2017-02-21

Duration of second stage of labour at term and pushing time : risk factors for postpartum haemorrhage

Looft, Emelie; Simic, Marija; Ahlberg, Mia; Snowden, Jonathan M; Cheng, Yvonne W; Stephansson, Olof

Paediatr Perinat Epidemiol. 2017 Mar;31(2):126-133.
http://doi.org/10.1111/ppe.12344
http://hdl.handle.net/10616/45541

Duration of Second Stage of Labour at Term and Pushing Time: Risk Factors for Postpartum Haemorrhage

Emelie Looft,[a] Marija Simic,[a] Mia Ahlberg,[a]
Jonathan M. Snowden,[b] Yvonne W. Cheng,[c,d] Olof Stephansson[a,e]

Affiliations

a. Clinical Epidemiology Unit, Department of Medicine, Karolinska University Hospital and Institutet, Stockholm, Sweden

b. Departments of Obstetrics and Gynecology, and Public Health and Preventive Medicine, Oregon Health and Science University, Portland, USA

c. Department of Surgery, University of California at Davis, Sacramento, USA

d. Division of Maternal-Fetal Medicine, Department of Obstetrics and Gynecology, California Pacific Medical Center, San Francisco, USA

e. Division of Epidemiology and Biostatistics, School of Public Health, University of California, Berkeley, USA

Correspondence

Olof Stephansson
Karolinska University Hospital
Clinical Epidemiology Unit, Stockholm, Sweden
E-mail: olof.stephansson@ki.se

Running title: Second stage of labour, pushing and postpartum haemorrhage

Abstract

Background: Prolonged labour is associated with increased risk of postpartum haemorrhage (PPH), but the role of active pushing time and the relation with management during labour remains poorly understood.

Methods: A population-based cohort study from electronic medical record data in the Stockholm-Gotland Region, Sweden. We included 57 267 primiparous women with singleton, term gestation, live births delivered vaginally in cephalic presentation in 2008-2014. We performed multivariable Poisson regression to estimate the association between length of second stage, pushing time and PPH (estimated blood loss >500 ml during delivery), adjusting for maternal, delivery and fetal characteristics as potential confounders.

Results: The incidence of PPH was 28.9%. The risk of PPH increased with each passing hour of second stage: compared with a second stage <1 hour, the adjusted relative risk (RR) for PPH were for 1 to <2 hours 1.10 (95% confidence interval (CI) 1.07, 1.14); for 2 to <3 hours 1.15 (95% CI 1.10, 1.20), for 3 to <4 hours 1.28 (95% CI 1.22, 1.33), and ≥4 hours 1.40 (95% CI 1.33, 1.46). PPH also increased with pushing time exceeding 30 minutes. Compared to pushing time between 15-29 minutes, the RR for PPH were for <15 minutes 0.98 (95% CI 0.94, 1.03); 30-44 minutes 1.08 (95% CI 1.04, 1.12), 45-59 minutes 1.11 (95% CI 1.06, 1.16), and ≥60 minutes 1.20 (95% CI 1.15, 1.25).

Conclusions: Increased length of second stage and pushing time during labour are both associated with increased risk of PPH.

Keywords: Postpartum haemorrhage; labour; second stage; pushing; prospective cohort study

Introduction

Postpartum haemorrhage (PPH) is a major cause of maternal mortality worldwide. In both developed and undeveloped countries, PPH accounts for nearly one-third of all maternal deaths worldwide.[1, 2] In addition to maternal mortality, PPH also leads to severe maternal morbidity.[3] Risk factors for PPH reported in previous studies include: advanced maternal age, maternal obesity, nulliparity, multiple birth, epidural analgesia, oxytocin augmentation, instrumental delivery and macrosomia.[3] The annual incidence of PPH has increased in developed countries including the UK, Canada, Sweden, and the US even after considering the increasing trend in risk factors like advanced maternal age and obesity.[4-7] The most frequent causes of PPH are uterine atony, retained placenta, and birth canal lacerations.[8]

Previous studies have shown an increased risk of PPH with prolonged duration of second stage of labour.[9-15] A US study also examined the role of pushing time and found increased risk of PPH after two hours of pushing.[16] In addition a French study reported a linear increased risk of PPH with expulsion duration.[17] However, many of these studies have limitations in study design and methodology.[18] Some of these limitations include inconsistency in the definition of PPH, oversimplified categorisation of prolonged second stage of labour without consideration given specifically to pushing time, lack of control of maternal and delivery characteristics for the study population. Further, in many studies the identification of PPH is based on discharge diagnosis from hospital records. Such information tends to lack exact measurement of blood loss, nor precise antenatal and intrapartum information. Additionally, the correlation between duration of second stage of labour by different causes of PPH, to our knowledge, has not previously been studied.

We designed a population-based cohort study to investigate whether a prolonged second stage of labour and pushing time are associated with increased risk of PPH. We hypothesised that the length of second stage, as well as increasing pushing time, was associated with increased risk of PPH.

Methods

This is a population-based cohort study, with data retrieved from the Stockholm-Gotland Obstetric Database, which contains data derived from the medical record system that is used at all maternity, delivery and postnatal care units in the region.[19] The care providers prospectively entered detailed information on the mother and the fetus, from registration at prenatal care until discharge from the delivery hospital. The database also includes information registered in the labour partograph with detailed information about start, progress, duration and interventions (i.e., oxytocin use and pushing time) during labour and delivery. The regional ethical committee at Karolinska Institutet, Stockholm, Sweden approved the study protocol (No. 2009/275-31 and No. 2012/365-32).

Study population

The study population consisted of all primiparous women with singleton term births in the region from 2008 through October 2014 (n=78 984). We excluded deliveries with non-cephalic presentation (n=4233), elective (n=3365) and emergency (n=9198) caesarean deliveries, deliveries without partograph data (n=850), or without recorded time of fully dilated cervix in the partograph before delivery (n=3987). We additionally excluded

deliveries without recorded blood loss measurement (n=84), resulting in a final study population of 57 267 deliveries.

Exposures

Duration of second stage of labour was defined as time in hours from fully dilated cervix until delivery, divided into five groups of 1-hour intervals: <1 hour (referent comparison group), 1 to <2 hours, 2 to <3 hours, 3 to <4 hours and ≥4 hours in accordance with previous research.[9, 13] Obstetrical management during second stage of labour in Sweden recommend that the woman begin pushing when she has the natural urge to push or in case of lack of urge when the fetal vertex has reached the pelvic floor. Since start time of second stage (complete cervical dilation) usually occurs before the woman's urge to push and before the fetal head has reached the pelvic floor, substantial differences between duration of second stage and pushing time occurs. Pushing time was defined as time in minutes from when the woman actively starts pushing until delivery based on information retrieved in the labour partograph. Pushing time was categorised in 15-minute intervals as 0-14, 15-29, 30-44, 45-59 and ≥60 minutes.

Outcome

The outcome of interest was PPH, defined as estimated blood loss >500 ml during delivery including blood loss during delivery of the fetus until expulsion of the placenta, and blood loss after placental expulsion until two hours postpartum. The International Classification of Diseases, 10th Revision (ICD-10) codes at discharge from the delivery hospital were used to

categorise PPH by aetiology into: (i) uterine atony (O721A or O722); (ii) retained placenta (O720, O730 or O731); or (iii) birth canal laceration (O721B).

Covariates

Selection of potential confounding factors was based on biological plausibility and on results from previous studies using a Directed Acyclic Graph[20] (Figure 1). In selecting covariates, we considered the roles of the variables in the causal structure between exposure (second stage of labour) and outcome (PPH). We determined that the baseline maternal characteristics (e.g., age, BMI) and obstetric management occurring before the second stage were the potential confounders of the association. In contrast, obstetrical management during the second stage (e.g., oxytocin initiated during the second stage, pushing) were determined to be potential mediators of the association between second stage and PPH, and thus they were not included as confounding covariates.

Data on parity and maternal weight and height for calculation of body mass index (BMI) was retrieved from the records of the first antenatal visit, usually in the first trimester. Gestational age was determined using the following hierarchy: (i) date of embryo transfer (4.7%); (ii) early second trimester ultrasound (93.3%); (iii) date of last menstrual period reported at the first antenatal visit (2.0%); and (iv) from a postnatal assessment (<1%). From the labour partograph and standardised birth records we obtained data on maternal age at delivery, induction of labour, use of epidural analgesia, oxytocin augmentation started during the first stage of labour and birthweight.

Statistical analysis

The associations between prolonged second stage of labour and pushing time and the risk of PPH was based on relative risk (RR) with 95% confidence interval (CI) were estimated by multivariable Poisson regression analysis with robust variance. Analyses were adjusted for the confounding effects of maternal age, height, BMI, smoking, induction of labour, use of oxytocin during the first stage of labour, gestational age and birthweight in analysis of duration of second stage of labour. We then analysed risk of PPH associated with duration of 2nd stage of labour by the major causes of PPH.

To examine the duration of second stage in a way that reflects this clinical reality, we also analysed the risk of PPH associated with second stage and delivery within an hour compared with any time later during second stage. We then repeated this analysis for a 2-hour duration compared to any time later during the second stage, and so on. In analyses for pushing time and PPH risk, we included these covariates in the regression model: maternal age, height, BMI, smoking, induction of labour, oxytocin augmentation prior to pushing, duration of second stage until pushing, gestational age and birthweight.

Results

A total of 57 267 deliveries met the study inclusion criteria. Characteristics associated with increased risk of PPH included duration of second stage of labour, pushing time, advanced maternal age, high statue, overweight and obesity, induction of labour, epidural analgesia, instrumental delivery, advanced gestational age, high birthweight and oxytocin

augmentation during first stage of labour. Women who smoked had lower risk of PPH compared with non-smokers (Table 1).

Adjusted relative risks for PPH increased with each passing hour from complete cervical dilation to birth. Compared to women whose second stage was <1 hour in duration, those with a second stage of 1-2 hours had a 10% increase in the risk of PPH (Table 2). Similarly, women whose second stage duration was 2 to <3 hours, their risk of PPH was 15% higher compared to <1 hour. For women, whose second stage lasted from 3 to <4 hours, the risk of PPH was increased by 30% compared to those with a second stage <1 hour, and such risk was increased by 40% when the duration of second stage was ≥4 hours; Table 2.

In addition to duration of second stage, we also examined the active pushing time during the second stage and its association with PPH. Compared to women who delivered vaginally with a pushing time between 15-29 minutes, women who had a pushing time lasting between 30-44 minutes, or 45-59 minutes, their risk of PPH was increased. When the pushing time extended to 60 minutes and longer, the risk of PPH in these women was 20% higher compared to women who pushed for 15-29 minutes (Table 2). In additional analyses, we also investigated the association between duration of second stage, pushing time and estimated blood loss >1000 ml (Supplementary Table). Although the absolute risks were lower the relative risks were similar in magnitude.

Next, we examined potential pathophysiological causes of PPH in relation to duration of second stage. In multivariable models designating second stage <1 hour as referent, the risk

of PPH due to uterine atony increased with each passing hour of second stage (Table 3). Similar risks increased with duration of second stage for those PPH due to retained placenta, and/or birth canal laceration (Table 3).

We assessed the association between PPH and duration of second stage by examining the risk of PPH in the second stage by each passing hour compared to all deliveries thereafter. As such, the risk of PPH in women who delivered beyond the first hour (i.e., ≥1 hour) of second stage was approximately 20% higher compared to those who delivered in the first hour (Table 4). For women who delivered with a second stage ≥2 hours, ≥3 hours or ≥4 hours, their risk of PPH was approximately 10-20% higher compared to their counterparts delivered in the preceding hour of second stage (Table 4).

Comment

In this population-based cohort study of primiparous women who had vaginal deliveries at term, we observed that the risk of PPH, including those due to uterine atony, retained placenta, and birth canal laceration progressively increased with each passing hour of the duration of second stage of labour, as well as length of pushing time. As management of second stage is evolving and second stage is increasingly being examined as two phases, i.e., passive descent and active pushing,[21, 22] the information regarding pushing time and risk of PPH can be clinically useful. Furthermore, in the clinically setting, providers and patients could not reliably predict timing of delivery. As such, the clinician is faced with the dilemma of offering obstetric interventions (operative vaginal delivery or caesarean), or wait (expectant management) without knowing whether the patient will deliver in the next hour,

two hours, or longer. We report that compared to deliveries in the hour prior, expectant management is associated with an approximately 10-20% increase in risk of PPH.

Strengths of the study

The major strength of this study was the population-based design with a large study population and access to detailed prospective ascertainment of data. By using structured clinical labour data from the partograph with exposure collected before the outcome PPH, this prospective study design precludes recall bias. We defined PPH using reported blood loss and not from diagnostic codes at discharge from the delivery hospital, which minimize misclassification. The proportion of primiparous women with PPH in this cohort was 28.9%, which is very high in an international comparison. The Swedish definition of PPH is estimated blood loss >1000 ml with a national prevalence of 7.0% based on diagnosis at discharge from the delivery hospital.[8] We additionally examined associations based on PPH defined as >1000 ml. As >500 ml is often the threshold of blood loss used to define of PPH for vaginal deliveries,[3] one study examined different definitions of PPH (above 500 ml, 1000 ml and 1500 ml) and reported an association between prolonged second stage of labour and PPH, regardless of definition used, and stronger associations for PPH >1000 ml.[15] We found similar relative risks of PPH associated with duration of second stage of labour and pushing time regardless of definition (>500 ml or >1000 ml), however, the more stringent definition of PPH (>1000 ml) might have broader clinical significance with higher impact on maternal morbidity.

Limitations of the data

There are limitations in this study. First, we defined PPH using the birth records, which contain 2 fields for estimated blood loss recording up to 2 hours postpartum. However, according to international definitions,[23] PPH is often defined as excessive bleeding up to 24-hours postpartum. Thus, we might have missed some women who may have qualified for having PPH if excessive bleeding occurs after the 2-hour window. However, as the majority of blood loss tends to occur immediately after birth, we suspect the effect of this misclassification would be small. Second, there might be women with precipitous labour without clear documentation of time at complete cervical dilation. As such, we could not capture the length of second stage in these women; they were excluded from analysis. On the other hand, women with the shortest duration of second stage and pushing time had the lowest risk of PPH, which is reassuring. Furthermore, we used information from vaginal examinations during labour and consequently our measurement of second stage may have been underestimated. Third, we excluded women who delivered by caesarean in the second stage from analysis. This exclusion limits our ability to assess the effect of second stage on PPH, as many women who had prolonged second stage would undergo caesarean delivery. Yet, this exclusion of caesarean delivery was purposeful since the intent was to examine the length of second stage on PPH without the influence of PPH risk ensuing from a surgical procedure.

While numerous studies have examined the association between duration of second stage and associated maternal and neonatal outcomes,[9-14, 16] whereas few had PPH as a primary outcome.[15, 17, 23] As such, the effect estimate between duration of second stage and PPH can be prone to biases such as ascertainment, confounding, selection, or misclassification. As our

findings are consistent with several previous studies,[9, 10, 12, 24] this study was specifically designed to examine PPH as a primary outcome.

When we examined potential pathophysiological causes of PPH, we identified that uterine atony was the most common aetiology. We posit that the length of the second stage can be a marker of uterine contractility and cephalic-pelvic disproportion such that the presence of inadequate or ineffective uterine contractions can lead to prolonged second stage and subsequent PPH due to uterine atony and retained placenta. Similarly, tissue oedema in the presence of a long second stage likely contributes to higher risk of birth canal lacerations, and potentially resulting in PPH. These findings suggest that regardless of potential causes, the duration of second stage may be a marker leading to increased risk of PPH. This information is important in the clinical setting when managing women with progressively long second stage.

In Sweden, as in many parts of Europe, women have been advised to practice delayed pushing until fetal head descends into the pelvic floor and stimulate the urge to actively expulse the fetus. As delayed pushing in the second stage becomes a more common practice in the US and worldwide, we were able to analyse second stage of labour with delineation of passive descent and active pushing time. We report that both total second stage time and pushing time are associated with increased risk of PPH. Our findings were consistent with one large randomised controlled trial of delayed versus active pushing which reports an increased risk of PPH after 2 hours of pushing,[16] and in line with a French study demonstrating a linear association between the expulsive phase duration and PPH risk.[17]

Thus, prolonged pushing time, especially in women with a long second stage, warrants potential preventive actions for PPH, balancing the risks and benefit of instrumental and operative deliveries weighed against those of expectant management.

In the analysis of the risk with delivery within an hour or at any later stage mimics the clinical situation where you have to make decision on whether to intervene now or deliver at any later stage. We could show that the risk increase was relatively consistent and did not increase by duration of second stage of labour, which is an important finding. Hence, the decision may be not to intervene but increasing duration of second stage and prolonged pushing warrants actions for PPH prevention like administration of uterotonic drugs, enhanced level of uterine massage and supervision in the early postpartum period.

Conclusions

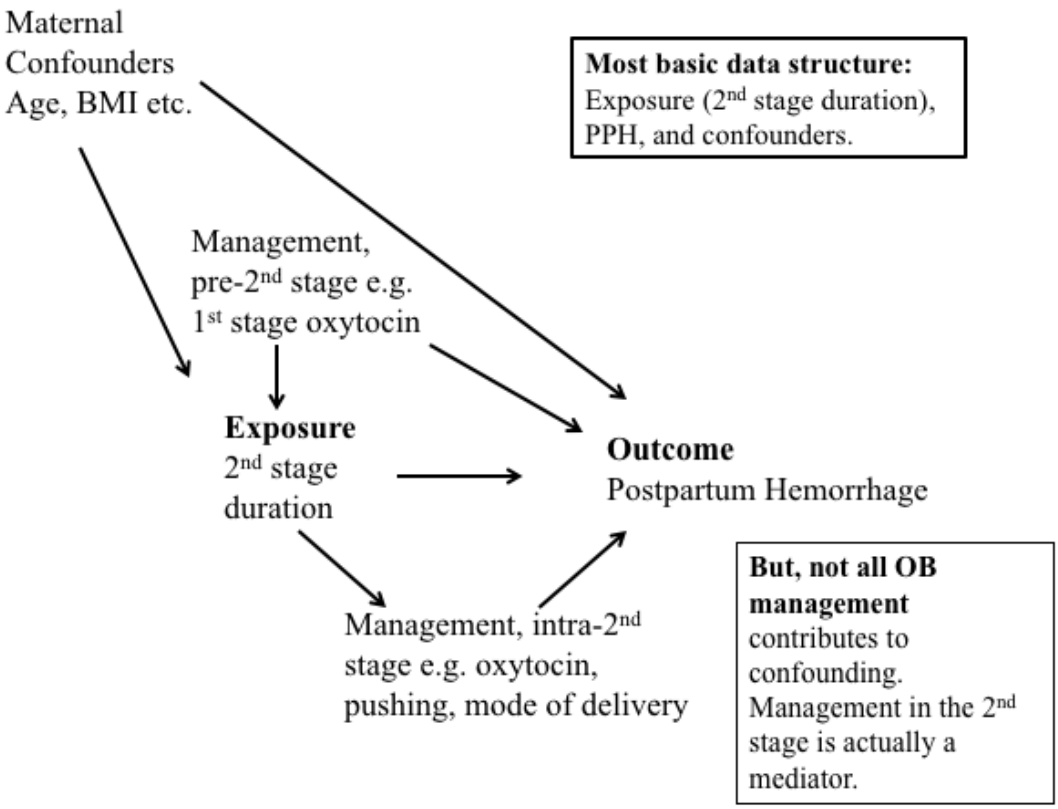
Findings from this study support that prolonged second stage of more than one hour and pushing time more than 30 minutes are both associated with increased the risk of PPH. Prolonged second stage likely contributes to the risk of PPH regardless of potential underlying aetiologies of PPH, such as uterine atony, retained placental tissue, or vaginal/cervical lacerations. Further, we report that the risk of PPH increases by 10-20% with each passing hour compared to deliveries thereafter. This knowledge may help in clinicians and patients in the counselling and decision-making process regarding risks of PPH and the trade-off of obstetric interventions versus expectant management during the second stage of labour.

Acknowledgements

This study was supported by grants from the Swedish Research Council (2013-2429, OS) and by grants provided by the Stockholm County Council (ALF project 20130156, OS). The funding sources had no involvement in conduct of the research or preparation of the article.

Figure legend

Figure 1 Directed Acyclic Graph (DAG) for the association between duration of second stage of labour at term and the risk of postpartum haemorrhage (PPH) in primiparous women



References

1. Say L, Chou D, Gemmill A, Tuncalp O, Moller AB, Daniels J, et al. Global causes of maternal death: a WHO systematic analysis. *Lancet Global Health* 2014; 2:e323-333.
2. Ronsmans C, Graham WJ, Lancet Maternal Survival Series steering group. Maternal mortality: who, when, where, and why. *Lancet* 2006; 368:1189-1200.
3. Oyelese Y, Ananth CV. Postpartum hemorrhage: epidemiology, risk factors, and causes. *Clinical Obstetrics & Gynecology* 2010; 53:147-156.
4. Blomberg M. Maternal obesity and risk of postpartum hemorrhage. *Obstetrics and Gynecology* 2011; 118:561-568.
5. Bateman BT, Berman MF, Riley LE, Leffert LR. The epidemiology of postpartum hemorrhage in a large, nationwide sample of deliveries. *Anesthesia and Analgesia* 2010; 110:1368-1373.
6. Callaghan WM, Kuklina EV, Berg CJ. Trends in postpartum hemorrhage: United States, 1994-2006. *American Journal of Obstetrics and Gynecology* 2010; 202:353 e351-356.
7. Kramer MS, Berg C, Abenhaim H, Dahhou M, Rouleau J, Mehrabadi A, et al. Incidence, risk factors, and temporal trends in severe postpartum hemorrhage. *American Journal of Obstetrics and Gynecology* 2013; 209:449 e441-447.
8. Oberg AS, Hernandez-Diaz S, Palmsten K, Almqvist C, Bateman BT. Patterns of recurrence of postpartum hemorrhage in a large population-based cohort. *American Journal of Obstetrics and Gynecology* 2014; 210:229 e221-228.
9. Cheng YW, Hopkins LM, Caughey AB. How long is too long: Does a prolonged second stage of labor in nulliparous women affect maternal and neonatal outcomes? *American Journal of Obstetrics and Gynecology* 2004; 191:933-938.

10. Myles TD, Santolaya J. Maternal and neonatal outcomes in patients with a prolonged second stage of labor. *Obstetrics and Gynecology* 2003; 102:52-58.

11. Laughon SK, Berghella V, Reddy UM, Sundaram R, Lu Z, Hoffman MK. Neonatal and maternal outcomes with prolonged second stage of labor. *Obstetrics and Gynecology* 2014; 124:57-67.

12. Saunders NS, Paterson CM, Wadsworth J. Neonatal and maternal morbidity in relation to the length of the second stage of labour. *British Journal of Obstetrics and Gynaecology* 1992; 99:381-385.

13. Rouse DJ, Weiner SJ, Bloom SL, Varner MW, Spong CY, Ramin SM, et al. Second-stage labor duration in nulliparous women: relationship to maternal and perinatal outcomes. *American Journal of Obstetrics and Gynecology* 2009; 201:357 e351-357.

14. Allen VM, Baskett TF, O'Connell CM, McKeen D, Allen AC. Maternal and perinatal outcomes with increasing duration of the second stage of labor. *Obstetrics and Gynecology* 2009; 113:1248-1258.

15. Lu MC, Muthengi E, Wakeel F, Fridman M, Korst LM, Gregory KD. Prolonged second stage of labor and postpartum hemorrhage. *Journal of Maternal-Fetal and Neonatal Medicine* 2009; 22:227-232.

16. Le Ray C, Audibert F, Goffinet F, Fraser W. When to stop pushing: effects of duration of second-stage expulsion efforts on maternal and neonatal outcomes in nulliparous women with epidural analgesia. *American Journal of Obstetrics and Gynecology* 2009; 201:361 e361-367.

17. Dionne MD, Deneux-Tharaux C, Dupont C, Basso O, Rudigoz RC, Bouvier-Colle MH, et al. Duration of expulsive efforts and risk of postpartum hemorrhage in nulliparous women: A population-based study. *PLoS One* 2015; 10:e0142171.

18. Altman MR, Lydon-Rochelle MT. Prolonged second stage of labor and risk of adverse maternal and perinatal outcomes: a systematic review. *Birth* 2006; 33:315-322.

19. Stephansson O, Sandstrom A, Petersson G, Wikstrom AK, Cnattingius S. Prolonged second stage of labour, maternal infectious disease, urinary retention and other complications in the early postpartum period. *BJOG* 2016; 123:608-616.

20. Howards PP, Schisterman EF, Poole C, Kaufman JS, Weinberg CR. "Toward a clearer definition of confounding" revisited with directed acyclic graphs. *American Journal of Epidemiology* 2012; 176:506-511.

21. Hansen SL, Clark SL, Foster JC. Active pushing versus passive fetal descent in the second stage of labor: a randomized controlled trial. *Obstetrics and Gynecology* 2002; 99:29-34.

22. Tuuli MG, Frey HA, Odibo AO, Macones GA, Cahill AG. Immediate compared with delayed pushing in the second stage of labor: a systematic review and meta-analysis. *Obstetrics and Gynecology* 2012; 120:660-668.

23. Bais JM, Eskes M, Pel M, Bonsel GJ, Bleker OP. Postpartum haemorrhage in nulliparous women: incidence and risk factors in low and high risk women. A Dutch population-based cohort study on standard (> or = 500 ml) and severe (> or = 1000 ml) postpartum haemorrhage. *European Journal of Obstetrics and Gynecology and Reproductive Biology* 2004; 115:166-172.

24. Janni W, Schiessl B, Peschers U, Huber S, Strobl B, Hantschmann P, et al. The prognostic impact of a prolonged second stage of labor on maternal and fetal outcome. *Acta Obstetrica et Gynecologica Scandinavia* 2002; 81:214-221.

Table 1

Maternal and delivery characteristics, and rate of postpartum haemorrhage (500 ml), primiparous women with vaginal delivery in Stockholm-Gotland, Sweden, 2008-2014

Characteristics	Total births	Postpartum Haemorrhage[a]	
		n	%
	57 267	16 554	28.9
Time from retracted cervix to birth (hours)			
<1	19305	4702	24.4
1 to <2	16439	4628	28.2
2 to <3	10155	3100	30.5
3 to <4	6689	2312	34.6
≥4	4679	1812	38.7
Pushing time (minutes)			
0-14	7013	1785	25.5
15-29	17540	4557	26.0
30-44	13813	4018	29.1
45-59	8028	2482	30.9
≥60	7423	2511	33.8
Missing	3450	1201	-
Maternal age (years)			
≤24	9461	2439	25.8
25-29	18613	5273	28.3
30-34	20291	6064	29.9
≥35	8868	2770	31.2
Missing	34	8	-
Height (cm)			
≤154	1507	415	27.5
155-164	19128	5250	27.5
165-174	29424	8646	29.4
≥175	6622	2084	31.5
Missing	586	159	-
Body-mass index (kg/m^2)			
<18.5	1778	439	24.7
18.5-24.9	38825	10942	28.2
25.0-29.9	10251	3190	31.1
≥30	3616	1149	31.8
Missing	2797	834	-
Cigarette smoking			
Non-smoker	54264	15788	29.1

Smoker	2511	611	24.3
Missing	492	155	-
Delivery characteristics			
Induction of labour			
Yes	9904	3358	33.9
No	47363	13196	27.9
Epidural analgesia			
Yes	35466	10327	29.1
No	21801	6227	28.6
Oxytocin during 1st stage of labour			
Yes	26312	8377	31.8
No	30955	8177	26.4
Mode of delivery			
Non-Instrumental	46569	12583	27.0
Instrumental[b]	10698	3971	37.1
Gestational age (weeks)			
37	2522	589	23.4
38	5873	1395	23.8
39	13069	3371	25.8
40	18376	5310	28.9
41	12863	4239	33.0
≥42	4564	1650	36.2
Fetal characteristics			
Birthweight (g)			
<2500	598	95	15.9
2500- 2999	6525	1194	18.3
3000- 3499	22203	5291	23.8
3500- 3999	20509	6699	32.7
4000- 4499	6486	2757	42.5
≥4500	910	503	55.3
Missing	36	15	-

[a]Estimated blood loss >500 ml during delivery. [b]Vacuum extraction or forceps delivery.

Table 2

Time from retracted cervix to vaginal birth, crude and adjusted risk ratios for postpartum haemorrhage >500 ml

	Postpartum haemmorhage		Relative risk (95% confidence interval)	
	n	%	Unadjusted	Adjusted
Time from retracted cervix to birth (hours)[a]				
<1	4702	24.4	1.00 (Reference)	1.00 (Reference)
1 to <2	4628	28.2	1.16 (1.12, 1.20)	1.10 (1.07, 1.14)
2 to <3	3100	30.5	1.25 (1.21, 1.30)	1.15 (1.10, 1.20)
3 to <4	2312	34.6	1.42 (1.36, 1.48)	1.28 (1.22, 1.33)
≥4	1812	38.7	1.59 (1.52, 1.66)	1.40 (1.33, 1.46)
Pushing time (minutes)[b]				
0 to 14	1785	25.5	0.98 (0.94, 1.03)	0.98 (0.94, 1.03)
15 to 29	4557	26.0	1.00 (Reference)	1.00 (Reference)
30 to 44	4018	29.1	1.12 (1.08, 1.16)	1.08 (1.04, 1.12)
45 to 59	2482	30.9	1.19 (1.14, 1.24)	1.11 (1.06, 1.16)
≥60	2511	33.8	1.30 (1.25, 1.36)	1.20 (1.15, 1.25)

[a]Adjusted for maternal age, height, BMI, smoking, induction of labour, 1st stage oxytocin, gestational age and birthweight

[b]Adjusted for maternal age, height, BMI, smoking, induction of labour, oxytocin before pushing, time of retracted cervix until pushing, gestational age and birthweight

Table 3

Adjusted risk ratios for postpartum haemorrhage >500 ml divided into the major causes by time from retracted cervix to birth

	Uterine Atony (n=2659)			Retained placenta (n=1735)			Birth canal laceration (n=1101)		
	n	**%**	**RR (95% CI)**	**n**	**%**	**RR (95% CI)**	**n**	**%**	**RR (95% CI)**
Time from retracted cervix to birth (hours)									
<1		3.6	1.00 (Reference)		2.3	1.00 (Reference)		1.3	1.00 (Reference)
1 to <2		4.5	1.12 (1.01, 1.25)		2.9	1.22 (1.07, 1.39)		1.9	1.31 (1.10, 1.55)
2 to <3		5.0	1.18 (1.05, 1.32)		3.5	1.39 (1.20, 1.60)		2.1	1.38 (1.14, 1.66)
3 to <4		5.7	1.35 (1.19, 1.53)		3.8	1.42 (1.21, 1.66)		2.5	1.57 (1.28, 1.92)
≥4		7.3	1.62 (1.42, 1.85)		4.1	1.54 (1.29, 1.83)		3.6	2.18 (1.78, 2.67)

RR, relative risk; CI, confidence interval

Relative risks are adjusted for maternal age, parity, height, BMI, smoking, induction of labour, 1st stage oxytocin, gestational age and birthweight

Table 4

Time from retracted cervix to vaginal birth and crude and adjusted risk ratios for postpartum haemorrhage >500 ml with previous hour as reference group

Time from retracted cervix to birth (hours)	Postpartum haemmorhage		Relative risk (95% confidence interval)	
	n	%	Unadjusted	Adjusted[a]
<1	4702	24.4	1.00 (Reference)	1.00 (Reference)
≥1	11 852	31.2	1.28 (1.24, 1.32)	1.18 (1.15, 1.22)
1 to <2	4628	28.2	1.00 (Reference)	1.00 (Reference)
≥2	7224	33.6	1.19 (1.16, 1.23)	1.13 (1.09, 1.16)
2 to <3	3100	30.5	1.00 (Reference)	1.00 (Reference)
≥3	4124	36.3	1.19 (1.14, 1.23)	1.16 (1.11, 1.20)
3 to <4	2312	34.6	1.00 (Reference)	1.00 (Reference)
≥4	1812	38.7	1.12 (1.07, 1.18)	1.10 (1.05, 1.16)

[a] Relative risks are adjusted for maternal age, height, BMI, smoking, induction of labour, 1st stage oxytocin and gestational age and birthweight

Supplement Table. Time from retracted cervix to vaginal birth, crude and adjusted risk ratios for postpartum haemorrhage >1000 ml

			Postpartum Haemorrhage Risk	
Characteristics			**Crude**	**Adjusted**
Time from retracted cervix to birth (hours)[a]	**n**	**%**	**RR 95% CI**	**aRR 95% CI**
<1	1252	6.5	1.00 Reference	1.00 Reference
1 to <2	1375	8.4	1.29 (1.20, 1.39)	1.18 (1.09, 1.27)
2 to <3	975	9.6	1.48 (1.37, 1.60)	1.27 (1.17, 1.38)
3 to <4	775	11.6	1.79 (1.64, 1.94)	1.48 (1.35, 1.62)
≥4	709	15.2	2.34 (2.14, 2.55)	1.86 (1.70, 2.03)
Pushing time (minutes)[b]				
0 to 14	517	7.4	1.01 (0.91, 1.11)	1.02 (0.92, 1.13)
15 to 29	1285	7.3	1.00 Reference	1.00 Reference
30 to 44	1223	8.9	1.21 (1.12, 1.30)	1.13 (1.05, 1.22)
45 to 59	797	9.9	1.36 (1.25, 1.47)	1.21 (1.11, 1.32)
≥60	827	11.1	1.52 (1.40, 1.65)	1.32 (1.21, 1.44)

[a]Adjusted for maternal age, height, BMI, smoking, induction of labour, 1st stage oxytocin, gestational age and birth weight.

[b]Adjusted for maternal age, height, BMI, smoking, induction of labour, oxytocin before pushing, time of retracted cervix until pushing, gestational age and birth weight.