

## **Episode 56: Elective Caesarean Delivery**

Dr. Joe Chappelle: Hello everyone and welcome back. I'm Joe Chappelle and you're listening to episode 56 of the OB/GYN Podcast. As promised, I have a ton of new material coming out for you in the next few weeks. In addition to some more interviews from the National Perinatal Association annual meeting that just happened in April. As a reminder before I get started today, all the transcripts are now going up on the website [www.obgyn.fm](http://www.obgyn.fm) so you can go find them there. Now, these transcripts, the show, the website, are all supported by the people who support us on Patreon. So, if you like this show and you want to support it, please you can go find that link on the website as well.

Now, onto today's episode. One of the rising trends that we see in obstetrics is the elective primary cesarean. What I've always found difficult is articulating the risks and benefits so that these women who are requesting it are well informed before they make that decision. So, I was really happy when Dr. Oystein Bergoy told me he wanted to tackle this topic. I at least know that when Oystein sends me an episode, that it's going to be extremely well researched and comprehensive, and he did not disappoint. This is really a grand rounds level discussion and he walks us through every important study on the subject. So, grab some coffee, strap yourself in, and let's get started with Episode 56: Elective Caesarean Delivery.

Dr. Oystein Bergoy: Hello and welcome to the OB/GYN Podcast. My name is Oystein Bergoy and I'm an OB/GYN resident working in Norway. Today I would like to talk to you about complications following caesarean section. As most of you probably know, caesarean section is one of the world's most commonly performed operations. It is a procedure we should know all the ins and outs of, both in order to do the procedure ourselves and to inform our patients about it.

Before we get deep into the numbers and studies, I think I should give you some information to keep in mind as we go along. In order not to make this too overwhelming, I have had to narrow the focus on which patients to address. My main goal is to prepare us for the counseling of the patient asking for a caesarean section on so-called maternal request, i.e. with no clear medical indication for the caesarean section. The reason for this is, is not where a caesarean is medically indicated, it's usually easier to counsel the patient about the more clear risks and benefits about having the caesarean or not. Therefore, I have tried looking for the studies looking at exactly this patient group, but sometimes I've had to look for more or less suitable proxies.

I will address both the long-term and short-term harms and benefits for both the mother and child. Even though you might find the scope of this podcast now, you will be able to use a lot of the information to counsel other patients as well, specially with regards to long-term complications. Unfortunately, as in most of our science, the majority of the studies I found are done in high-income countries, with all that

entails of antenatal, perinatal and postnatal care, socioeconomic factors, diet, family planning, comorbidities, facilities and so on. Please keep this in mind when you try to think if the studies' perspective can be used to inform your own patients. One of the most important tasks when reading a paper is, in my opinion, to evaluate whether the population studied is reflective of one's own patient population. If not, it's not certain you can use the findings of the paper in question.

I also want you to know that our knowledge of complications following a caesarean section often stands on very shaky ground. For instance, as you have most definitely noticed if you practice obstetrics, there are many ways of doing a caesarean section and many ways of managing vaginal birth. Examples of factors that may vary greatly between studies, but are rarely described in the paper, may be degree of sharp versus blunt approaches during the caesarean section, the ratio of forceps versus vacuum use in operative vaginal delivery, prophylactic antibiotic use, analgesic use, the expectation of the patient of what a normal birth is and what indication local guidelines say there are for emergency caesarean sections versus vaginal operative delivery versus expectant management.

Furthermore, many studies do not have an intention to treat protocol. This means that they have looked at complications based on the actual root of delivery. And why is that a problem? It is a problem because the opposite of an elective caesarean section is not a vaginal birth, it's a trial of labor. If you want to know if trying a vaginal delivery is safe compared to an elective caesarean section in a particular patient, you have to know the outcomes of exactly those two scenarios, namely what are the risks of an elective caesarean section versus a trial of labor that might end up with a vaginal delivery or an emergency caesarean section. If you look at the risks based on the root of delivery, you will not get your question answered. And therefore, you can't use this info to inform your patient properly.

I've tried to address these problems by finding studies that have an intention to treat protocol, or letting you know when they don't. I've also tried to find research with clearly defined patient populations and have found two population groups where there are a certain amount of data. These are patients who have not had a previous caesarean and has no medical indications for one, and a patient who has had one single previous caesarean section. In addition, to address some serious but rare complications, like maternal mortality and abnormal placentation, I will have to use studies with aggregated data, not separating between different clinical scenarios or patient populations.

One last thing before we start. Please know that this is not a systematic review. I tried to search for studies as broadly as I can, following links and references and looking up topics in aggregated sites, like [uptodate.com](http://uptodate.com). I think I've found the most important studies that keep getting referred to, but I can never be sure. If you have some studies or other content you missed, I'd be grateful if you shared it with us on our Slack group.

With that long introduction out of the way, I'll start with talking about short-term complications. First, I'll briefly go through the rare but serious outcomes. Most serious of them all, is probably maternal and neonatal death. It's hard to exclude all confounding factors and find out exactly what deaths are attributable to caesarean section itself. A study in AJOG from 2014 estimated that two to six women die each year in the United States because of caesarean section alone. This translates into 0.2 to 0.6 per 100,000 caesarean deliveries. Reasons might be complications to anesthesia, postoperative infection, amniotic fluid embolism or thromboembolism.

When it comes to neonatal death, it was hard to find any good data on the risks of caesarean section itself. In the UpToDate article called "Caesarean delivery on maternal request", two studies are mentioned that have found a probable slight increase in neonatal mortality after an elective caesarean section compared to a vaginal birth. But both studies were limited by a significant risk of confounding factors, meaning that the risk observed might be due to the indication of the caesarean section and not the operation itself.

These mortality rates were mostly based on the risks of caesarean section in general. Now I'd like to tell you about short-term risks of a planned caesarean section versus a trial of labor in the two patient populations outlined in the start, namely those without a prior caesarean section and those with one previous caesarean section.

First, let's have a look at the planned caesarean section versus trial of labor in women with no prior caesareans who are at term in a normal pregnancy. This is for example the patient with a non-pathological fear of labor but no other medical indications for a caesarean. How should we counsel her about the risks and benefits of her options for delivery?

Cochrane unfortunately can't help us with this question, since they in 2012 tried to make a meta-analysis of RCTs but unsurprisingly found none. Visco et al. made a systematic review article in 2006 published in the Green Journal. Where they tried to investigate this topic. They found very few studies that reported what kind of delivery was planned but rather just reported actual route of delivery. Therefore, they were unable to draw firm conclusions.

Of what the authors call moderate quality evidence they found a decreased risk of postpartum hemorrhage in planned caesarean section versus planned vaginal delivery but a prolonged hospitalization of the mother when a caesarean section was performed. No numbers are stated in the article so it's unclear how large these risks are. The review states that it sought to compare delivery methods based on the mother's preference, but it was a bit hard to find what kind of pregnancies were included and excluded. It was also a bit unclear to me how the studies were

measured with regards to quality and which endpoints were studied through RCTs and which had only observational studies as a foundation.

I was able to find four additional studies not included in the review article. These are all observational studies. The first was a study by Declercq et al. published in 2007 in the Green Journal. It was based on a database of birth certificates from Massachusetts between 1998 and 2003. It divided all low-risk nulliparous women into two groups, namely planned caesarean and planned vaginal births. This is therefore the only study with an intention to treat protocol I could find on this topic. The groups were defined on whether they were coded as in labor or not. Those who were coded as having a caesarean section but did not have a labor code was defined as a planned caesarean section. Those who had a code for having been in labor and had a code for either vaginal delivery or caesarean section was defined as a planned vaginal delivery.

If you have ever worked in a labor ward, you know that a woman who has been scheduled for a caesarean section may present in labor before said caesarean section. So, some of the women laboring might be planned caesarean section who either decided to deliver vaginally or have an emergency caesarean section. If this has any effect, you'd suspect it to affect the planned caesarean group positively as they get rid of their potentially more complicated emergency caesarean sections.

The main outcome studied was rehospitalization and they found a near double risk for this in the planned caesarean section group. The absolute risk was 2% versus 0.75% in the planned vaginal group. Mainly, this was due to wound infection.

The next study was by Allen et al., published in the Green Journal as well. This is a retrospective cohort study from 2006 based on a database containing all pregnancies in Nova Scotia, Canada, from 1988 to 2002. I'll try to go a bit deep into this study, as it's maybe the most important one addressing our question about first time caesarean section on maternal request. This is because it looked for several important complications and at the same time tried to divide its participants into groups based on planned mode of delivery. I don't think they quite succeeded, but I'll get back to that.

About 1,779 nulliparous women with low-risk pregnancies were enrolled. Of those, 879 women had a caesarean section without labor and was compared to the rest, who were induced around term. All caesareans had a medical indication, where 85% were breech or other malpresentations and around 5% were because of suspected cephalopelvic disproportions. Of note, 5% were because of fetal distress, and you would expect many of these caesareans to have been performed fairly acutely, so it's hard to know whether these were really planned vaginal or planned caesarean sections. Furthermore, only around 85% of the women undergoing caesarean section had regional analgesia. If this also accounts for the

anesthesia, that means that 15% approximately were done under general anesthesia, which sounds very high and unnecessarily risky.

There were no breech presentations in the induction group, whose main indications were post-mature pregnancy, 56%, and pre-labor rupture of membranes, 27%, making up together 83% of all inductions. Being an observation study, the authors tried to reduce the risks of confounding by controlling for maternal age, type of anesthesia, use of antibiotics, gestational age at delivery and birth weight.

The main findings were that elective caesareans reduced the incidence of early postpartum hemorrhage with an NNT of 32 and a composite outcome of maternal mortality with and NNT of 34. PPH was defined as bleeding estimated to over 500 mL after vaginal delivery and over 1,000 mL after a caesarean. A composite outcome is kind of like a bag you put different outcomes in. If a participant obtains one or more of the composite outcomes, they are counted as having obtained a composite outcome. It's often used to study rare events. A problem arises if one of the composite outcomes occurs a lot more frequently than the others, as it makes up the bulk of the composite outcome. This might be a problem because it looks like a rare and serious event is more common than it is because, in a way, free rides on the back of the more common event. In other words, the difference in composite outcome between the groups in this study may be driven entirely by the difference in PPH. This is namely a part of the composite outcome. Also note that the way PPH is defined, the participant in the planned vaginal group could in theory bled less than the women in the ones caesarean section group since we don't know the average bleeding estimates.

There were no differences observed in transfusion rates between the groups. No significant differences were seen either in the rates of thromboembolism, wound infection, febrile morbidity, intraoperative trauma, hysterectomy or maternal death. The women who had the caesarean section had on average one day longer hospital stay than the others who were induced.

A large Chinese retrospective cohort study of nulliparous women published in AJOG in 2015 used special consent forms to identify women who had been scheduled for an elective caesarean on maternal request. They compared these groups to a group of planned vaginal delivery. This group was defined as not being scheduled for an antepartum caesarean. All were singleton and vertex, and fairly similar in baseline characteristics. And when not, it seems to favor the planned vaginal group.

In the planned vaginal delivery group, almost 81% achieved a spontaneous vaginal delivery. And around 7% had an assisted vaginal delivery, and around 12% ended up with an intrapartum caesarean. The study did not specify its primary or secondary outcomes. They found no significant differences in maternal death,

severe postpartum hemorrhage, maternal ICU admission, maternal infection, thromboembolic events, maternal organ injury, perinatal death or necrotizing enterocolitis. The definition of severe PPH in this study was if there were 4 g. per deciliter fallen hemoglobin, the patient received blood transfusion or if she needed an intervention like a Bakri balloon.

The study found that decreased risk of mild postpartum bleeding favored the planned caesarean section group 1.7% versus 3.4%. This was defined as a bleeding in excess of 500 mL but not meeting the criteria for severe PPH. Maternal organ injury were injuries involving the anal sphincter, the uterus or intraperitoneal organs.

Where they did find a difference was in the neonatal morbidity, where planned caesarean delivery on maternal request was better than planned vaginal delivery when it came to birth traumas for the baby. 0.2‰ versus 1.1‰; less frequent admissions to the NICU, 3.0% versus 3.7%; fewer neonatal infections, 0.4 versus 0.7%; fewer cases of hypoxic ischemic encephalopathy, 0.4 versus 1.9‰; and fewer cases of meconium aspiration syndrome, 0.2‰ versus 0.6‰. The only factor that was increased in the planned caesarean section group was RDS with 0.6% versus 0.4%.

There were quite a few elective caesareans performed between 37 and 39 weeks of gestation. The authors did a subgroup analysis based on week of delivery and found that the RDS risk was only significant in the group under 39 weeks of gestation. They explained that it was not uncommon in their hospital to grant elective caesareans a bit early to accommodate parents' wishes regarding for instance specific birthday dates.

The authors comment that this study is limited by it only being able to record short-term outcomes. They did not record outcomes after the initial discharge. Hence, complications might have been underestimated, especially in the planned vaginal delivery group, since they stayed approximately 1.5 days shorter than the around 5.5 days the planned caesarean patients did. They also question how generalizable this study is to countries with a different population, specially the BMI rates, since it's a challenging factor to ignore, since the highest incidence of obesity was seen in the elective caesarean group, with 3.6%. This might skew the results in a more favorable way for the caesarean group than one would expect in a country with a higher obesity rate.

Some additional limitations in my opinion was that the induction rate was 31%, which some might find a bit high. The authors did however control for medical complications in the pregnancy. It is unclear for me if the elective caesareans before week 39 were treated with antenatal corticosteroids or not. If not, this might offset some of the difference in the RDS rates. Lastly, some of the outcomes seem to me to be exceptionally low. For instance, incidence of third and fourth degree

perinatal tears were in total around 0.4 to 0.5%. In Norway, where I practice, this number is at least double if not three times that at a normal labor ward.

Moving on to the last study looking at primigravida. A Canadian observational study from 2017 looked at a national registry that included all in-hospital births in most of the country's provinces from 1991 to 2005. The authors used the database to compare around 2.2 million planned vaginal births, with around 46,000 elective caesarean deliveries for breech presentation. They used the latter as a surrogate for a caesarean on maternal request and looked at differences in maternal mortality and severe morbidity.

The women were at term, singleton and had no previous caesarean sections and none of the comorbidities that the authors had deemed as not low-risk. In the breech group they also tried to exclude the ones that had an emergency caesarean. The planned vaginal group also included breech deliveries.

They found that there was a small but significant increase in overall severe morbidity in the caesarean group versus the planned vaginal delivery group, 2.73% versus 0.9%. Most of these were due to wound infection. But also, major morbidities like cardiac arrest, hysterectomy and venous thromboembolism were statistically significantly increased in the caesarean group. Although these risks were relatively small, the absolute risk increase for cardiac arrest was for instance 1.6 per 1,000 deliveries. Keep in mind that these are healthy young patients and that the planned caesarean is common. Hemorrhage requiring blood transfusion was increased in the planned vaginal group. The authors speculate that the reasons why blood transfusions were more common in the planned vaginal group, but hysterectomy was more common in the planned caesarean group was due to the ease of hysterectomy when already doing a caesarean. There was no significant difference in the mortality between the groups, but it's unclear whether the study was large enough to detect a potential difference.

Some limitations with this study that might have influenced the result were that there were some parameters one would've liked to know that was not available. For instance, the BMI of the women that might predispose to wound infection, and parity that might influence the risk of a planned vaginal delivery. Also, the study might have excluded patients in the vaginal group who had complications arising after the onset of labor, but were apparently healthy before they entered labor, and thus making the planned vaginal group look more favorable. Likewise, some patients may have ended up in the elective caesarean group, when they in reality had an emergency caesarean for a complication not coded. But this lack of appropriate coding might also have affected the planned vaginal group. Also, keep in mind that the planned vaginal group included the breech deliveries, which had some increased risks of emergency caesarean sections. But it's hard to say if these numbers were high enough to make an impact on the overall risks.

So, when it comes to short-term complications after a planned caesarean section versus a trial of labor in women with normal, term pregnancies, and no prior caesareans, we can perhaps say that either method of delivery for the individual woman is safe in high-income countries. But on a population level, there seems to be an increased risk of severe maternal morbidity and a slightly lower risk of serious neonatal morbidity associated with an elective caesarean section compared to a trial of labor.

After that slightly frustrating topic, it's time to have a look at the better studied clinical question: how does a planned repeat caesarean compare to a trial of labor after a caesarean? I will, by the way, hereafter use the abbreviation TOLAC for this group. You also see the abbreviation BVAC sometimes used interchangeably, but this is not accurate, as VBAC is short for vaginal birth after caesarean, and should be used for a successful TOLAC, so when I use the term BVAC hereafter, it means that the study in question have looked at the actual root of delivery as opposed to the planned root of delivery.

One of the main fears of the clinician caring for a woman doing TOLAC is the risk of rupture of her scar that might result in maternal circulatory compromise and fetal demise. On the other hand, a repeat caesarean can be challenging if there have formed adhesions that increases the risk of damage to the bladder or intestines when doing the operation. Also, the risk for placenta previa is increased with a prior caesarean.

In order to counsel our patients properly, we need to know some numbers. I found a couple of studies, all observational, that might help us. There are no Cochrane analysis to guide us this time either. When the last did a review in 2013, the authors found only one useful RCT, but it had only 23 participants. On a side note, it's interesting though that they had been able to randomize these patients to do a TOLAC or a repeat caesarean.

The first study I want to mention is a meta-analysis by Guise et al. published in the Green Journal in 2010. The population was women from high-income countries with singleton cephalic pregnancies and one prior caesarean. They excluded the pregnancies younger than 37 weeks and where there were known fetal anomalies. A major limitation with this paper is that all the studies included reported mode of actual delivery and was therefore not intention to treat. However, looking at a few random studies included, they seem to have differentiated between elective and emergency caesareans, making it less likely that a failed TOLAC is grouped together with elective caesareans, at least in some of the studies.

The main findings were that compared to BVAC, an elective repeat caesarean had a slightly increased maternal mortality, from 0.04‰ to 0.13‰, with a number needed to harm of approximately 11,111. Uterine rupture was unsurprisingly decreased from 0.7‰ to 0.26‰ with an NNT of approximately 227. Perinatal and



neonatal mortality was also slightly decreased from a bit of over 1‰ to around half a per mil, with an NNT of approximately 1,250 and 2,000 respectively.

In 2012, Crowther and colleagues published a study in the Open Access Journal PLoS Medicine where they let eligible women choose between a TOLAC or a second caesarean. These were Australian women with singleton pregnancies, 37 weeks or more and cephalic presentation and no contraindications to vaginal birth based on a pre-specified list. This was the only prospective observation study with an intention to treat protocol that I was able to find on the topic at the time of doing my research. And I guess this is as high-quality evidence we will have from a single study so far. This study also included a nested randomized trial and this is where the 22 participants in the Cochrane analysis mentioned earlier comes from.

The study participants split into two groups as follows: 1,225 chose a TOLAC and 1,098 chose an elective caesarean. The groups were fairly similar with regards to baseline characteristics, although the caesarean section group had higher BMI, and higher socioeconomic status. Parameters like gestational age, smoking, maternal age and previous successful vaginal births were similar. The latter were 13 and 15% respectively.

Of those who opted for TOLAC, around 43% achieved a vaginal birth and the rest ended up with a caesarean section. Of these, around half were elective and around half were as an emergency procedure. I would advise you to check if these proportions are similar in your own institution before considering applying the findings of this study into your practice. In the other group, almost 98% delivered by caesarean and the vast majority, around 88% did this through a planned procedure.

The primary outcome was a composite outcome of perinatal death and serious neonatal morbidity. I want to go a bit into the details here, since this study is important, and the interpretation of composite outcomes can be a bit difficult.

As you remember, we talked about a bit earlier, a composite outcome is a grouping together of different outcomes into a singular outcome. If one participant obtains one or more of the outcomes, this is recorded as one composite outcome. One main benefit of using this type of outcome is to be able to study rare outcomes without having to make your study size too large. This ease comes, however, with a price. Several studies and articles have pointed out some major limitations of using composite outcomes, and these are mainly that the individual composite outcomes are often not very well crafted. If, for instance, the outcomes are not similar in severity and frequency, a single outcome within the composite outcome can alone make composite outcomes significantly different between the two groups. Thus, the reader might be led to think that the intervention leads to difference in outcomes which it really does not. I know this might be a bit challenging to understand if you have not thought about it before, but I'll try to use

the Crowther study as an example. I've linked to some of the articles concerning composite outcomes in the show notes if you want to know more on the topic.

As I said, the Crowther study had a composite outcome as its primary outcome, called death or serious infant outcome. This was significantly reduced in the elective caesarean group compared to the TOLAC group 0.9% versus 2.4% from which the authors calculated an NNT of 66. You might get the impression that if we did caesarean section in all of these women, you might save a few lives, but here is an example of where a composite outcome can be very misleading. In a table, the authors list the individual outcomes included in composite outcome. Death was recorded zero times in the caesarean section group and twice in the TOLAC group, of course, not reaching statistical significance. The authors also write that the cause of the two deaths remained unexplained after autopsy.

No individual outcomes reached statistical significance in and of itself, but the outcome that came closest was the cord blood deficit equal to or more than 12 that had a p value of 0.06. You can hardly argue that death and base deficit of 12 are equally severe.

Of the secondary outcomes, a bleeding of 1,500 mL or more, or requiring transfusion was the only outcome reaching statistical significance and was reduced for the patients who got an elective caesarean section, 0.8% versus 2.3% with an NNT of 66.

For me, it's hard to know what to take away from this study other than that in high-income countries, in the short run, both TOLAC and a repeat caesarean section seems fairly equally safe. This is when not considering potential future pregnancies. Various respiratory diseases are perhaps the most serious short-term complications of a caesarean section for the child. This run the spectrum from transient tachypnea of the newborn, TTN, and respiratory distress syndrome, RDS, to persistent pulmonary hypertension, PPHN. It is hypothesized that labor and rupture of membranes triggers a catecholamine surge in the fetus, which in turn reduces fetal lung liquid and increases the secretion of lung surfactant.

A large Danish perspective cohort study published in 2008 in BMJ found an increased risk of respiratory morbidity, defined as TTN, RDS and PPHN in children delivered by elective caesareans compared to those born after trial of labor, regardless of the final root. All live born singleton births between week 37 to 41 without congenital malformations in one of Denmark's largest area hospitals were included between 1998 and 2006.

The authors then compared children born by elective caesareans to those born after trial of labor, including by emergency caesareans. The comparisons were done in two main ways. First, elective caesareans were compared to the trials of labor in each gestational week. Second, the elective caesareans in each week were compared to a trial of labor in week 40. The latter was done to compare

elective caesareans to what the authors meant was the most realistic alternative in most normal pregnancies, namely a spontaneous delivery at term. They also controlled for various potential confounding factors, both for the mother and child, and did a subgroup analysis of pregnancies deemed as low risk, i.e. those with intrauterine growth restriction, diabetes, preeclampsia or hypertension. Their primary outcome was a composite outcome that the authors called respiratory morbidity and consists of TTS, RDS and PPHN. I think this was a reasonable and meaningful use of composite outcomes since these diseases are not always easily separated and have similar treatment algorithms.

The main result from the study was, as compared to babies born after trial of labor, the babies born after an elective caesarean were more likely to suffer from respiratory morbidity. When compared to those who underwent the trial of labor in the same week as the elective caesarean was done, there was a significant difference in week 37, odds ratio of 3.9. Week 38, odds ratio of 3.0 and week 39, odds ratio of 1.9, but no significant difference in week 40 or 41. After analyzing the subgroup defined as low risk, they found an augmentation of the risk, but there was still no significant difference in week 40 and 41.

When compared to trial of labor in week 40, there were only significant difference in the risk for those delivered by elective caesarean in week 37 and 38, odds ratio 7 and 3.5 respectively after controlling for confounding factors. There were no significant differences in elective caesareans from week 39 and older, but the 95% confidence interval was fairly wide, so further studies might change this.

The authors also had an outcome that they defined as serious respiratory morbidity. This was also a composite outcome of the neonates requiring treatment with three or more days with continuous oxygen supplementation, nasal continuous positive airway pressure or a period of mechanical ventilation. There was a significant increased risk of this outcome in the babies born after an elective caesarean section in week 37 and 38 both compared to a trial of labor in the same week and in week 40. No significant difference was observed in babies born in week 39 and older. But again, the confidence intervals were large enough that larger studies might change this.

I think the take home message from this study is that elective caesareans are a potential risk factor for acute respiratory illness, but that this is mostly mitigated by not performing an elective caesarean before week 39. This is at least in Norway standard practice.

According to uptodate.com, the incidence of RDS in an American population in week 39 is approximately 0.3%. That is also reflected in the large confidence interval in this study when approaching week 39 and older gestations. The number of trials of labor one would have to do to avoid one RDS after an elective caesarean is likely to be high. That being said, as we keep coming back to, if we increase

elective caesareans on maternal demand, we will probably see more acute respiratory pathology on a population level.

To sum up short-term risks of a repeat caesarean versus a TOLAC, these options also seem to be fairly equally safe for the expecting mother when assessing the risk of the individual patient. On a population level, there is a small increase in uterine ruptures when performing TOLACs, but based on these studies mentioned, this does not seem to increase maternal mortality.

We have not addressed risk factors or challenges that will make outcomes like uterine rupture more likely, like a prior non low transverse incision or a labor ward unfamiliar with TOLAC. The latter might also make it more dangerous for a woman to suffer a uterine rupture once it has occurred compared to a ward that is trained on that scenario. These are examples of factors that need to be considered when counseling your patient with a prior caesarean and planning her birth.

With regards to the risk of the child, as long as the caesarean is performed in week 39 or later, it does not seem to be a big difference in performing a repeat caesarean versus a TOLAC.

We have so far explored the short-term consequences of a caesarean section for mother and child. I would now like to shift the focus to long-term complications. I found two systematic reviews and meta-analysis I would like to tell you about. These studies do not look strictly at caesareans on maternal request, so keep that in mind. They include quite different studies, since one looked at repeat caesareans compared with BVAC and included retrospective studies, whereas the other included only prospective studies and looked at caesareans versus vaginal deliveries in general.

The one that explored BVACs was from 2011 and is much cited. It's by Marshall et al. and was published in AJOG in 2011. This was a meta-analysis of observational studies looking at complications related to increasing numbers of caesareans. All of the studies included had cephalic singleton pregnancies from high-income countries, with at least one previous caesarean, and excludes studies looking at specific diseases and conditions, and studies conducted before 1980.

In total, 2,280,000 births were included in the meta-analysis. It found that both placenta previa and placenta accreta increases with increasing amount of caesarean sections. With regards to placenta previa, the study reports 1% in women with one previous caesarean and 2.8% in women with three or more. To repeat something I said before, remember that even through the absolute numbers may seem low to you, a low percentage may translate into a high number of patients if the prevalence is high enough. In other words, if multiple caesareans become more prevalent in a population, the number of abnormal placentations might reach a number we would be uneasy with as a result.

The study also found that women with a placenta previa and three or more prior caesareans compared to women with a previa who had no prior caesarean had a significantly increased risk of placenta accreta, 50 to 67% versus 3.3 to 4%. And hysterectomy, 50 to 67% versus 0.7 to 4%. A composite outcome of serious maternal morbidity was also increased to 83% versus 15%. I won't go into the details of this outcome, but it contained mostly hard endpoints and few or no surrogate endpoints,

The last paper I will talk about is by Keag et al. They published a comprehensive systematic review and meta-analysis that looked at long-term risks and benefits of caesarean sections for the mother, child and subsequent pregnancies in PLoS Medicine in January 2018. They included studies that compared vaginal deliveries with caesarean sections at term, not necessarily regarding indication for these nor the rate of operative vaginal deliveries. Most were large prospective cohort studies, but it also included one RCT. This was, for many of you, a well-known study called the *Term Breech Trial*, which randomized women with a breech pregnancy to either undergo a trial of labor or a caesarean section. The result from the RCT was reported independently of the observational studies for statistical reasons, and I will do the same,

For outcomes related to the mother, they included 23 prospective cohort trials and the one RCT that gave a total of almost 3,850,000 participants. In the main article, the risks are given in odds ratios, since this is the correct way of reporting findings from these types of observational studies. However, the authors have calculated numbers needed to benefit or harm, also called NNB and NNH, and supplied these in a table that you can check out. The link is in the show notes to the article. I will use the numbers needed to benefit and harm instead of the odds ratios wherever I can, since I find odds ratios often hard to interpret, and therefore of little help to me when I counsel my patients. However, there's a big caveat with these numbers, but it's a little nerdy, but still very important.

Number needed to treat is dependent on the time to follow-up. This means you can't really use it with a lot of confidence when there is a large difference in the time the patients are followed up for, and the studies have not made a statistical adjustment for this. In the studies included in this review, there's often a vast difference in follow-up time. Take urinary incontinence, for example. The studies included follow the patients for everything from a year or two and up to twenty years after giving birth. Even though these studies all report an increased risk of urinary incontinence after vaginal delivery compared to caesarean section, it does not make much sense to talk about number needed to treat when the follow-up time is so variable. If we did use the numbers the authors have calculated, namely 17, we still have to answer what this number really means. Does it mean that you have to do 17 caesarean sections in order to spare one woman for urinary incontinence for the first five years postpartum, or 20 years, or her lifetime?

As much as I'd love to, I can't go into the details of this any further. I have provided a link to an article elaborating on this in the show notes. Sufficient to say, you cannot calculate the NNT if you have varying and long follow-up times unless you have done some statistical magic called a Kaplan-Meier analysis. This is as far as I can see not done here, and I will therefore only quote NNTs when the outcomes are not that far into the future, like future pregnancies. I have to admit that I'm a bit in deep water here, so please do not hesitate to let me know if you are better than me at statistics and are tearing your hair out because of my use of these concepts.

Okay, so back to the paper. The authors grouped their outcomes into three categories as I mentioned earlier: long-term outcomes for the mother, long-term outcomes for the child and outcomes in any subsequent pregnancy. I'll start with the latter. All of these findings were supported by the observational studies and not the RCT. As with the meta-analysis by Marshall et al. we just discussed, this paper by Keag et al. has also explored abnormal placentation.

Compared with no previous caesarean, having had one previous elective caesarean section increases the risk in a future pregnancy of placenta previa, with an NNH of 494. There was an increased risk of stillbirth, with an NNH of 1,144. Women who delivered by caesarean were more likely to experience inability to become pregnant again compared to those who delivered vaginally with an odds ratio of 1.6. They also found an increased risk of placental abruption with an NNH of 534. With regards to uterine rupture and postpartum hemorrhage, I would refer you to the discussion we had on the short-term risks. The risks are rupture and PPH quoted in this review is not, as far as I can see, adjusted for mode of delivery in the subsequent pregnancy. They may therefore quote the risk for BVACs and second caesareans as one number.

Of note, non-pregnancy related maternal outcomes, they looked primarily at pelvic organ prolapse, urinary and fecal incontinence. This is a bit of a hot topic, especially if you get an urogynecologist in to do the discussion and should probably be a topic of a podcast in itself.

Annoyingly, the authors don't tell us much about the participants included, so we don't really know whether the women in the caesarean group only had deliveries by caesarean or if they might have had a BVAC in the follow-up time. They don't tell us whether they adjusted for this either. However, I looked at the studies included that reported a result on pelvic floor dysfunction. They all seem to have included women who only delivered by caesarean or vaginally, or they have had a follow-up time of maximum 18 months postpartum.

The rate of operative vaginal delivery, which is probably a risk factor of these outcomes as well, are not mentioned either, but the authors write that they included these patients in the vaginal delivery group if they found them in the studies included. The numbers from observational studies found that when compared to

vaginal delivery, women who delivered by caesarean section were more protected against pelvic organ prolapse with an OR of 0.9 and a 95% confidence interval of 0.17 to 0.51. And with urinary incontinence, there was an OR of 0.56 with a 95% confidence interval of 0.47 to 0.66. No differences were seen with regards to fecal incontinence.

The RCT, who had a two-year follow-up was not able to show any difference between the groups with regards to urinary or fecal incontinence. The observational studies had, as previously mentioned, varying follow-up time, from 12 months to up to 8 years of age. The studies looking for pelvic organ prolapse had 20 years follow-up or longer. It is important to note that all of these outcomes did occur on the caesarean delivery group as well, including fecal incontinence, so a caesarean section, counter probably too many patients' beliefs, is not able to fully protect against these forms of pelvic floor dysfunction.

Of secondary outcomes, the observational studies found an increased risk of dyspareunia in those who were delivered by caesarean section with an OR of 1.49, but this was not shown in the RCT. No differences were found with regards to pelvic pain, but the 95% confidence interval just hit 1.00 and had a range from 0.54 to 1.00, almost favoring those delivered by caesarean. More studies looking at this might change this result. The RCT looked at painful or heavy menstruations following the delivery but found no differences.

Regarding the long-term complications of a caesarean section for the child, studies have found an association between caesarean section and asthma, allergy and obesity in childhood. The Keag paper chose child asthma up to age 12 as their primary outcome for the child. They found an increased risk of asthma in the children delivered by elective caesarean versus after trial of labor with an OR of 1.21, 95% confidence interval 1.11 to 1.32. The studies included here also varied in follow-up time and in primary outcomes measured.

In the secondary outcomes in the meta-analysis, the authors also found an increased risk of over-weight and obesity in the children born after an elective caesarean but no significant difference in allergy, and a decreased risk of inflammatory bowel disease.

To summarize the findings on long-term complications of caesarean sections, there are some benefits and some harms. These are greater in absolute numbers than the short-term complications and therefore, long-term complications should probably be the topic where you spend most time on in your average counseling. The ones you could argue are the most serious are mostly rare, although different patients will of course have not all the same definitions of what the most serious outcomes for them personally are. It is also important to try to differentiate between risks only relevant for a subsequent pregnancy and the ones that also can affect

the woman in front of you even though she will get a sterilization after this pregnancy.

A caesarean section compared to a trial of labor seems to protect against pelvic organ prolapse and urinary incontinence and might also protect against inflammatory bowel disease for the child. However, it seems to increase the risk of future ability to conceive, stillbirth, abnormal placentations, dyspareunia for the mother and for asthma and obesity for the child.

A repeat caesarean compared to BVAC is also associated with an increased risk of abnormal placentations, and this risk increases with the number of caesareans a woman undergoes.

We have not found evidence that shows a caesarean section protects against fecal incontinence, nor have we found solid evidence of it protecting against pelvic pain, but this might change with larger studies.

I've not discussed any pathophysiological mechanisms so far, and I won't say much about it now either. All I do want to say is that when it comes to the long-term outcomes for the child, there's a lot of fascinating ongoing research exploring the differences in the child's gut microbiome after a caesarean without prior labor compared to one born after a trial of labor. Especially our ongoing interventions studies exploring the harms and benefits of vaginal seeding followed with excitement. In these, the mother's vaginal bacteria flora is introduced to the newborn baby after an elective caesarean in order to try to give the child a normal gut microbiome.

So, to try to summarize all that we have talked about. The goal of this podcast was to explore the risks and benefits of an elective caesarean done without any proper medical indication, as a caesarean section on maternal request is something all of us seeing pregnant patients should be able to counsel about. We wanted to know of both short-term and long-term effects for the mother and child. The studies we have looked at have been done in mostly high to middle-income countries so keep that in mind when trying to use these findings in your practice.

We have found that both options are equally safe with regards to short-term complications for the individual patient, but that they differ a bit more with regards to long-term complications both for the mother and child. On a population level, however, it would make sense to try to avoid unnecessary caesareans since rare but serious complications will probably arise. Lastly, the risk for the mother is sometimes dependent on whether she wishes to have more children or not.

I want to thank you for listening. I hope you have gotten some concrete advice to use when discussing the risks and benefits of caesareans with your patients.