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Does giving birth in a "birth environment room" versus a standard birth room lower augmentation of labor? – Results from a randomized controlled trial

Iben Prentow Lorentzen[a,*], Charlotte S. Andersen[a], Henriette Svenstrup Jensen[a], Ann Fogsgaard[a], Maralyn Foureur[b], Finn Friis Lauszus[a], Ellen Aagaard Nohr[c,d]

[a] Department of Gynecology and Obstetrics, Gl. Landevej 61, 7400, Herning, Denmark
[b] Nursing and Midwifery Research Centre, Hunter New England Health and University of Newcastle, NSW, 2300, Australia
[c] Research Unit for Obstetrics and Gynecology, Institute of Clinical Research, University of Southern Denmark, Campusvej 55, 5230, Odense C, Denmark
[d] Centre of Women's, Family and Child Health, University of South-Eastern Norway, Kongsberg, Norway

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ABSTRACT

Objective: In the last decade, there has been an increased interest in exploring the impact of the physical birth environment on midwifery practice and women's birth experiences. This study is based on the hypothesis that the environment for birth needs greater attention to improve some of the existing challenges in modern obstetric practice, for example the increasing use of augmentation and number of interventions during delivery.

Study design: A randomized controlled trial was carried out to study the effect of giving birth in a specially designed "birth environment room" on the use of augmentation during labor. The study took place at the Department of Obstetrics and Gynecology, Herning Hospital, Denmark and included 680 nulliparous women in spontaneous labor at term with a fetus in cephalic presentation. Women were randomly allocated to either the "birth environment room" or a standard birth room. The primary outcome was augmentation of labor by use of oxytocin. Secondary outcomes were duration of labor, use of pharmacological pain relief, and mode of birth. Differences were estimated as relative risks (RR) and presented with 95% confidence intervals.

Results: No difference was found on the primary outcome, augmentation of labor (29.1% in the "birth environment room" versus 30.6% in the standard room, RR 0.97; 0.89–1.08). More women in the "birth environment room" used the bathtub (60.6% versus 52.4%, RR 1.18; 1.02–1.37), whereas a tendency to lower use of epidural analgesia (22.6% versus 28.2%) did not reach statistical significance (RR 0.87; 0.74–1.02). The chance of an uncomplicated birth was almost similar in the two groups (70.6% in the "birth environment room" versus 72.6% in the standard room, RR 0.97; 0.88–1.07) as were duration of labor (mean 7.9 hours in both groups).

Conclusions: Birthing in a specially designed physical birth environment did not lower use of oxytocin for augmentation of labor. Neither did it have any effect on duration of labor, use of pharmacological pain relief, and chance of birthing without complications. We recommend that future trials are conducted in birth units with greater improvement potentials.

1. Introduction

One of the main challenges in modern obstetrics is the high rate of intervention during birth [1–4]. For uncomplicated, nulliparous women with a spontaneous onset of labor, synthetic oxytocin for augmentation has become a normal part of obstetric practice in many settings [5]. The rate of augmentation in nulliparous women has reached 35-50% in Scandinavia and other industrialized countries [6–9]. The use of synthetic oxytocin may have severe side effects, including hyper-stimulation, which may cause fetal distress and operative delivery [10–12].

Many initiatives were implemented during the last 30 years to optimize safety in childbirth, and the ability to act quickly in acute situations was the main focus of improvements in maternity care

* Corresponding author.
E-mail addresses: ibelor@rm.dk (I.P. Lorentzen), charae@rm.dk (C.S. Andersen), henje@viborg.dk (H.S. Jensen), anfogs@rm.dk (A. Fogsgaard), Maralyn.Foureur@health.nsw.gov.au (M. Foureur), Finn.Lauszus@rsyd.dk (F.F. Lauszus), eanohr@health.sdu.dk (E.A. Nohr).

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[13–15]. Although knowledge from evidence-based health care design has grown rapidly in the last decade, arguing that we need to re-think hospital design to improve patient outcomes [16–18], the birth room has not received much attention, and only little research was performed on the effect of the design of the birth room. Results from two randomized controlled trials indicate that the physical birth environment may affect the duration of labor, pain intensity, and use of augmentation. However, sample sizes were small, and therefore adequately powered trials are needed [19,20]. The aim of this study was to examine whether a birth room using an immersive, carefully designed décor to minimize stress had an effect on the use of oxytocin for augmentation of labor and selected birth outcomes.

2. Material and methods

This open randomized controlled study (NCT02478385) was conducted between May 2015 and March 2018 in accordance to the local Scientific Ethical Committee (ref. no. 247/2014) and the Declaration of Helsinki. The study compared birth outcomes between a specially designed "birth environment room" and a standard birth room. A detailed description of the design and methods was published previously: https://doi.org/10.1016/j.conctc.2019.100336 [21].

2.1. Setting and recruitment

The study took place at the Department of Obstetrics and Gynecology at Herning

Hospital, Denmark; a tertiary unit with 2500 births per year. Nulliparous women with a singleton fetus were introduced to the study at the antenatal visit with the midwife at 28 weeks of gestation, if they were more than 18 years old and able to speak and understand Danish. The midwife provided oral information about the study and a written pamphlet with a detailed description and a consent form. Upon arrival at the labor ward, the woman was invited to participate if she was in spontaneous labor, at term, the fetus was a cephalic presentation, and both the birth environment room and a standard room were available. Fig. 1 shows a study flowchart with a detailed description of the data from enrollment to analysis.

2.2. Randomization

Upon arrival at the labor ward, eligible and consenting women were randomly assigned to either the birth environment room (n = 340) or a standard birth room (n = 340), using sequentially numbered opaque envelopes and block-randomization with blocks of 40. The midwives were not aware of the randomization sequence, and after the last woman was enrolled, it was ensured that randomization procedure was followed correctly.

2.3. Intervention and control

The intervention was birthing in the "the birth environment room" and the comparison was birthing in a standard birth room.

The "birth environment room" was furnished with home-like lamps, table, chairs and a sofa (Figs. 2 and 3). The room was divided into three different zones – a wellness zone with the bathtub in the middle and a small table for drinks, an active zone with a double-sized, height adjustable sofa, and a birth zone with the labor bed and a bed height stool for the partner. The resuscitation table for the newborn was placed next to the labor bed. Resuscitation equipment for the mother was available in a cupboard behind the labor bed but not visible. On three of the walls in the room, it was possible to project four different moving nature scenarios: 'forest

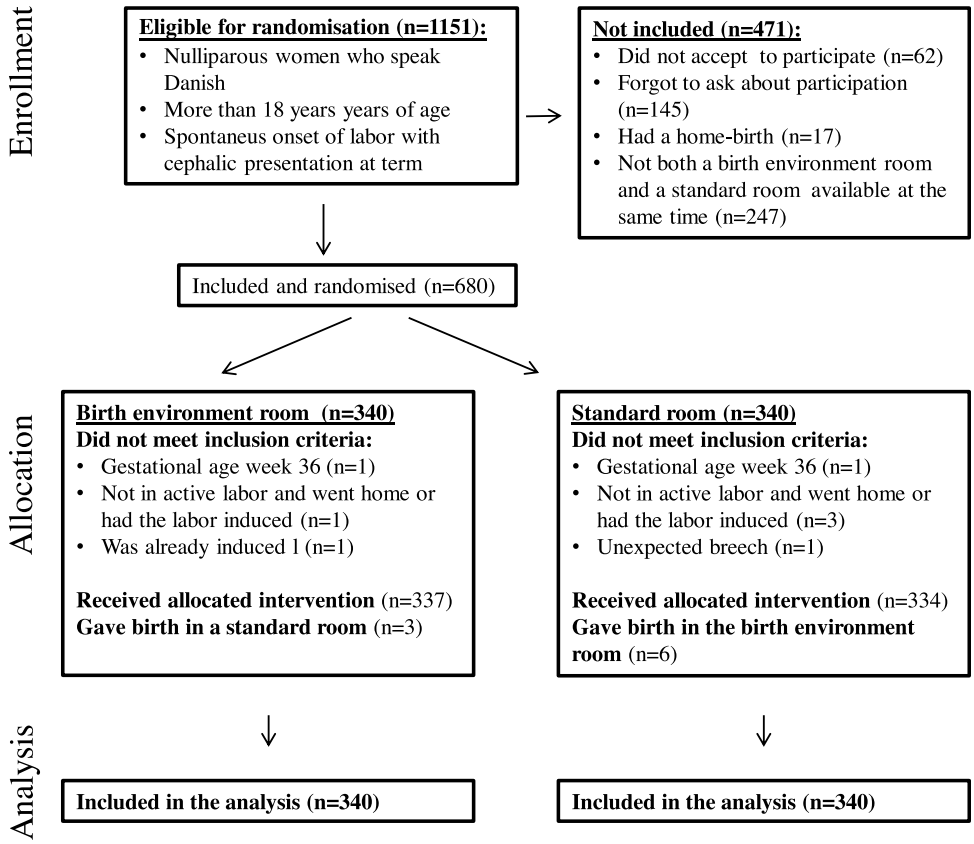

Fig. 1. Flowchart of eligible women from enrollment to analysis.

Fig. 2. Birth environment room with projection of the forest.

Fig. 3. Birth environment room without projection on the walls.

winter landscape', 'beach with waves', 'forest springtime', and 'forest autumn'. The parents were able to choose either sounds from nature, or relaxing music, together with the projected scenarios. They could also choose individual light settings in the different zones of the room.

All standard birth rooms in this setting had the same interior set up as the birth environment room, including a bathtub and an ensuite bathroom with toilet and shower (Fig. 4). The labor bed was placed in a central position in the room with a lounge chair for the partner beside the bed. A neonatal resuscitation table was

Fig. 4. Standard birth room with bathtub.

Fig. 5. Standard birth room with bed and neonatal resuscitation table.

placed at the other side of the bed, and behind the bed the equipment for resuscitation of the mother hung on the wall (Fig. 5). It was possible for the parents to listen to music using the compact disk player in the room.

2.4. Outcome measures

The main outcome measure was the use of oxytocin for augmentation of labor. Secondary outcomes were length of labor from arrival to the labor ward to birth, use of pain relief during labor, and the proportion of uncomplicated vaginal births.

A number of other birth and neonatal outcomes were also measured to evaluate any possible benefits or side effects of the intervention. These outcomes included mode of birth, indications for vacuum extraction and cesarean section, blood loss, Apgar score < 7 at 5 minutes, moderate and severe acidosis, admittance to neonatal intensive care unit, caseload midwife present at birth, and number of consecutive midwives during birth.

2.5. Statistical analysis

The sample size calculation was based on an estimated 10% difference in the use of augmentation during labor between the groups (35% and 25%). A total of 328 women in each group were needed to detect this difference with 80% power and a 2-sided alpha of 5%. With dropout in mind, this number was increased to 340 women in each group.

Data were analyzed in accordance with the "intention to treat principle". Baseline characteristics were compared using chi-square test for categorical variables and T-test for continuous variables. Risk ratios with 95% confidence intervals were used to compare primary and secondary outcomes. Other birth characteristics and outcomes were compared using chi-square test for dichotomized variables and T-test for continuous variables. The significance level was set to $P < 0.05$. The statistical analysis was performed with IBM SPSS Statistics 20.

3. Theory/calculation

As described in the introduction, we argue that attention needs to be paid to the design of the birth room. The birth process is dependent on the release of the neuro-hormone oxytocin to induce contractions. In labor, endogenous oxytocin also increases the pain threshold and has an anxiolytic effect. Oxytocin is released when we feel calm, safe and relaxed [22]. Therefore, if the space for birth is perceived as calming and not stressful, birth outcomes may be improved by optimizing the release of this neuro-hormone during labor [23].

4. Results

4.1. Description of the study population

During the inclusion period, 1151 women met the inclusion criteria, but 471 women were excluded for different reasons (Fig. 1). This left 680 women who agreed to participate and were randomly allocated to the birth environment room (n = 340) or a standard birth room (n = 340). Of these, nine women gave birth in another room than they were allocated to. In addition, eight women did not meet the inclusion criteria. All 680 women were included in the analysis and analyzed in the group they were randomized to in accordance with the intention to treat principle. According to Table 1, there were no differences for any of the measured baseline characteristics. On average, women were 27-28 years old at the time of birth with a BMI of 24 kg/m^2 and were living with a partner. More than 82% had higher education (two years or more).

4.2. Main analysis

We observed no difference between the two groups on the primary outcome – use of oxytocin for augmentation in labor – with 29.1% of women in the intervention group and 30.6 % in the control group receiving it (RR 0.97 (0.82–1.14) (Table 2). The use of epidural analgesia was somewhat lower in the birth environment room than in the standard room (22.6% versus 28.2%) but this difference did not reach statistical significance (RR 0.87 (0.74–1.02). Bath tub for pain relief was more often used in the birth environment room (60.6% versus 52.4%, RR 1.18 (1.02–1.37) whereas other types of analgesia during birth were the same in the two groups. The number of uncomplicated births was almost similar in the two groups (70.6% versus 72.6%, RR 0.97 (0.88–1.07). Length of labor from randomization to birth was 7.9 hours in both groups.

4.3. Additional analysis

Table 3 presents other outcomes of labor in the two groups. For most of these, we observed no differences. The only exception was admission to the neonatal intensive care unit which was more frequent in infants born in the birth environment room (8.2% versus 4.1%, p = 0.04) and the number of infants who had moderate acidosis (7% in the birth environment room versus 3% in the standard birth room, p = 0.01). There was only one infant in each group with severe acidosis. None of the infants with moderate or severe acidosis had long-term sequelae except one infant born in a standard birth room. Long term sequelae were determined by an audit of the medical record 6 months after birth. If the infant was no longer followed by the pediatric ward 6 months after birth, it was concluded that no long-term sequelae were expected.

5. Discussion

5.1. Main findings

We carried out a large randomized trial including 680 nulliparous women. Contrary to our hypothesis, we did not find that giving birth in a specially designed birth environment room lowered the use of augmentation during labor. Neither did we observe any effect on the use of pharmacological pain relief, duration of birth, and chance of birthing without complications.

In 2009, a Canadian pilot study including 62 nulliparous women found that fewer women needed oxytocin during labor in a so-called 'ambient birth room' (40% versus 68%, p = 0.03) [19]. Furthermore, one observational study, based on 789 nulliparous women birthing in another Danish hospital, examined the use of oxytocin in women giving birth in a sensory birth room compared to a standard birth room and observed a lower, but not statistically different, use of oxytocin (30% versus 35%, odds ratio 0.83; 95% CI 0.61–1.13) [24]. These findings may not be comparable to our study because of the observational design and the fact that women were assigned to the sensory room based on preference.

Use of oxytocin stimulation in our standard room was similar to that seen in the sensory room in the Danish study. This might reflect that in the last 5–7 years, Danish maternity services have had a more expectant approach towards labor and a greater focus on the adverse side effects of oxytocin infusion during birth [25]. Thus, for women in Robson Group 1 (nulliparous women with a

Table 1
Baseline characteristics.

	Birth environment room N = 340	Standard room N = 340	P-value
Social status			
Living with partner	326 (95.9)	322 (94.7)	0.35[a]
Living alone	12 (3.5)	18 (5.3)	
Unknown	2 (0.6)	0(0)	NS
Highest level of education[b]			
< High school	26 (7.6)	21 (6.2)	0.95 [a]
High School	33 (9.7)	30 (8.8)	
Higher education, 2 years or more	274 (80.6)	239 (70.3)	
Missing	7 (2.1)	50 (14.7)	NS
Smoking			
Smokers	53 (15.6)	45 (13.2)	0.44 [a]
Medical conditions			
No medical conditions	297 (87.4)	307 (90.3)	0.27 [a]
Gestational diabetes mellitus or type 2 diabetes	11 (2.9)	8 (2.4)	0.64 [a]
Pregnancy induced hypertension or preeclampsia	5 (1.5)	3 (0.9)	0.72 [a]
Other diseases (e.g. Ulcerative colitis colitis, Crohn disease)	27 (7.9)	22 (6.5)	0.55 [a]
Age, body mass index[d] **and cervix dilation**	**Mean (SD)**	**Mean (SD)**	
Age	27.9 (3.76)	27.5 (3.87)	0.68[c]
Prepregnant body mass index	24.1 (4.23)	24.4 (4.85)	0.58[c]
Cervical dilatation at arrival at the Birth Unit (cm)	4.7	4.7	1.0

Values are given as N (%) or mean (SD).
[a] Chi2 test (unknown are omitted from the analysis).
[b] Self-reported data from the questionnaire sent to the woman 4 months after birth.
[c] Students T.
[d] Weight in kilograms divided by the square of the height in meters.

Table 2
Primary and secondary birth outcomes according to type of birth room.

	Birth environment room N = 340	Standard room N = 340	Risk-ratio (95% CI)	P-value
Oxytocin for augmentation	99 (29.1)	104 (30.6)	0.97 (0.89-1.08)[a]	0.74[a]
Epidural analgesia	77 (22.6)	96 (28.2)	0.93 (0.85-1.01)[a]	0.11[a]
Bathtub for pain relief,	206 (60.6)	178 (52.4)	1.21 (1.02-1.44)[a]	0.04[a]
Acupuncture, transcutaneous electric nerve stimulation, inhalation analgesia, or morphine	124 (36.5)	130 (38.2)	0.97 (0.86-1.09)[a]	0.69[a]
Uncomplicated births[b]	240 (70.6)	247 (72.6)	0.97 (0.88-1.06)[a]	0.61[a]
	Mean (SD)			
Length of labour from randomisation to birth (hours)	7.9 (5.70)	7.9 (5.41)		0.96[c]

Values are given as % (N) or mean (SD).
With Apgar >9 after 5 minutes.
[a] Chi2 test.
[b] Spontaneous vaginal birth, no episiotomy or 3rd or 4th degree lacerations, Blood loss <1000 ml, and infant with Apgar >9 after 5 minutes.
[c] Students T-test.

Table 3
Other birth characteristics according to type of birth room.

	Birth environment room N = 340	Standard room N = 340	P-value[a]
Mode of birth			
Spontaneous	283 (83.2)	297 (87.4)	0.29
Vacuum extraction	36 (10.6)	29 (8.5)	
Cesarean section	21 (6.2)	14 (4.1)	
Indications for vacuum extraction	***N = 36***	***N = 29***	
Fetal Scalp pH < 7.20	*18 (50.0)*	*14 (48.3)*	
Non-reassuring fetal heart rate	*8 (22.2)*	*6 (20.7)*	
Exhausted mother or long second stage	*10 (27.8)*	*8 (27.6)*	
Severe preeclampsia	*0 (0)*	*1 (3.4)*	
Indications for caesarean section	***N = 21***	***N = 14***	
Scalp pH <7.20	*3 (14.3)*	*2 (14.3)*	
Non-reassuring fetal heart rate	*6 (28.6)*	*1 (7.1)*	
Dystocia	*3 (14.3)*	*7 (50.0)*	
Maternal exhaustion	*1 (4.8)*	*0 (0)*	
Maternal request	*1 (4.1)*	*0 (0)*	
Vacuum extraction failure	*6 (28.6)*	*2 (14.3)*	
Undiagnosed breech	*0 (0)*	*2 (14.3)*	
Abruptio placenta	*1 (4.1)*	*0 (0)*	
Caseload midwife present at birth or more than 75% of the labour	156 (45.9)	146 (42.9)	0.49
Number of consecutive midwives during birth (one to one care)			
1 midwife	172 (50.6)	165 (48.5)	0.87
2 midwives	131 (38.5)	136 (40.0)	
3 or more midwives	37 (10.9)	39 (11.5)	
Blood loss			
0-499 ml	270 (79.4)	278 (81.8)	0.50
500-999 ml	52 (15.3)	37 (10.9)	0.11
1000-1499 ml	11 (3.2)	13 (3.8)	0.84
1500 ml or above	7 (2.1)	12 (3.5)	0.35
Gestational age in days (mean)	281	280	0.57
Birth weight in gram (mean)	3482	3499	0.54
Neonatal outcome			
Apgar score<7 at 5 minutes	2 (0.6)	1 (0.3)	NS
Severe acidosis (cord artery pH < 7.0)	1 (0.3)	1 (0.3)	NS
Moderate acidosis (cord artery pH < 7.11 and ≥7.0)	24 (7.1)	9 (2.6)	0.01
Admitted to neonatal intensive care unit within the first 24 hours after birth	28 (8.2)	14 (4.1)	0.04

Values are given as N (%) or mean.
[a] Chi2-test for categorical variables and students T-test for continuous variables.

single cephalic pregnancy more than 37 weeks of gestation in spontaneous labor), a reduction was seen in oxytocin for augmentation from 38% in 2012 to 32% in 2018 in Denmark [26]. This means that the use in our trial was lower than the average use for all hospitals in Denmark [26].

In the birth environment room, we observed slightly fewer women with epidurals and more women used the bathtub for pain relief. Length of labor was the same in the two groups. The cozy atmosphere around the bathtub with the special light setting and the wooden furniture may have influenced the woman's choice of bathtub for pain-relief and reduced the need for an epidural.

We observed slightly more uncomplicated births in the standard room, but it is important to note that the frequency of uncomplicated births was more than 70% in both groups which was substantially higher than the Danish national rate of 63.9% between 2016 and 2018 [27]. Also, the cesarean section rate in both groups were considerably lower than the average rate in Robson Group 1 in Denmark within the same period (9.3% for the years 2015–2018) [26].

Continuity of midwifery care, which is known to lower intervention rates [28], was high in the trial, as approximately 45% of the women birthing in the trial were attended by an already

known caseload midwife, and approximately 50% received care from only one midwife throughout their labor. In conclusion, the potential for further improvement in outcomes might be limited in this setting.

5.2. Strengths and limitations

The randomized design was a strength to evaluate treatment effects of the birth environment. Most midwives cared for participants allocated to both rooms during the study period, so the midwifery care was supposedly equal in both settings. We could not blind the intervention and cannot preclude that the midwife may have compensated in some way when the woman was allocated to the standard birth room. This might have influenced her care and treatment during labor.

Before the trial was initiated, the birth environment room was used for all births in a 4-months period so the midwives could become familiar with the birth environment room. After the trial started, the birth environment room was reserved for participants only, and we found that an individual midwife on average cared for four birthing women in the birth environment room during the 3-year study period. Therefore, some midwives may still have been unfamiliar with the birth environment room. This may have affected their actions in acute situations, which again may explain why we observed more neonates with moderate acidosis in the birth environment room. This finding could also be a chance finding, but, obviously, a reason of concern. We regard it as important that midwives understand the premise for the design of this birth environment room, so their actions and initiatives during birth will be appropriately oriented towards supportive, low interventionist practice. At the same time, they need to feel confident in the new environment to ensure patient-safety.

6. Conclusions

We did not observe any difference in the use of augmentation when birthing in a specially designed birth environment room compared to a standard room. Neither did we find any notable differences in secondary outcomes. These findings should, however, be seen in a context where the intervention rates were very low, both within the trial and in the birth unit during the study period, too. The lack of difference might also reflect that even standard rooms in this setting are relatively new, bright and spacious with aesthetically neutral décor. Similar studies need to be conducted in birth units with greater improvement potentials as the rate of augmentation of labor in our unit was already lower than the national rate in Denmark. In future trials, we recommend a longer introduction period for midwives in practicing in a new physical birth environment to ensure their confidence and to make best use of the opportunities provided.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.eurox.2021.100125.

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Iben Lorentzen is a midwife and Vice-director at the Maternity Ward in Herning. She graduated as midwife in 2001, and had a Master in Health Science in 2014. Iben Lorentzen has completed more than one quantitative randomized controlled trial in different obstetric fields, including birth environment. She has published in peer-reviewed journals and presented at national as well as international conferences.

Charlotte Sander Andersen is a supervising midwife at the Maternity Ward in Herning. She graduated as midwife in 2002, and had in 2016 a Quality Improvement advisor education. Beside her interest in birth environment, she has a major interest in avoiding obstetric anal sphincter injuries and has completed research projects in both fields. She has published articles in peer-reviewed journals. She has presented at national as well as international conferences.

Henriette Svenstrup Jensen is a midwife and had a master degree in Anthropology in 2007. Henriette S Jensen is an innovative expert and participated in the development of digital solutions such as apps and games for new parents as well as interactive hospital rooms, where patients design the room themselves. She is one of the creative partners behind the design of the birth environment room at Herning Maternity Ward – and has presented birth environment research at international conferences. Henriette has initiated a variety of both qualitative and quantitative research projects in the birth environment field.

Ann Fogsgaard is a midwife and Head of Department of Gynecology and Obstetrics in Herning Hospital, Denmark. Ann Fogsgaard graduated as midwife in 1983 and has a long career in management at different obstetric wards in Denmark. Ann Fogsgaard is well known for her extraordinary, inspiring and innovative efforts for new families, and had in 2019 price of the year from the Organization "Parents and Infant"(forældre og fødsel). She is primarily responsible for the creation of the new birth environment room at Herning Hospital, and also the initiation of a wide range of research about birth environment.

Professor Maralyn Foureur is an internationally esteemed researcher and clinician in the field of maternity care and midwifery. Her work is highly acclaimed for its contribution to maternity care advancements in Australian hospitals. In fact, in the mid-1990s, Maralyn's PhD study introduced an entirely new model of maternity care into Australia known as "continuity of care", which is now championed as best practice in our country and many others worldwide. Maralyn's current research explores the impact of the built environment—specifically, birth units within Australian hospitals—on the birth experiences of women and their support teams, and therefore birth outcomes.

Associate Professor Finn Friis Lauszus is senior Consultant, Research Specialist at the Gynecology Dept. Herning Hospital, Denmark. He is active clinically and scientifically in the field of diabetes in pregnancy, PCOS, preeeclampsia and sexual behaviour and has published more than 100 scientific papers.

Ellen Aagaard Nøhr is professor in midwifery sciences and reproductive epidemiology at University of Southern Denmark/Odense University Hospital. During the last 20 years, she has done extensive research in epidemiological and clinical aspects of pregnancy and childbirth including the short- and long-term consequences for mothers and children. Several of her studies have evaluated strategies of midwives to improve birth outcomes, applying