Title: **Neonatal Outcomes following one Previous Caesarean Section**

Abstract:

Background: Vaginal Birth following a previous Caesarean section (VBAC) delivery is considered a safe option for subsequent deliveries following personal planning and counselling.

Aim: The aim of this study was to compare neonatal outcomes for both elective caesarean and vaginal birth to aid decision making for women/ pregnant people

Methods: Quantitative study using retrospective data collection. Inclusion criteria were low risk pregnant people / women at term with one previous CS (n=392). Logistic regression was used to determine the impact of delivery mode on neonatal outcomes.

***Findings*:** Logistic regression indicated that APGAR score was associated to be higher amongst those in the VBAC group compared to the ERCS group, while there were no differences in NNU admissions by delivery mode. Further descriptive analyses were carried out to explore these results and reasons for admission to NNU.

Conclusion: Statistical analysis shows minimal difference in neonatal outcomes, regardless of intention for either VBAC or ERCS for this cohort of participants.

Key Words: Vaginal Birth After caesarean/ VBAC; Elective repeat caesarean section /ERCS; Neonatal outcomes; APGAR; Respiratory distress syndrome / RDS; Sepsis; admission to NNU.

In the UK, one in three births between 2022-2023 resulted in a Caesarean section (CS) birth (NHS Digital, 2023). For subsequent pregnancies women / pregnant people are to decide whether to plan for an elective repeat CS (ERCS) or consider a vaginal birth after a previous Caesarean (VBAC) (NICE, 2023) (NHS, 2023). There is strict guidance on those deemed suitable to attempt a VBAC in the best interests of both mother and child (NICE, 2023). The current success rate for VBAC is 72-75%

(RCOG 2015; NHS 2023) although recent data from the National Maternity and Perinatal Audit (NMPA) Clinical Report, indicates the rate for England and Wales is 60% (NMPA, 2022). Clinical guidance advocates thorough counselling for this cohort of women / pregnant people because of the risks associated with each mode of delivery. Yet, there are no current standardised, national structure for advice which can often vary between healthcare professionals (Fitzpatrick et al 2019). During 2022-23 there were 547,244 births within the NHS, 210,492 of which were via CS births (NHS Digital, 2023) (NHS 2023). This equates to 38% which is higher than NICE guidance suggestion of 25-30%. This is a significant number of people potentially requiring informed and holistic tailored guidance on subsequent delivery mode options. The aims of this study were to examine whether there was an increased risk of adverse neonatal outcomes in women / pregnant people attempting VBAC compared with ERCS in one NHS Trust, providing local and meaningful data.

Methods

Design and data sources

A retrospective cohort design was employed to compare those attempting VBAC to those opting for ERCS. The study setting was at one National Health Service (NHS) hospital based in South East England, Kent. Data was examined over a period of 12 months; from two sources that contain routinely collected patient data: E3 (a specialist maternity system) and BadgerNet (neonatal system). The study population comprises of all pregnant people / women with a history of one previous lower segment caesarean section of a live singleton birth. Data included 5471 deliveries during this period. The inclusion/exclusion criteria is set out in table 1 below. After applying the above criteria, 392 deliveries were included in this sample.

Table 1. Inclusion/exclusion criteria for study sample

Inclusion	**Exclusion**
Parity 1	Multiparity > 1
Previous lower segment CS	Previous CS with inverted T uterine incision
Singleton pregnancy	Multiple birth
Cephalic presentation	Unstable/ Breech presentation
Term (37-42 weeks) gestation	Prematurity <37 weeks gestation. Post maturity >42 weeks gestation
Women/ pregnant person aged 18 and over	Women/ Pregnant people aged 17 or under
No fetal anomalies (detected via ultrasound screening and blood tests during pregnancy)	Any antenatal detected fetal anomalies
Women / pregnant people with no underlying medical disorders.	Maternal Co-morbidities-diabetes, Hypertensive disorders. Epilepsy, Medical history that may predispose to neonatal health issues/risks to the baby or identified fetal anomalies
	Women / Pregnant people with any previous uterine surgery

Data Analysis

Data analysis was carried out in three stages, each of which is presented below. First descriptive statistics were explored for the entire sample. Second, a logistic regression was employed to examine the APGAR scores at 5 minutes (points scoring depending on physical health of neonate; heart rate, respiratory effort, muscle tone, response to stimuli and skin colouration/perfusion) and Neonatal unit admissions between VBAC and ERCS groups. Finally, further descriptive analysis was carried out to explore the characteristics of NNU admission in relation to intended delivery mode.

Ethical approval

Permission to proceed with this study required ethical approval from the University of Greenwich (UREC/ SREP-EH& HS-20-21 M01-02. 07.01)

Ethics Committee and the local NHS trust. This permission was granted on the 26th November 2020.

Results

Descriptive statistics

The sample contained 392 births, of which 266 were intended ERCS, compared to 126 intended VBAC. The majority of pregnant people / women (n = 361; 92%) achieved their intended delivery mode of birth, with only n =16 (6%) of intended ERCS and n=46 (37%) of intended VBAC having an EMCS. The overall mean APGAR score at 5 minutes was 9.52 (SD= .68) for the sample. APGAR scores were slightly higher amongst the VBAC group (M = 9.7, SD = 0.56) compared to the ERCS group (M = 9.44, SD = 0.72)

Table 2. Descriptive statistics for delivery modes

	Mean APGAR (SD)	NNU admissions (n, %)
Intended (VBAC)		
Yes	9.52 (0.67)	N = 11 (8.7%)
No	9.52 (0.67)	n = 16 (6%)
Actual delivery		
VBAC	9.70 (0.56)	n = 6 (7.5%)
ERCS*	9.44 (0.72)	n = 15 (6%)
EMCS	9.61 (0.67)	n = 6 (9.7%)

*one ERCS APGAR score missing

Logistic regression

A logistic regression was undertaken to assess the association of mode of birth on APGAR scores at 5 minutes and NNU admissions. The full model containing all predictors were statistically significant $X^2(2, N = 392) = 13.47$, $p < .001$ indicating that the model was able to distinguish between the two intended modes of delivery in relation to neonatal outcomes based on APGAR at 5 minutes and NNU admissions. This establishes a difference but not that this was caused by the mode of birth. The model explained between 3.4% (Cox and Snell R squared) and 4.7% (Nagelkerke R squared) of the variance in neonatal outcomes, and correctly classified 68.5% of cases. The logistic regression suggests that APGAR score was likely to be higher amongst those in the VBAC group compared to the ERCS group however the admittance to NNU was not different between either intended delivery mode. Results are summarised in table 3 and figures 1 and 2, which show the distribution of APGAR scores and NNU admissions between each group.

Figure 1. Violin plot of APGAR scores by mode of intended birth

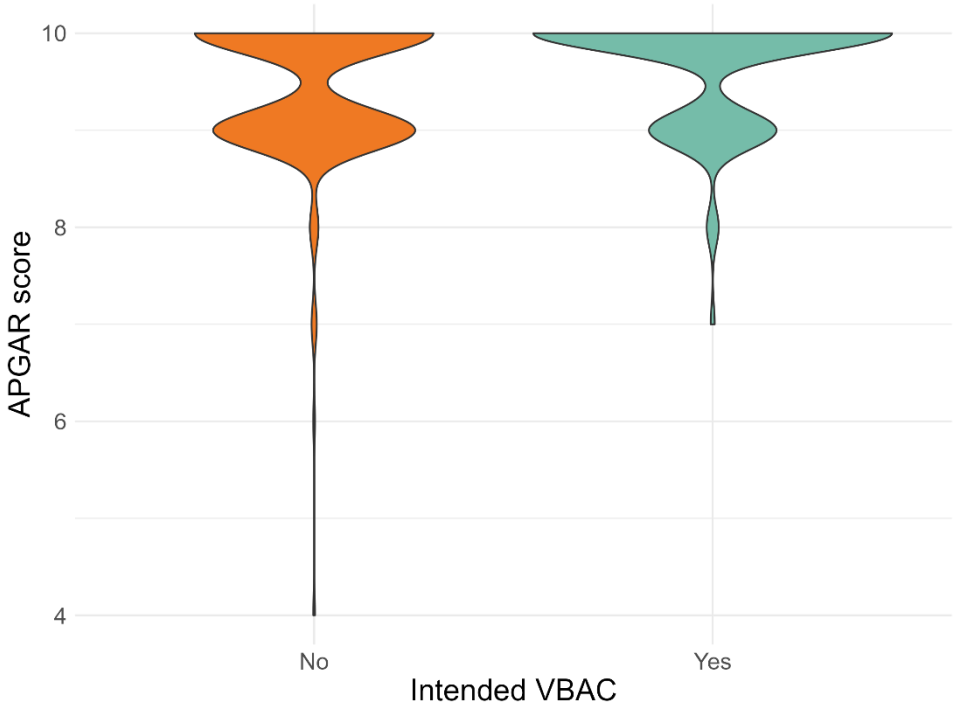

Figure 2. Number of NNU admissions by mode of intended birth

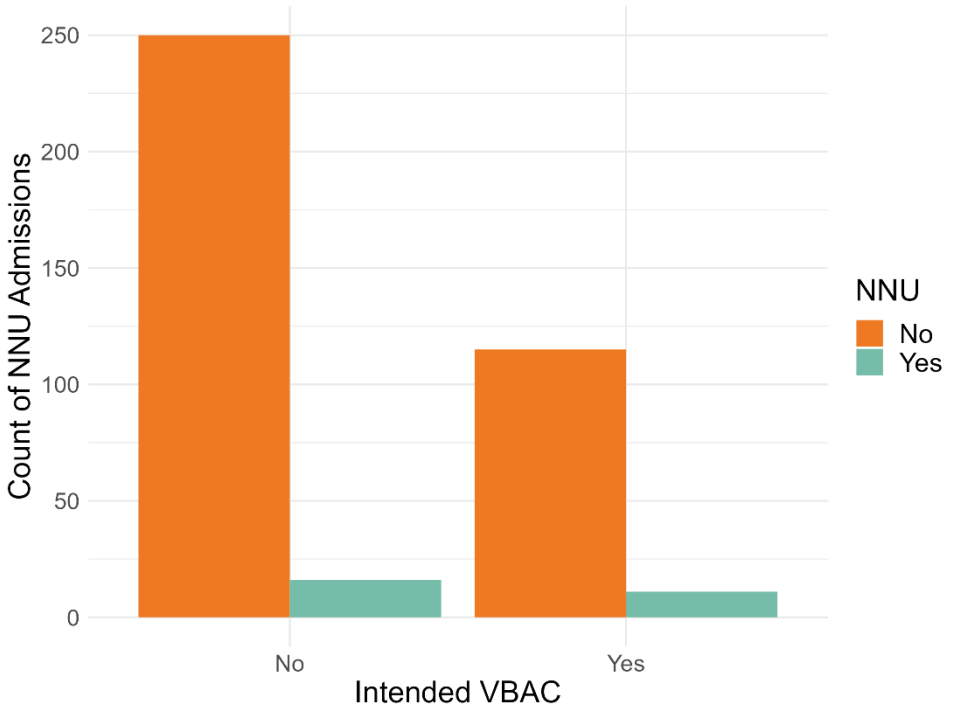

Table 3 Logistic regression output prediction of neonatal outcomes based on intended delivery mode

	B	S.E.	Wald	df	p	Odds ration	95% CI low	95% CI high
APGAR	.654	.201	10.537	1	.001	1.923	1.296	2.854
NNU admission	.698	.434	2.586	1	.108	2.010	0.858	4.707
Constant	-7.053	1.946	13.134	1	<.001	.001		

NNU admissions

Further descriptive analysis was carried out to explore factors related to NNU admission. Only 27 (6.8%) neonates were admitted into NNU from this sample

The majority of admissions into NNU had a primary and secondary reason recorded. Respiratory distress syndrome (RDS) was the most common reason followed by suspected sepsis. These results are summarised in table 4. Despite having higher APGAR scores, the intended VBAC group had a higher percentage of admissions to NNU (n = 11, 8.73%) compared to the ERCS group (n = 16, 6.01%). Suspected sepsis admissions were higher in the intended VBAC group as a primary admission reason than intended ERCS group. Suspected sepsis recorded as a secondary admission reason was higher in the ERCS group. These results are summarised in table 4.

Admission for feeding concerns was never a primary indicator for admission and this occurred more in the VBAC group, more of a secondary indicator. The cardiac

admission reason was an outlier and an isolated case similar to the 3 suspected genetic disorders.

Table 4 Reasons for NNU admissions based on intended delivery mode

Primary and Secondary Reasons for Admission to NNU based on Intended Delivery Mode				
	Intended VBAC Primary Admission Reason % of all VBAC	*Second Admission Reason*	**Intended ERCS Primary Admission Reason % of all ERCS**	*Second Admission Reason*
RDS	5 3.9%	0	14 5.2%	0
Suspected Sepsis	3 2.3%	5 3.9%	1 0.3%	11 4.1%
Cardiac	0	0	1 0.3%	0
Feeding Concern	0	2 1.5%	0	1 0.3%
Other:	3 2.3%	1 0.7%	0	2 0.7%
Total	11 8.73%		16 6.01%	

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Discussion

This study sought to examine whether there was an increased risk of adverse neonatal outcomes in those attempting VBAC compared with ERCS. The above results suggest that those who opted for VBAC had a higher APGAR scores compared to those to who did not, while admissions to NNU did not differ by intended mode of birth. In saying this, overall mean APGAR scores were similar between all groups in this study, meaning that both intended VBAC and ERCS had

generally high APGAR scores. It may be other factors which are more salient in impacting APGAR scores and NNU admissions.

These findings are reflected in the broader literature, that VBAC is a safe option for neonates (RCOG, 2015; NICE, 2023). The National Maternity and Perinatal Audit for England 2019-2020 (HQIP, 2022) stated that 98.6% of term neonates scored an APGAR >7 at 5 minutes. While this evidence does not probe the data further into delivery modes, the results from the above study appear to be similar.

The findings also indicate that that more women opted for ERCS than VBAC at this trust. The 2022 National Maternity and Perinatal Audit (HQIP, 2022) revealed that between 1st April 2018 and 31st March 2019, those that attempted VBAC that were considered eligible was 38% compared with only 32.1% at this Kent NHS Trust. One notable difference, albeit slight (and not significant), was the EMCS had higher mean APGAR score than ERCS. Whilst this could be a chance finding due to sample size an explanation for this can again be found in the broader literature, that is, for ERCS the neonate is exposed to contractions prior to delivery, this can have a positive physiological effect in preparing the neonate for ex-utero adaptation (Boxwell et al 2019). The total number of neonates admitted to NNU was 27 (or 6.8 %) of the sample. Reviewing the outcomes as modes of delivery indicated that NNU admissions were higher in the EMCS group at 9.7% and lowest in the ERCS group at 6.0%. This was expected and is reflected in the literature (Pan et al, 2022) however, as reported in the APGAR discussion of findings, the mean APGAR score for EMCS was higher than ERCS. RDS was the primary admission reason for all neonates regardless of intended mode. It was evident that amongst the intended ERCS there was a slightly (although not statistically significant) higher number of RDS cases; 5.26% of deliveries compared with only 3.96% of the intended VBAC.

RDS in CS cases is caused by surfactant deficiency combined when the neonate not being exposed to the usual hormone changes that occur in labour. For such reasons neonates born by CS are potentially at risk of RDS (Li et al, 2019) (Edwards et al, 2013) and therefore potentially increased NNU admissions. However, latest NICE review suggest there is not enough evidence to suggest this entirely (NICE, 2023). Admission for suspected sepsis was the second highest primary reason (n = 4; 1%) and the highest reason for secondary admission reason (n=16; 4%). Sepsis admissions were higher in the intended VBAC group as a primary admission reason, accounting for 2.38% compared with only 0.37% for intended ERCS. VBAC risk factors for sepsis include; prolonged rupture of membranes, Group B Streptococcus, multiple vaginal examination or maternal suspected infection (Morgan et al, 2016). All of these reasons could predispose the neonate to infection in the birth canal (Grassham et al 2021). This study did not expand further to explore infection status of these neonates which should be duly noted and would be recommended in future studies. In addition, thresholds for treating suspected infections can vary from Trust to Trust based on parameters and local guidance (Crocker et al 2021). The reasons for admission to NNU for all other conditions were also generally explained in the current literature. For example, feeding concerns (which was the secondary reason for 11.1% of admissions) was likely due to the primary reasons for admission: RDS or sepsis (Crocker et al 2021; Grassman et al 2021).

In practical terms this study suggests that while there were differences, both VBAC and ERCS were safe. Both VBAC and ERCS had similar rates of NNU admissions This study does however, indicate that the uptake of VBAC could be higher at this NHS Trust. The NMPA Clinical Report for 2022 revealed that between 1st April 2018

and 31st March 2019 those eligible for VBAC were 38% compared with only 32.1% at this NHS Trust. Whilst this is an incidental finding this remains useful background information in the context of this study for women / birthing people and Trust practitioners. The findings from this study could be presented to pregnant person/ women at antenatal appointments to aid informed, collaborative decision making.

There are a number of limitations related to this study that are worth noting. First, demographics and potential confounding variables, such as co-morbidities, age and ethnicity were not included in the above analyses, this means that we could not account for their impact on neonatal outcomes. For these reasons, care should be taken in generalising these findings and future studies should aim to include these variables. Furthermore, this study did not include any person who underwent induction of labour (IOL) and did not investigate the neonates who were ward attenders into NNU only those admitted (stays for longer than 4 hours). These groups should be considered in any future analyses. Finally, while the sample included almost 400 people, there was a small number of births that results in particularly low APGAR scores and NNU admissions. To fully investigate these groups a much larger sample would be needed to investigate the factors that impacted APGAR scores and NNU admissions.

Conclusions

These results suggest that both VBAC and ERCS are safe options for neonates. The gold standard for health care professionals is to empower women / pregnant people and their families to support them in their decision making with evidence. This study

contributes to this knowledge base. Gaps in present knowledge of local outcomes exist, from here a suggested future initiative is to undertake a broader study with a larger cohort of participants, including compounding variables such as co-morbidities, age, ethnicity, to fully explore in depth factors influencing neonatal outcomes.

Key points

- The evidence related to neonatal outcomes after a caesarean section birth is limited.
- This study sought to examine neonatal outcomes amongst VBAC and ESRC following one prior LSCS.
- While VBAC had slightly higher APGAR scores the difference was generally minimal. NNU admissions did not differ between the groups.
- The main conclusion is that from this study both modes of delivery are safe.
- As practitioners we must improve the information, based on best evidence we can provide to counsel women/ birthing people in their informed decision making.

CPD Reflective Questions

- How could midwives in every day practice enhance the informed decision-making process for VBAC versus ERCS?
- How could midwifery and obstetric healthcare professionals combine expertise to apply this in a MDT approach with women /pregnant person and their families.
- How could we better improve the decision-making process to support women / pregnant people as part of a MTD?
- Does your Maternity service share local outcomes? Or how can we share more readily local outcomes with our service users?

Declaration of interests: The authors have no conflict of interest to declare.

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Summary of Revisions

Comment	Response	Location
Reviewer 1		
A dissemination for a wider audience would be a good idea. This is focussed on Kent trust, however demographics etc will be different for different areas.	Thank you very much for your considered and detailed feedback. We have made some changes to our in the limitations, highlighting the need for care in generalising these findings. Thank you, we have reviewed the Re: Birth Study and have adjusted throughout the manuscript to align language with findings.	Limitations Paragraph Throughout Manuscript
I can see confounding is mentioned but should be stressed as there is limited discussion of the inclusion criteria of the women involved in this study and their co-morbidities etc which may have had an effect on the neonatal outcomes.	Thank you for your considered and concise feedback. Regarding the limitations of the study, we have amended the wording to emphasise this point and that it is of the upmost importance that care should be taken in generalising these findings since we did not include factors such as co-morbidities. The inclusion and exclusion criteria have been amended to be clearer. If you feel there are any more specific changes, we could make regarding this point we would be happy to consider them.	Limitations Paragraph Table 1
Reviewer 2		
A little out of date in terms of research, guidance, UK approach to mode of birth - suggestions in my comments but would advise this is brought up to date prior to publication.	Thank you for these suggestions. We have now brought this manuscript up to date with the newest evidence and guidance available. Thank you.	Throughout Manuscript
Changes need to be made to show understanding around what retrospective data analysis can tell us in terms of findings.	This is a good point; you will see we have made changes throughout the manuscript in line with your comments – namely that retrospective analysis can only show associations.	Throughout Manuscript
Manuscript reviews		
In text recommendations	Thank you for these valuable recommendations. We have made amendments throughout the manuscript and highlighted in yellow	Throughout Manuscript