)	N/R	0 (0)	90 (17)
Missing					3 (2)	0 (0)	0 (0)		0 (0)	3 (0.1)
Manual removal of placenta	20 (47)	3 (11)	4 (7)	N/R	N/R	N/R	4 (7)	N/R	0 (0)	31 (15)
Missing	16 (27)	0 (0)	0 (0)				0 (0)		0 (0)	16 (7)
Arterial ligation	3 (6)	0 (0)	5 (9)	35 (47)	21 (12)	N/R	8 (14)	2 (3)	1 (4)	75 (14)
Missing	12 (20)	0 (0)	0 (0)	0 (0)	3 (2)		0 (0)	2 (3)	0 (0)	17 (3)
Uterine compression sutures	3 (8)	10 (37)	8 (14)	13 (17)	38 (22)	29 (10)	3 (5)	0 (0)	4 (15)	108 (13)
Missing	19 (32)	0 (0)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)	2 (3)	0 (0)	24 (3)
Interventional radiology	11 (19)	0 (0)	3 (5)	7 (9)	6 (4)	2 (1)	7 (12)	0 (0)	1 (4)	37 (4)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)	2 (3)	0 (0)	5 (0.6)

BE, Belgium; DK, Denmark; FI, Finland; FR, France; UK, United Kingdom; IT, Italy; NL, The Netherlands; SK, Slovakia; SE, Sweden; N/R, not reported.

<sup>a</sup>Not reported due to ≥50% missing values.

**TABLE 2** Number of surgical interventions, including radiological intervention, performed during the management before peripartum hysterectomy. Presented as n (%)

Country	BE n = 59	DK n = 27	FI n = 56	FR n = 75	UK n = 173	IT n = 301	NL n = 59	SK n = 73	SE n = 26	Total n = 849
Women without PAS										
0	18 (31)	2 (7)	28 (50)	20 (27)	80 (46)	140 (47)	30 (51)	70 (96)	13 (50)	401 (47)
1	19 (32)	9 (33)	8 (14)	30 (40)	54 (31)	36 (12)	14 (24)	3 (4)	6 (23)	179 (31)
2	12 (20)	6 (22)	14 (25)	21 (28)	31 (18)	36 (12)	10 (17)	0 (0)	4 (15)	134 (16)
3	2 (3)	6 (22)	5 (9)	4 (5)	7 (4)	33 (11)	4 (7)	0 (0)	3 (12)	64 (8)
≥4	8 (14)	4 (15)	1 (2)	0 (0)	1 (1)	56 (19)	1 (2)	0 (0)	0 (0)	71 (8)
Country	BE n = 14	DK n = 17	FI n = 16	FR n = 23	UK n = 103	IT n = 188	NL n = 36	SK n = 30	SE n = 26	Total n = 453
Women with PAS										
0	1 (7)	2 (12)	7 (44)	4 (17)	56 (54)	90 (48)	24 (67)	25 (84)	21 (81)	230 (51)
1	8 (57)	5 (29)	7 (44)	7 (30)	29 (28)	76 (40)	7 (19)	4 (13)	4 (15)	147 (33)
2	4 (29)	5 (29)	1 (6)	10 (44)	16 (16)	19 (10)	4 (11)	1 (3)	1 (4)	61 (14)
3	0 (0)	3 (18)	1 (6)	2 (9)	2 (2)	3 (2)	1 (3)	0 (0)	0 (0)	12 (3)
≥4	1 (7)	2 (12)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (1)

BE, Belgium; DK, Denmark; FI, Finland; FR, France; UK, United Kingdom; IT, Italy; NL, The Netherlands; SK, Slovakia; SE, Sweden; AIP, abnormally invasive placenta.

before hysterectomy varied between 25/30 (83%) in Slovakia and 21/26 (81%) in Sweden to 1/14 (7%) in Belgium (Table 2).

A total of 399/451 (89%) women received transfusion of erythrocytes, 264/445 (59%) fresh frozen plasma and 136/448 (30%) thrombocytes. Women in Denmark and Finland received relatively high numbers of erythrocyte units: 13 (IQR 5–22) and 12 (IQR 6–12) respectively (Table 3).

### 3.3 | Outcomes and complications

Maternal mortality occurred in 14/1272 women, giving a case fatality rate of 1%. The most common complications following peripartum hysterectomy were hematologic (95/1202, 8%) and respiratory (81/1101, 7%) (Table 5). In all, 760/1272 (60%) women were admitted to the Intensive Care Unit (ICU). In Slovakia, only 20/103 (20%) were admitted to an ICU. The total duration of admission into ICU and the total duration of hospital stay were comparable between countries where such data were available. An adverse neonatal outcome occurred in 79/1259 (6%) births, likely associated with the considerable proportion of preterm births (487/1302, 37%) (Table 6).<sup>3</sup>

## 4 | DISCUSSION

The main finding of our study was the considerable inter-country variation in the management of major obstetric hemorrhage ultimately leading to hysterectomy for women with as well as without PAS. Use of uterotonics, surgical procedures and transfusion rates all varied considerably between the nine European countries. In

women who underwent peripartum hysterectomy, substantial rates of maternal mortality, complications and neonatal adverse outcomes were observed.

Many differences in management were found. In Slovakia, intrauterine balloon tamponade, uterine compression sutures and interventional radiology procedures were almost never performed. Low rates of interventional radiology are in line with low availability, with only two hospitals in the country performing interventional radiology for obstetric indications. At the same time, Slovakia had the second highest prevalence of peripartum hysterectomy of included countries (7 per 10 000 births), which may reflect a practice of performing hysterectomy at a relatively early stage in the course of hemorrhage.<sup>3</sup> In the Nordic countries, interventional radiology is also not available in every hospital and use varies, with the highest rate in Finland.<sup>9</sup> In Denmark, combining intrauterine balloon tamponade with uterine compression sutures (“the sandwich model”) appears to be used frequently.<sup>24</sup> Conservative management, such as leaving the placenta in situ in women with PAS, appears to be common practice in France. In women with PAS, clinicians in Sweden, the Netherlands and Slovakia performed almost no other surgical intervention before performing hysterectomy. This contrasts starkly with clinical practice in the UK, Finland and Belgium, where multiple other interventions are attempted to stop bleeding and preserve the uterus. Use of surgical procedures other than interventional radiology and administration of blood products will be less susceptible to availability and accessibility and rather reflect differences in preference between countries. These differences underline the results of a previous international review of hysterectomy, where in-depth audit revealed possible differences in management between countries.<sup>25</sup>

In a previous systematic review and meta-analysis, maternal mortality within women undergoing peripartum hysterectomy was

TABLE 3 Proportions and numbers of transfusion of blood products. Presented as n (%)

Country	BE n = 59	DK n = 27	FI n = 56	FR n = 75	UK n = 173	IT n = 301	NL n = 59	SK n = 73	SE n = 26	Total n = 849
<b>Women without PAS</b>										
Erythrocytes	38 (69)	25 (93)	54 (100)	69 (96)	166 (98)	251 (83)	58 (98)	65 (89)	26 (100)	752 (90)
Median, n (IQR)	4 (0-8)	15 (9-22)	12 (8.75-18)	8 (5.25-10.75)	11 (7-18)	4 (2-6)	16 (11-24)	N/R	11.5 (9-18.25)	7 (4-12)
Missing	4 (7)	0 (0)	2 (4)	3 (4)	3 (2)	0 (0)	0 (0)	0 (0)	0 (0)	12 (1)
Fresh frozen plasma	40 (74)	24 (89)	48 (100)	62 (87)	137 (81)	157 (52)	45 (85)	41 (56)	21 (91)	575 (70)
Median, n (IQR)	2 (0-5.25)	8 (4-14)	8 (4.25-13.5)	6 (4-9)	4 (2-6)	1 (0-3)	6 (3-10)	N/R	6 (2-15)	4 (0-6)
Missing	5 (9)	0 (0)	8 (14)	4 (5)	3 (2)	0 (0)	6 (10)	0 (0)	3 (12)	29 (3)
Thrombocytes	25 (50)	24 (89)	38 (75)	27 (39)	76 (45)	39 (13)	38 (68)	41 (57)	16 (67)	324 (39)
Median, n (IQR)	0 (0-2)	3 (2-5)	16 (0-24)	0 (0-1)	0 (0-2)	0 (0-0)	2 (0-2)	N/R	1 (0-2)	0 (0-2)
Missing	9 (15)	0 (0)	5 (9)	5 (7)	3 (2)	0 (0)	3 (5)	0 (0)	2 (8)	27 (3)
<b>Women with PAS</b>										
Erythrocytes	8 (62)	14 (82)	15 (100)	22 (96)	100 (97)	157 (84)	35 (97)	25 (83)	23 (89)	399 (89)
Median, n (IQR)	4 (0-13.5)	13 (4.5-21.5)	12 (6-19)	8 (5-10)	10 (6-16)	3 (2-4)	11 (5.25-16)	N/R	7 (2-17)	5 (2-10)
Missing	1 (7)	0 (0)	1 (6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (0.4)
Fresh frozen plasma	10 (77)	13 (77)	11 (100)	22 (96)	73 (71)	69 (37)	27 (79)	22 (73)	17 (65)	264 (59)
Median, n (IQR)	3.5 (0.75-10)	8 (0.5-15)	8 (6-11)	4 (3-7)	4 (0-6)	0 (0-2)	3.5 (2-6.25)	N/R	4 (0-9)	2 (0-9.25)
Missing	1 (7)	0 (0)	5 (31)	0 (0)	0 (0)	0 (0)	2 (5.6)	0 (0)	0 (0)	8 (2)
Thrombocytes	6 (46)	13 (77)	8 (53)	10 (44)	43 (42)	10 (5)	13 (38)	22 (73)	11 (44)	136 (30)
Median, n (IQR)	1 (0-5.5)	2 (1-5.5)	8 (0-24)	0 (0-2)	0 (0-2)	0 (0-0)	0 (0-1)	N/R	0 (0-2)	0 (0-1.5)
Missing	1 (7)	0 (0)	1 (7)	0 (0)	0 (0)	0 (0)	2 (6)	0 (0)	1 (4)	5 (1)

BE, Belgium; DK, Denmark; FI, Finland; FR, France; UK, United Kingdom; IT, Italy; NL, The Netherlands; SK, Slovakia; SE, Sweden; IQR, interquartile range.

**TABLE 4** Management of women with obstetric hemorrhage due to placenta accreta spectrum. Presented as n (%). Percentages calculated after excluding missing data

Country	BE n = 14	DK n = 17	FI n = 16	FR n = 23	UK n = 103	IT n = 188	NL n = 36	SK n = 30	SE n = 26	Total n = 453
Uterotonics	9 (64)	13 (77)	5 (31)	17 (74)	84 (82)	71 (38)	29 (81)	18 (60)	19 (73)	265 (59)
Oxytocin	7 (54)	13 (81)	5 (33)	12 (52)	84 (82)	68 (36)	26 (72)	17 (57)	18 (69)	250 (56)
Missing	1 (7)	1 (6)	1 (6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (0.7)
Prostaglandins	7 (58)	9 (60)	2 (13)	13 (57)	47 (46)	27 (14)	20 (56)	9 (30)	2 (8)	136 (30)
Missing	2 (21)	2 (12)	1 (6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	5 (1)
Ergometrin	1 (10)	N/R	N/R	N/R	38 (37)	N/R	7 (19)	15 (50)	1 (4)	62 (30)
Missing	4 (29)				0 (0)		0 (0)	0 (0)	0 (0)	4 (2)
Surgical interventions										
Suturing placental bed	2 (20)	13 (77)	N/R	N/R	N/R	N/R	0 (0)	N/R	3 (12)	18 (20)
Missing	4 (28.6)	0 (0)					0 (0)		0 (0)	4 (4)
Interventional radiology	4 (29)	0 (0)	9 (60)	3 (13)	3 (3)	50 (27)	4 (11)	1 (3)	5 (19.6)	79 (17.5)
Missing	0 (0)	1 (6)	1 (6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (0.4)
Arterial ligation	1 (10)	5 (6)	0 (0)	12 (52)	12 (12)	N/R	1 (3)	4 (13)	0 (0)	35 (14)
Missing	4 (29)	0 (0)	1 (6)	0 (0)	0 (0)		0 (0)	0 (0)	0 (0)	5 (2)
Manual removal of placenta	10 (77)	6 (38)	0 (0)	N/R	N/R	N/R	8 (22)	N/R	0 (0)	24 (12)
Missing	1 (7)	1 (6)	1 (6)				0 (0)		0 (0)	3 (3)
Placenta left in situ	1 (8)	N/R	N/R	10 (44)	N/R	N/R <sup>a</sup>	0 (0)	N/R	0 (0)	11 (12)
Missing	1 (7)			0 (0)			0 (0)		0 (0)	1 (1)
Vaginal/uterine packing	2 (22)	N/R	1 (7)	1 (4)	15 (15)	22 (12)	2 (6)	N/R	1 (4)	44 (11)
Missing	5 (36)		1 (6)	0 (0)	0 (0)	0 (0)	0 (0)		0 (0)	6 (2)
Uterine compression sutures	2 (20)	1 (7)	1 (7)	6 (26)	8 (8)	22 (12)	0	1 (3)	0 (0)	41 (9)
Missing	4 (29)	1 (6)	1 (6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	6 (1)
Balloon tamponade	0 (0)	1 (6.7)	3 (21)	1 (4)	29 (28)	N/R <sup>a</sup>	3 (8)	0 (0)	2 (8)	39 (9)
Missing	5 (35.7)	1 (6.3)	1 (6.3)	0 (0)	0 (0)		0 (0)	0 (0)	0 (0)	7 (3)
Curettage	N/R	N/R	N/R	N/R	0 (0)	8 (4)	0 (0)	N/R	0 (0)	8 (2)
Missing					0 (0)	0 (0)	0 (0)		0 (0)	0 (0)

BE, Belgium; DK, Denmark; FI, Finland; FR, France; UK, United Kingdom; IT, Italy; NL, The Netherlands; SK, Slovakia; SE, Sweden; N/R, not reported.

<sup>a</sup>Not reported due to  $\geq 50\%$  missing values.

1.4% in high-income settings, comparable to our results.<sup>2</sup> The same meta-analysis demonstrated different rates of complications, the most prominent being hematologic (26%) and infectious (19%) complications vs hematologic (8%) and respiratory (7%) in our study. That study included hysterectomies up to 6 weeks postpartum, thereby also including indications such as infection, which are more likely to occur beyond the 48-hour time limit.

A major strength of our study is that we pooled data from seven nationwide and two multi-regional obstetric surveillance studies, which led to the largest cohort of women who had peripartum hysterectomy described in the literature, as far as we are aware. The vast majority of previous studies are from single institutions. Management interventions in such studies are biased by availability of surgical interventions such as interventional radiology, operator preference and local protocols. By using nationwide data, such local differences are diminished and national trends become noticeable. Furthermore, quality of data is high, with low rates of missing data, even though not all countries were able to report all variables.

The main limitation of this study is that it encompasses data from nine studies performed during different time periods, the first starting in August 2004 and the last ending in August 2016.<sup>3</sup> Inevitably, obstetric practice will have changed over time, such as preferences and management protocols within countries. However, recent literature has not added significant new insight into management of postpartum hemorrhage other than administration of tranexamic acid.<sup>26</sup> Novel surgical interventions such as local uterine segment resection known as "one-step" surgery or modified uterine compression suturing techniques were not described in our cohort. We had no information as to whether the hysterectomy was anticipated or took place in an emergency setting. Some hysterectomies will have been planned, especially in women with suspicion of PAS. However, the finding that one in eight women with PAS gave birth vaginally illustrates that a sizeable proportion would have been unplanned hysterectomies. As such, women with PAS might have undergone fewer additional interventions, with lower transfusion rates and possibly fewer

**TABLE 5** Complications of peripartum hysterectomy. Presented as n (%). Denominator in totals calculated after subtracting missing or not reported values

Country	BE n = 73	DK n = 44	FI n = 72	FR n = 98	UK n = 276	IT n = 489	NL n = 95	SK n = 103	SE n = 52	Total n = 1302
Hematologic	12 (16)	2 (5)	0 (0)	N/R	16 (6)	46 (9)	2 (2)	17 (17)	0 (0)	95/1202 (8)
Respiratory	3 (4)	5 (11)	0 (0)	N/R	26 (9)	35 (7)	5 (5)	N/R	7 (14)	81/1101 (7)
Genitourinary	3 (4)	0 (0)	3 (4)	N/R	0 (0)	N/R	13 (14)	5 (6)	4 (8)	29/713 (4)
Cardiovascular	0 (0)	4 (9)	2 (3)	9 (9)	7 (3)	15 (3)	5 (5)	N/R	1 (2)	43/1195 (4)
Gastrointestinal	2 (3)	1 (2)	2 (3)	N/R	N/R	N/R	4 (4)	1 (1)	0 (0)	10/437 (2)
Endocrinological	0 (0)	1 (2)	0 (0)	N/R	N/R	N/R	6 (6)	N/R	0 (0)	7/336 (2)
Wound-related	0 (0)	0 (0)	0 (0)	5 (5)	0 (0)	N/R	4 (4)	4 (4)	0 (0)	13/808 (2)
Thromboembolic	0 (0)	1 (2)	1 (1)	3 (3)	4 (1)	1 (0.2)	1 (1)	N/R	2 (4)	13/1196 (1)
Infection	1 (1)	0 (0)	0 (0)	5 (5)	0 (0)	1 (0.2)	9 (10)	N/R	1 (2)	17/1196 (1)
Renal	1 (1)	0 (0)	1 (1)	N/R	3 (1)	7 (1)	2 (1)	N/R	0 (0)	14/1101 (1)
Psychological	1 (1)	0 (0)	0 (0)	N/R	N/R	N/R	2 (2)	N/R	0 (0)	3/336 (0.9)
Neurological	2 (1)	2 (5)	0 (0)	0 (0)	0 (0)	5 (1)	0 (0)	N/R	0 (0)	8/1196 (0.7)

BE, Belgium; DK, Denmark; FI, Finland; FR, France; UK, United Kingdom; IT, Italy; NL, The Netherlands; SK, Slovakia; SE, Sweden.

**TABLE 6** Maternal and neonatal outcome after peripartum hysterectomy. Presented as n (%).

Country	BE n = 73	DK n = 44	FI n = 72	FR n = 98	UK n = 276	IT n = 489	NL n = 95	SK n = 103	SE n = 52	Total n = 1302
Maternal mortality	1 (1)	1 (2)	0 (0)	3 (3)	2 (0.7)	5 (1)	2 (2)	0 (0)	0 (0)	14 (1)
Missing	2 (3)	0 (0)	0 (0)	0 (0)	0 (0)	28 (6)	0 (0)	0 (0)	0 (0)	30 (2)
Mother admitted into ICU	48 (67)	26 (59)	34 (48)	49 (50)	231 (84)	230 (50)	81 (85)	20 (20)	41 (79)	760 (60)
Missing	1 (1)	0 (0)	1 (1)	0 (0)	0 (0)	27 (6)	0 (0)	1 (1)	0 (0)	30 (2)
ICU (days) <sup>a</sup>	3 (2–4)	N/R	N/R	3 (1–4)	2 (1–3)	2 (1–3)	2 (1–3)	2 (2–3)	N/R	2 (1–3)
Hospital stay (days) <sup>a</sup>	9 (7–12)	N/R	N/R	8 (7–13)	N/R	N/R	8 (6–13)	7 (5–8)	N/R	8 (6–11)
Neonatal adverse events	7 (10)	5 (11)	5 (7)	6 (6)	8 (3)	31 (7)	6 (6)	7 (7)	4 (8)	79 (6)
Missing	1 (1)	0 (0)	0 (0)	0 (0)	4 (1)	36 (7)	1 (1)	1 (1)	0 (0)	43 (3)

BE, Belgium; DK, Denmark; FI, Finland; FR, France; UK, United Kingdom; IT, Italy; NL, The Netherlands; SK, Slovakia; SE, Sweden; ICU, Intensive Care Unit.

<sup>a</sup>Presented as median (interquartile range).

complications because surgery took place in a planned setting. Some women with PAS performed in planned settings, will not have experienced hemorrhage ( $\geq 1$  L). Given that our dataset did not include total amount of blood loss, these women will have been included in our study. This might partly explain the relatively low rates of uterotonic use and transfusion rates in some countries. Variation in use of uterotonics in women without PAS may be explained by the contribution of non-atomic bleeding, such as surgery-related bleeds around hysterectomy, and – to a limited extent – coding problems. It is clear that in the case of atony, uterotonics should be first-line management. Additionally, it was impossible to identify in how many women hysterectomy initiated the hemorrhage rather than being the ultimate measure taken to stop bleeding. Also, variation in available resources, particularly with regard to interventional radiology, hampers comparisons. Finally, complications were coded by the principal investigator of each study, possibly leading to differences in the definitions

used. Complication rates should be interpreted with caution, as these may in some women result from the major bleeding rather than the surgery itself. For example, thromboembolism can result from major bleeding with subsequent disseminated intravascular coagulation.

One might argue that in the management of obstetric hemorrhage in these women, all interventions performed up to the hysterectomy were unsuccessful and led to a delay that sometimes even contributed to the deaths of women whose hysterectomies were too delayed. On the other hand, in other women, hysterectomy was probably performed in an early stage of bleeding. A decision to perform hysterectomy may be taken more readily in older and parous women and by a surgically skilled obstetrician. However, we believe that the greatest contributor to the variance is the lack of international guidance on optimal management of life-threatening major obstetric hemorrhage. There is no conclusive evidence about the superiority of one management intervention over another.<sup>5,27</sup>

Moreover, any management strategy should take into account the underlying cause of hemorrhage, and local availability and accessibility of management interventions. Implementation of standardized step-down management strategies previously has shown to reduce rates of hysterectomy and maternal mortality.<sup>28</sup> Finally, for women with PAS, guidelines propose a multidisciplinary approach and, although evidence for interventional radiology is limited, accessibility is recommended.<sup>29</sup>

To identify the optimal management strategy for every woman with major obstetric hemorrhage, further research is necessary. Ideally, a case-control design could help establish associations between different surgical interventions and maternal outcomes or clinical parameters related to the bleeding, taking into account known risk factors. Larger cohorts could potentially enable propensity-matched comparisons between management strategies. For gathering adequate numbers of participants, INOSS provides an ideal platform. A prospectively designed cohort study conducted simultaneously in multiple nationwide surveys could be a next step.

## 5 | CONCLUSION

Obstetric hemorrhage remains a leading cause of maternal morbidity and mortality. Management strategies differed markedly between the nine European countries studied. The optimal management strategy remains a subject for discussion.<sup>5</sup> Practice variation related to the use of oxytocin, balloon tamponade and interventional radiology may contribute to increased hysterectomy rates in some countries. Risk factors for hemorrhage, such as cesarean section, are rising, translating into increased rates of peripartum hysterectomy. This illustrates the importance of optimizing management strategies in major obstetric hemorrhage.<sup>27</sup> This includes the timing of hysterectomy, avoiding early and preventable removal of the uterus, as well as late hysterectomies associated with severe morbidity and death.

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## CONFLICT OF INTEREST

None.

## ORCID

Athanasios F. Kallianidis  <https://orcid.org/0000-0001-6078-1185>

Alice Maraschini  <https://orcid.org/0000-0003-4754-5385>

Serena Donati  <https://orcid.org/0000-0002-4607-2072>

Pelle G. Lindqvist  <https://orcid.org/0000-0002-1652-8235>

Thomas van den Akker  <https://orcid.org/0000-0002-9890-9145>

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### SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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