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Maternal and neonatal complications during delivery according to passive versus active second stage in woman with medical conditions (ComPActSS)

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Abstract

Background: The incidence of serious complications during vaginal delivery with a passive second stage in women with medical conditions is unknown.

Methods: Our retrospective cohort study with matched groups (pairing 1 passive with 2 active second stage) included women who had a medical delivery plan from the high risk obstetric team at our center. The primary outcome was a composite of major maternal and neonatal complications.

Results: The primary outcome occurred in 50% (12/24) of women in the passive group versus 35.4% (17/48) ($p = 0.24$) in the active group. In the passive group, we observed a longer passive second stage of labor (28 vs. 8 min, $p < 0.001$), a tendency towards more assisted vaginal births (29.2% vs. 12.5%, $p = 0.08$), and more traumatic deliveries (16.7% vs. 0%, $p = 0.012$).

Conclusion: The higher proportion of complications in women who had a passive second stage should encourage physicians to make this recommendation only in selected cases.

Keywords

Passive second stage, maternal medical conditions, complications, delivery

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Introduction

Complex medical conditions are encountered in 1–4% of pregnancies.[1] Cardiac conditions occur in 1% of pregnant women.[2] In these high risk cases, safety during pregnancy needs to be carefully evaluated and delivery planned accordingly. Delivery, including the Valsalva maneuver during the active second stage of labor, may provoke drastic hemodynamic changes.[3–5] Most experts agree that caesarean deliveries do not decrease maternofetal complications and should be restricted to obstetrical indications.[6–9] Therefore, to prevent complications associated with Valsalva, some experts support the use of an assisted second stage to reduce its duration and decrease cardiac workload.[6,8] In specific situations, experts even recommend a mandatory passive second stage (no Valsalva). However, this approach can prolong the duration of the second stage[10] which can lead to higher rates of caesarean and operative deliveries,[11] post-partum hemorrhage and infections[12] and adverse neonatal outcomes, including umbilical artery acidemia, birth asphyxia-related complications and admission to neonatal intensive care unit (NICU).[13] It also frequently necessitates an assisted delivery[14] with vacuum extractor or forceps that carries significant risks, including perineal tear or neonatal intra or extra-cranial hemorrhage.[3] In our center, "mitigated pushing" is frequently recommended. It consists of small thrust with open glottis, which implies only a minimal effort and no real Valsalva. Although no literature supports this practice for hemodynamic reasons, it is a well studied practice to avoid perineal lesions during delivery.[15]

The objective of this study was to evaluate the consequences for women and their neonates of a mandatory passive compared to an active second stage of labor, in a population with high risk medical conditions. To our knowledge, there is no study evaluating the risks and benefits of current practice. We hypothesized that a mandatory passive second stage of labor leads to more maternal and neonatal complications.

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Methods

Study design

We conducted a retrospective cohort study with matched groups involving pregnant women with cardiac, neurologic, pulmonary, or gastrointestinal conditions who delivered at the Centre Hospitalier Universitaire de Sherbrooke (CHUS) from January 1st, 2008 to December 16th, 2019. The project was approved by "Centre intégré de santé et des services sociaux de l'Estrie-Centre Hospitalier Universitaire de Sherbrooke" research ethics committee with a delegated consent process (exempt from requiring individual patient consent) (Project # 2020-3470).

Population

We included women 18 years-old or higher with a cardiac, neurologic, pulmonary, or gastrointestinal condition. They were all evaluated by the multidisciplinary high risk obstetric team (including maternal-fetal medicine specialists and obstetric medicine physicians) during the study period and all had a detailed individualized written "medical delivery plan" prior to admission. Eligible women retained in the passive group had a documented medical recommendation of 1) a strict passive second stage during labor or 2) mitigated pushing only. Women in the active group had a medical recommendation allowing an active second stage of labor, without restriction. We excluded women who had an elective caesarean delivery, who had a multiple pregnancy, and those who delivered at another hospital.

Study conduct

First, we screened all the medical delivery plans available during the study period to determine which women would be eligible for either group. Every pregnancy was considered as unique and a woman could be included more than once. Then, we manually paired women of the passive group with those of the active group with a 1:2 ratio according to gestational age (categorized as less than 28 weeks, 28^{+0} to 34^{+6} weeks, 35^{+0} to 36^{+6} weeks or 37 weeks and more), parity (nulliparous or multiparous), and medical condition category (cardiac, neurologic, pulmonary, or gastrointestinal). When more than two women of the active group were eligible for pairing, a computerized program randomly selected them. Data prespecified for the study were abstracted manually from the women's and neonate's electronic medical records from the CHUS by the first author (EG).

Outcomes

For the primary outcome, we compared the two groups regarding a composite of maternal and neonatal major complications: urgent caesarean delivery, post-partum hemorrhage (defined as blood loss of more than 500 mL if vaginal delivery or more than 1000 mL if caesarean delivery), third or fourth degree perineal tear, women's admission to intensive care unit and severe neonatal complications (as defined under the composite outcome below).

The maternal secondary outcomes included individual components of the maternal primary outcome plus urgent caesarean (any cause, for fetal distress, or inability or failure of instrumentation), the duration of the second stage, instrumentation during delivery (vacuum extractor or forceps), episiotomy, exacerbation of maternal condition during the peripartum period not requiring intensive care, maternal mortality, and postpartum infections.

The fetal and neonatal secondary outcomes included neonatal major complications, a composite outcome including Apgar score ≤ 5 at ten minutes, intracranial hemorrhage, traumatic delivery (either subgaleal hematoma, skull fracture, brachial plexus trauma, wound on the face or the head (if reported on the discharge summary) or facial paralysis, stillbirth, neonatal deaths, early neonatal infection (positive hemoculture), respiratory distress requiring a period of observation or admission in NICU, and an ischemic-hypoxic insult, as per definition of the Canadian Paediatric Society.[16] The other fetal and neonatal secondary outcomes were the number of admissions to the neonatal unit and duration of hospitalization of the neonates.

Finally, we also assessed the adherence to the medical delivery plan regarding a mandatory passive second stage in the passive group by reviewing the medical and nurses' notes.

Statistical analysis

All the data were entered in Excel (by EG) using sequential identification for participants. Nominal data of participants were kept under key in a separate file.

Statistical analysis was conducted using SAS v9.4/v9.5 (SAS institute, Cary, NC, USA) plus SPSS v25/v26 (IBM Corporation, Armonk, NY, USA). Baseline characteristics, either of continuous or dichotomic nature, were analyzed by generalized estimation equations (GEE) model with a repeated statement, to take into account intra-trio correlation. If the incidence of a category was zero in one of the two groups, Fisher exact test was applied since GEE cannot converge in those cases. Dichotomic primary and secondary outcomes were analyzed with conditional logistic regression to take into account intra-trio correlation or with exact logistic regression when the incidence was zero in one of the two groups. Continuous secondary outcomes were analyzed with GEE with repeated statement to take into account intra-trio correlation. We also proceeded to subgroup analysis regarding incidence of the primary outcome according to either medical condition, parity or gestational age at time of delivery using conditional logistic regression in each subgroup. Primary and secondary outcomes were analysed in intention to treat. The primary outcome was also analysed per-protocol. We observed the incidence of the primary outcome in multivariate analysis adjusted for confounding factors (maternal age, rate of instrumentation, and birth weight) with conditional logistic regression and also regarding condition category only, without consideration with the belonging group, using Fisher exact test. We considered as statistically significative a p value < 0.05.

Results

Population characteristics

A total of 455 medical delivery plans were screened for inclusion and exclusion criteria, and 72 pregnant women were included in the study (24 in the passive group, 48 in the active group). We were able to perfectly pair 23 of the 24 women in the passive group. The last one was paired for parity and condition category, but not for gestational age (32^{+5} weeks). A list of the high risk medical conditions affecting women in each group is presented in Appendix 1.

Maternal and neonatal characteristics are presented in Table 1. The two study groups did not differ in terms of maternal age and birth weight. The majority had a cardiac (62.5%) or neurologic condition (25.0%) and most had a neuraxial anesthesia. Most pregnancies reached 37^{+0} weeks or more.

Primary outcome

Major maternal and/or neonatal complications occurred in a total of 29 women (40.3%) out of 72, of which five met two criteria of the

Table 1. Characteristics of women and neonates.

Characteristics of women	Passive group ($n=24$)	Active group ($n=48$)	*P* value
Age (years)	31 ± 4	29 ± 5	0.05
Gestational age (weeks)			
• 28^{+0}–34^{+6}	1 (4.2)	0 (0)	N/A*
• 35^{+0}–36^{+6}	1 (4.2)	4 (8.3)	
• 37^{+0} and more	22 (91.7)	44 (91.7)	
Parity			
• Nulliparous	13 (54.2)	26 (54.2)	N/A*
Condition category			
• Cardiac	15 (62.5)	30 (62.5)	N/A*
• Neurologic	6 (25.0)	12 (25.0)	
• Pulmonary	1 (4.2)	2 (4.2)	
• Gastrointestinal	2 (8.3)	4 (8.3)	
Induction of labor	15/23≠ (65.2)	30/48 (62.5)	0.79
• Amniotomy	6/15 (40.0)	20/30 (66.7)	0.08
Neuraxial anaesthesia	24 (100)	43 (89.6)	0.16¶
Characteristic of neonates	**Passive group ($n=24$)**	**Active group ($n=48$)**	***P* value**
Neonatal weight (g)	3077 ± 518	3209 ± 415	0.16

Data is presented as mean ± standard deviation or proportion, as appropriate.
* No tests were performed on these variables since used for pairing.
≠ One patient had a caesarean delivery before active labor had started.
¶ Calculated with Fisher exact test.

composite primary outcome, representing 12/24 women in the passive group (50.0%) and 17/48 women in the active group (35.4%) (OR = 1.89; 95% CI 0.66–5.39, p = 0.24). Multivariate analysis with conditional logistic regression to adjust for confounding factors (maternal age, rate of instrumentation, and birth weight) did not find any difference (aOR = 1.94; 95% CI 0.59–6.42, p = 0.28). There were some missing data about two neonates in the active group. For the first one, only the pH value of the umbilical cord blood was missing, but his APGAR was 9 at one minute so we assumed highly unlikely that the pH was below 7.00 (to confirm ischemic-hypoxic insult). About the second neonate, we had no information, but we assumed that his evolution was favorable since he was born in the hospital under midwife care and required no hospitalization. Analyses excluding these two cases were done and yielded similar results.

Overall (n = 72), in both groups, the primary outcome occurred in 42.2%, 38.9%, 33.3%, and 33.3% for women with cardiac, neurologic, pulmonary, and gastrointestinal conditions, respectively (p = 1.00).

Subgroup analysis showed no statistical differences on the frequency of the primary outcome by condition category, parity, or gestational age at birth (Table 2).

Secondary outcomes

For maternal outcomes, results are presented in Table 3. A total of 11 emergency caesarean deliveries were done, four among the passive group and seven among the active group. The majority were performed because of fetal distress, labor dystocia or malpresentation. The duration of the passive second stage was significantly longer in the passive group with a median of 28 min, IQR [6–122] minutes, compared to 8 min, IQR [5–27] minutes (Coeff = 39.26; 95% CI 17.73–60.80, $p < 0.001$). However, since the duration of the active second stage was significantly shorter in the passive group, the overall duration of the second stage was not different between the two groups.

Other maternal outcomes were not statistically different between the two groups although there was a trend towards more assisted vaginal delivery and episiotomy in the passive group. The most frequent indication for an assisted vaginal delivery was the prohibition of Valsalva in this group, compared to abnormal fetal heart rate in the active group. There were three third-degree perineal tears (10% in the passive group vs. 2.4% in the active group, $p = 0.26$). All but one post-partum hemorrhages were of early type, of which one needed blood transfusion. The two intensive care admissions were elective for observation only related to the maternal condition (pulmonary edema after first delivery, and frequent supraventricular arrythmia in this pregnancy with cardiomyopathy) and lasted less than two days. Among the five patients with exacerbation of their medical problem not requiring intensive care, only one had a significant event, with transient hypotension requiring 20 min of phenylephrine during labor and de novo left bundle branch block post-partum with suspicion of acute coronary syndrome that was eventually refuted. Finally, all maternal infections were chorioamnionitis ($n = 7$) except for one woman with endometritis plus urinary tract infection and one

woman with a wound infection. Both were in the active group. Post hoc analysis describing the effect of parity on maternal complications are shown in Table 4.

Neonatal outcomes are presented in Table 5. The composite of serious neonatal complications did not differ significantly between groups. Only traumatic delivery was significantly higher in the passive compared to the active group (16.7% ($n=4$) versus 0%, respectively ($p=0.012$)). It includes one brachial plexus trauma with shoulder dystocia in a non-macrosomic neonate (no instrumentation), two significant marks on the face (both after forceps), and one caput succedaneum of the neonate (no instrumentation).

There was no intracranial bleeding, stillbirth, neonatal death, or early neonatal infection. The only neonate who met the criteria for ischemic-hypoxic insult was a neonate with a pH value of 7.055 who required assisted ventilation at birth for at least ten minutes but did not encounter the other criteria of the definition.

Table 2. Subgroup analysis of the primary outcome.

	Proportion of primary outcome – *n* (%)		
Medical condition	Passive group ($n=24$)	Active group ($n=48$)	*P* value
Cardiac ($n=45$)	8 (33.3)	11 (22.9)	0.29
Neurologic ($n=18$)	3 (12.5)	4 (8.3)	0.49
Pulmonary ($n=3$)	0	1 (2.1)	1.0¶
Gastrointestinal ($n=6$)	1 (4.2)	1 (2.1)	1.0¶
Parity			
Nulliparous ($n=39$)	8 (33.3)	13 (27.1)	0.51
Multiparous ($n=33$)	4 (16.7)	4 (8.3)	0.30
Gestational age			
Full-term ($n=66$)	10 (41.7)	15 (31.3)	0.37
Pre-term ($n=6$)	2 (8.3)	2 (4.2)	1.0¶

¶ Calculated with Fisher exact test.

Adherence to recommendations

Adherence to recommendation of a mandatory passive second stage (including mitigated pushing) was well documented in 14 of the 20 women (70.0%) who delivered vaginally in the passive group. For the other six patients, three had documented Valsalva because: 1) the obstetrician allowed it, 2) the woman refused to comply and accepted the associated risks and 3) no clear reason documented. In three charts, there was no documentation about the type of pushing, so it was impossible to determine if the recommendations were followed. Six (42.9%) of the fourteen adherent women developed major maternal and/or neonatal complications, compared to 9/28 (32.1%) matched women in the active group (OR = 1.64; 95% CI 0.41–6.50, $p=0.48$).

Table 3. Maternal complications.

Maternal outcomes	Passive group	Active group	OR or Coeff [95% CI]	*P* value
Emergency caesarean delivery (any cause)	4/24 (16.7)	7/48 (14.6)	1.21 [0.28–5.20]	0.80
• For fetal distress before the beginning of the 2nd stage	1/24 (4.2)	5/48 (10.4)	0.40 [0.05–3.42]	0.40
• For fetal distress during the 2nd stage	0/24 (0)	0/48 (0)	–	–
• For inability/failure of instrumentation	1/24 (4.2)	0/48 (0)	–	0.33©
Duration of 2nd stage (minutes)	($n=20$)*	($n=42$)*		
• Total	38 [21–137]	32 [13–98]	15.22 [−4.85–35.28]	0.14
• Passive 2nd stage	28 [6–122]	8 [5–27]	39.26 [17.73–60.80]	< 0.001
• Active 2nd stage¶	12 [3–22]	18 [6–52]	−21.71 [−37.21 to −6.21]	0.006
Instrumentation	7/24 (29.2)	6/48 (12.5)	4.312 [0.85–21.90]	0.08
Episiotomy	9/20T (45.0)	9/41T (22.0)	4.562 [0.91–22.92]	0.07
Perineal tear (3rd or 4th degree)	2/20T (10.0)	1/41T (2.4)	4.000 [0.36–44.11]	0.26
Post-partum hemorrhage	2/24 (8.3)	5/48 (10.4)	0.800 [0.16–4.12]	0.79
Intensive care admission	1/24 (4.2)	1/48 (2.1)	2.000 [0.13–31.98]	0.62
Complication of maternal condition not requiring intensive care admission	2/24 (8.3)	3/48 (6.3)	1.443 [0.19–11.12]	0.73
Maternal infection	3/24 (12.5)	6/48 (12.5)	1.000 [0.23–4.35]	1.00

Data is presented as median [IQR] or proportion, as appropriate.
© Calculated with Fisher exact test.
¶Including full and mitigated Valsalva efforts.
*Number of women who entered the second stage of labor.
TVaginal delivery only.

Table 4. Effect of parity on maternal complications.

Outcomes	Parity	Passive group	Active group	Coeff [95% CI] or OR	*P* value
Duration of 2nd stage (minutes) – total	Nulliparous	125 [52–169]	93 [46–147]	17.65 [−10.80–46.10]	0.22
	Multiparous	23 [15–36]	13 [8–21]	19.34 [−8.19–46.87]	0.17
Duration of passive 2nd stage (minutes)	Nulliparous	105 [34–153]	23 [7–83]	68.49 [41.40–95.58]	<0.001
	Multiparous	7 [2–18]	5 [1–9]	15.96 [−9.77–41.70]	0.22
Duration of active 2nd stage (minutes)	Nulliparous	13 [0–25]	48 [19–81]	−45.57 [−66.19 to −24.95]	<0.001
	Multiparous	12 [6–16]	6 [3–16]	2.37 [−5.79–10.53]	0.57
Instrumentation	Nulliparous	6/13 (46.2)	6/26 (23.1)	3.39 [0.64–17.94]	0.15
	Multiparous	1/11 (9.1)	0/22 (0)	–	0.33*
Episiotomy	Nulliparous	6/10 (60.0)	7/21 (33.3)	4.48 [0.47–42.70]	0.19
	Multiparous	3/10 (30.0)	2/20 (10.0)	4.65 [0.46–46.88]	0.19
Perineal tear (3rd or 4th degree)	Nulliparous	1/10 (10.0)	1/21 (4.8)	2.00 [0.13–31.98]	0.62
	Multiparous	1/10 (10.0)	0/20 (0)	–	0.33*

Data for vaginal delivery only, except for instrumentation.
Data is presented as median [IQR] or proportion, as appropriate.
* Calculated with Fisher exact test.

Table 5. Neonatal complications.

Neonatal outcomes	Passive group *n* (%)	Active group *n* (%)	OR or Coeff [95% CI]	*P* value
Serious neonatal complications (composite)	6/24 (25.0)	5/46 (10.9)	2.90 [0.70–12.06]	0.14
Apgar ≤ 5 at 10 min	1/24 (4.2)	1/48 (2.1)	2.000 [0.13–31.98]	0.62
Intracranial hemorrhage	0/24 (0)	0/47 (0)	–	–
Traumatic delivery	4/24 (16.7)	0/47 (0)	–	0.012¶
Stillbirth	0/24 (0)	0/48 (0)	–	–
Neonatal death	0/24 (0)	0/47 (0)	–	–
Early neonatal infection	0/24 (0)	0/47 (0)	–	–
Respiratory distress requiring NICU observation or admission	2/24 (8.3)	5/47 (10.6)	0.74 [0.11–4.90]	0.75
Ischemic-hypoxic insult	1/24 (4.2)	0/46 (0)	–	0.33¶
Admission to NICU ($\geq$ 6 h)	2/24 (8.3)	2/47 (4.3)	2.00 [0.28–14.20]	0.49
Duration of hospitalization – median [IQR]	3.0 [2.0–4.0]	2.0 [2.0–3.0]	1.01 [−0.01–2.03]	0.052

¶Calculated by exact logistic regression model.

Discussion

In this single-center retrospective cohort study with matched groups, we looked at maternal and neonatal complications during labor and the first postpartum days, comparing women with prohibited Valsalva maneuver due to a high risk medical condition with women with similar condition but no restriction at the time of delivery. Our results showed 40.3% of complications overall, 50.0% (12/24) in the passive group and 35.4% (17/48) in the active group. In five cases, the primary outcome was identified due to both a maternal and a neonatal criterion. There were 23 maternal complications including emergent caesarean deliveries ($n = 11$), third-degree perineal tear ($n = 3$), post-partum hemorrhage ($n = 7$) and maternal admission to the intensive care unit ($n = 2$). However, only one caesarean was directly due to the prohibition of Valsalva. On the neonatal side (11 neonatal complications), the most frequent complication was observation or admission in NICU for respiratory distress ($n = 7$) of which only one neonate was premature at 32^{+5} weeks, followed by traumatic delivery ($n = 4$). Two neonates had more than one criterion for severe neonatal complications.

Although the majority of those complications are clinically significant, there were no maternal or fetal/neonatal death, no intracranial bleeding and only one ischemic/hypoxic insult which could be considered as major complications affecting the lifetime of mother and infant. Furthermore, a few complications were more benign than expected: among others, elective admissions in intensive care unit for surveillance and traumatic delivery mainly for face or head markings. Some were also not related to the mandatory passive second stage, including caesarean for fetal distress in first stage of labor.

The overall duration of the second stage was similar between the two groups. However, the passive second stage was significantly longer in the passive group compared to the active group, supporting that recommendations for Valsalva restriction were applied in the majority of the women in the passive group. This difference was driven by nulliparous women for whom the durations of both passive and active second stage were statistically longer. There was a trend towards more instrumentation and episiotomy in the passive group, and these numbers were driven by nulliparous women in both groups. Surprisingly, only 29% of women in the passive group required instrumentation, which is relatively low considering that this population did not have permission for full pushing efforts. In comparison, Cauldwell et al. reported an instrumentation rate of 61.6% ($n =$ 45/73) in women with cardiac condition.[14] In their study, only 5 instrumentations were indicated for fetal well-being, while 40 were attributed to a restricted second stage. In our study, mitigated pushing could have helped to avoid some instrumentation, since we observed three (two were nulliparous) assisted vaginal birth among the ten women who did mitigated pushing efforts, compared to three assisted vaginal birth among four nulliparous women with a strict passive second stage. Among the last seven women with mitigated pushing but without a need for instrumentation, six were multiparous. Concerning third degree perineal tears, although there was a trend against the women in the passive group, only 10% of them versus 2.4% of the active group had this

complication. None of these patients had instrumentation required for delivery. No fourth-degree perineal tear was reported. According to these results, counseling about a passive second stage of labor should be adapted according to parity, since multiparous women seem to have a better outcome.

Concerning the adherence to recommendations, we were unable to determine the kind of pushing effort made by three out of 20 women (15.0%) with a clearly prohibited Valsalva. Therefore, efforts to sensitize medical and nursing teams to clearly document this element in the chart should be reinforced.

Our study has some limitations. First, its design is retrospective and single-center, reducing its external validity, which is also affected by our local practice of mitigated pushing efforts that may not be seen elsewhere. Also, we were not able to match women for the severity of their condition (WHO classification for cardiac condition) due to lack of sufficient controls. Furthermore, no such classification exists for neurologic, pulmonary, and gastrointestinal diseases. This may have introduced a selection bias and the higher complications observed may be secondary to the severity of the disease rather than to the mode of delivery. Finally, the sample size is small (n = 72) and numerous analyses were made, reducing the power of the results.

This study presents several strengths. The question is relevant and has not been extensively studied. Thus, common practice is not evidence-based. In this retrospective cohort study with a pairing ratio of 1:2, we were able to match the patients according to three important characteristics, gestational age, parity, and medical condition. In the protocol, we clearly defined a priori the outcomes and their criteria, and applied them rigorously so there was no change or adjustment of definitions during the study conduct. Finally, the two study groups were very similar and there was very little missing data.

Conclusion

This single-center retrospective cohort study with matched groups presents the complication rate in women with cardiac, neurologic, pulmonary, or gastrointestinal conditions, showing a trend towards more complications in the group with passive second stage. These results need to be interpreted with caution as the study was not powered for rare but severe complications. However, they should prompt clinicians to make the recommendation for passive second stage only after a careful individualized analysis of risks and benefits by an interdisciplinary evaluation, with the participation of the woman and her partner. Further research, ideally prospective in a large cohort, is needed to confirm those preliminary results.

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Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical approval

The project was approved by the "Centre intégré de santé et des services sociaux de l'Estrie-Centre Hospitalier Universitaire de Sherbrooke" research ethics committee with a delegated consent process (exempt from requiring individual patient consent) (Project # 2020-3470).

Authorship

All authors contributed significantly to the present work. All authors have approved the manuscript and agree with its submission to Obstetric Medicine.

Guarantor

The lead author (Dr Nadine Sauvé, manuscript guarantor) affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

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Appendix 1. List of high risk medical conditions.

Passive group – ($n = 24$)	Active group – ($n = 48$)
	Cardiac
Aortic disease:	Arrhythmias:
- Ascending aortic dilatation (1) / replacement (2)	- Long-Ganong-Levine syndrome
- Marfan	- Multiple premature ventricular contractions
- Repaired coarctation (5)	- Right ventricular outflow tract tachycardia
- Turner	- Supraventricular tachycardia (7)
	- Wolff Parkinson White (4)
Cardiomyopathies:	Cardiomyopathies:
- Dilated	- Dilated (4)
- Hypertrophic	- Hypertrophic (2)
	- Tachycardiomyopathy
Repaired congenital malformation:	Congenital malformation:
- Atrioventricular canal defect plus mitral and tricuspid valvuloplasty	- Non-repaired atrial septal defect (ASD) with shunt
- Great vessel transposition	- Repaired aortic coarctation, ASD and ventricular septal defect
- Tetralogy of Fallot	Hypermobile Ehlers Danlos
	Valvular disease:
	- Aortic bicuspid valve (3)
	- Post-endocarditis mitral valvuloplasty
	- Pulmonary stenosis (1) / regurgitation (1)
	Neurologic
Hemorrhagic (2) and ischemic (3) cerebrovascular accidents	Dural arterio-veinous fistula
Syringomyelia with secondary paraplegia	Epilepsy (5)
	Intra-cerebral hemorrhage
	Multiple sclerosis
	Myasthenia gravis
	Pseudotumor cerebri (2)
	Transient ischemic attack
	Pulmonary
Recurrent pneumothorax	Cystic fibrosis
	Sleep apnea-hypopnea syndrome
	Gastrointestinal
Portal hypertension (2)	Crohn's disease (3)
	Autoimmune hepatitis/Sclerosing cholangitis