Vaginal preparation with chlorhexidine at cesarean section to reduce endometritis and prevent sepsis

Morton, Victoria Ann; Hewitt, Catherine; Wilson, Amie; Farmer, Nicola; Weckesser, Annalise; Dixon, Emily; Brocklehurst, Peter; Hardy, Polly; Morris, R. Katie

DOI:
10.1111/aogs.13737

Vaginal Preparation with Chlorhexidine at Cesarean Section to Reduce Endometritis and Prevent Sepsis: A Randomized Pilot Trial (PREPS)

Victoria Hodgetts Morton[1,2], Catherine A Hewitt[3], Amie Wilson[3], Nicola Farmer[1], Annalise Weckesser[4], Emily Dixon[3], Peter Brocklehurst[3], Pollyanna Hardy[3], R.Katie Morris[1,2,3]

1. Birmingham Women's and Children's Hospital NHS Foundation Trust, Birmingham, B15 2TG, UK
2. Institute of Metabolism and Systems Research, University of Birmingham, Birmingham, B15 2TT, UK
3. Birmingham Clinical Trials Unit, Institute of Applied Health Research, University of Birmingham, Birmingham, B15 2TT, UK
4. Centre for Social Care, Health and Related Research, Faculty of Health, Education and Life Sciences, Birmingham City University, City South Campus, Ravensbury House, Westbourne Road, Birmingham, B15 3TN, UK

*** Corresponding author details** – Dr R. Katie Morris, R.K.Morris@bham.ac.uk, +44 (0)121 623 6652 Academic Department of Obstetrics & Gynaecology, Third Floor, Birmingham Women's Hospital, Mindelsohn Way, Birmingham, B15 2TG, UK

Conflicts of Interest

The authors have no competing interests to declare.

Funding Information

This paper presents independent research funded by the National Institute for Health Research (NIHR) under the Research for Patient Benefit (RfPB) Programme (Grant Reference Number PB-PG-1215-20013). The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR, or the Department of Health and Social Care. The funder had no role in conducting the research or writing the paper.

Abstract

Introduction: Cesarean sections (CS) are the most common major operation worldwide. One in 10 women develop a surgical site infection post-CS. The PREPS pilot trial was developed to assess the feasibility of a randomised controlled trial (RCT) of vaginal cleansing with chlorhexidine (CH) before CS, to reduce infectious morbidity.

Material and methods: A multi-center, open-label, parallel-group pilot RCT across four UK maternity units. Women aged ≥16 years, undergoing elective or emergency CS, ≥34 weeks' gestation, and able to give informed consent were eligible. Women were randomized 1:1 to CH 0.05% or no cleansing and were followed-up until 6 weeks post-CS. The feasibility of a larger RCT was assessed by the pilot trial's recruitment, ability to utilize verbal consent in an emergency, adherence, follow-up and withdrawal rates. The main clinical outcome collected was CDC classification of endometritis at 30 days.

Results: A total of 320 women (128% of target) were randomized. Of these 93% (95% CI 89%-95%) received their allocated intervention. Of the 88 women who had an emergency CS, verbal consent was initially given by 32 (36%) women, with the remainder having sufficient time to give written consent. Endometritis (CDC definition) was collected from medical notes of 96% of women, 68% (95% CI 63%-73%) were followed up at both 14 and 30 days via telephone, and we were able to collect patient reported outcomes. In the vaginal cleansing arm 2/152 (1.3%) women had endometritis compared with 1/155 (0.7%) in the no cleansing arm (RR 2.08, 95% CI 0.19-22.31).

Conclusions: It is possible to perform a RCT in women undergoing an elective or emergency CS, using a verbal-followed-by-written consent process, whilst maintaining high adherence and retaining women in the trial.

ISRCTN33435996

Keywords: Sepsis, Endometritis, Surgical Wound Infection, Vaginal Douching, Chlorhexidine, Pilot Projects, Cesarean Section

Abbreviations: CDC, Center for Disease Control and Prevention; CH, Chlorhexidine; CS, cesarean section; PI, Povidone Iodine; PIL, patient information leaflet; PRO, Patient Reported Outcome; RCT, randomized controlled trial; SSI, surgical site infection; VC, vaginal cleansing

Key Message

A randomized controlled trial of vaginal cleansing with an antiseptic solution prior to elective and emergency cesarean section is feasible.

1 INTRODUCTION

Cesarean section (CS) is the commonest major operation worldwide; approximately 26% of pregnant women undergo a CS in the UK, equating to 177 793 per year in England.[1] One in 10 women experience a surgical site infection (SSI) post-CS, with 90% of infections being in the abdominal wound, 5% deep incisional, and 5% endometritis.[2] The post-CS endometritis rate varies from 0.94-15.8%,[3] due to changes in practice related to the routine introduction of antibiotic prophylaxis (reducing endometritis from 15.7% to 5.7%) and the definition of endometritis used (e.g. clinically-determined or Center for Disease Control and Prevention (CDC) criteria[4]).

Complications range from community-managed mild infections to sepsis requiring high-dependency care. While maternal mortality rates from sepsis have reduced, this is due to early identification and treatment, and reducing influenza in pregnancy via vaccination.[5] Of the women developing an SSI post-CS, 6 in 1000 require re-admission, equating to 1,066 women per year in England.[2] Post-operative morbidity further impacts mothers and babies in the important immediate postnatal period especial if they are separated.

Vaginal cleansing (VC) pre-CS may help prevent endometritis and SSI, through inhibiting ascending infection and reducing cross contamination of the surgical site. A systematic review and meta-analysis included 15 trials of vaginal cleansing pre-CS with an antiseptic (mainly Povidone Iodine (PI)) vs placebo or no cleansing and concluded that this reduced the endometritis incidence (4.5% v 8.8%; RR 0.52 95% CI 0.37-0.72).[6] Sub-group analyses demonstrated a greater reduction in women in labor at CS and/or with ruptured membranes. Vaginal cleansing at CS with PI has not been adopted within the UK, and does not feature within the NICE guidelines,[7] due to concerns about exposure of the fetal skin to iodine causing transient hypothyroidism and potentially affecting newborn congenital hypothyroid screening.[8]

One randomized controlled trial (RCT) (n= 93) found no significant difference between PI and chlorhexidine in terms of endometritis or wound infection after elective CS (RR 2.04 95% CI 0.39-10.62).[9] The principle of VC as an antiseptic is sound; it is the use of PI that prevents translation into practice, and therefore it is reasonable to consider an alternative antiseptic such as chlorhexidine, whose bacteriostatic and bactericidal properties make it a suitable alternative antiseptic. An RCT assessing vaginal cleansing with chlorhexidine at CS to reduce SSI is therefore required. There are a number of feasibility questions that needed answering before a definitive RCT could be conducted. The aim of this study was to

determine if verbal consent was acceptable in time-critical situations; if randomization were possible; if it were possible to perform VC; and if we could successfully follow up women post-CS who are rapidly discharged?

2 METHODS

PREPS was an unblinded, parallel-group pilot RCT comparing vaginal cleansing using chlorhexidine 0.05% vs no cleansing (standard practice) at CS. Two qualitative focus groups (n=15) and telephone interviews (n=6) were conducted prior to the pilot RCT to identify key areas that matter to women to inform women-focused outcomes, and to obtain input regarding the proposed trial processes including verbal consent.[10]

Since this was a pilot study, no formal sample size calculations were undertaken as the study was not designed or powered to detect a statistically significant difference in efficacy between the treatment arms. A recruitment target of 250 participants was chosen as we expected this would be sufficient to estimate the feasibility outcomes. This sample size is in accordance with the literature which suggests that the size of the pilot trial should be at least 10% of the anticipated size of the substantive study,[11] the calculations for this are detailed in the published protocol. The initial plan was to open 3 sites with individual site targets: site A, 100 women, and sites B and C, 75 women each, recruiting over a period of 12 to 16 weeks. During setup it became clear that sites B and C did not have 24-hour availability of trained research staff on the labor ward and were struggling to deliver intrapartum research, therefore an additional site (Site D) was added, recruiting for a shorter period (6 weeks).

Women were eligible if ≥34 weeks' gestation, having a CS, able to give informed consent, able to receive a telephone interview, and aged ≥16 years. Women were ineligible if they had a known allergy to chlorhexidine gluconate/acetate, were receiving prophylactic intravenous antibiotics for group B streptococcus colonization or for suspected infection (standard CS intravenous prophylaxis was not an exclusion criteria), or enrolled in an RCT intending to reduce SSI. All women booking at participating sites during the study period who were ≥34 weeks' gestation received a patient information leaflet (PIL) in the post. Women undergoing elective CS were approached prior to surgery, by a clinician who introduced the study and obtained written consent. Women presenting in labor were approached by either a clinician or

a research midwife to introduce with the same PIL as posted, and were asked whether they would consider participation if a CS became necessary. When the decision to perform an emergency CS was made, if time allowed, written consent was obtained. When time was limited, women provided verbal consent for the intervention with written consent obtained prior to discharge. If written consent was not obtained prior to discharge, then confirmation of consent was sought by sending a PIL and consent form to women in the post. If written consent was still not acquired, any data collected on the participant was not included in the analysis. After the woman's eligibility was confirmed and informed consent obtained, randomization was performed by members of the research team at the recruiting hospital, utilizing a 24/7 telephone randomization system provided by the University of Aberdeen. Women were randomized at a 1:1 ratio to either chlorhexidine 0.05% vaginal cleansing or no cleansing. A minimization algorithm was used to ensure balance in the treatment allocation for randomizing center, and whether the woman was in labor. A random element was included to ensure allocation concealment.

Chlorhexidine gluconate 0.05% (Unisept®) or Chlorhexidine acetate 0.05% was used to perform vaginal cleansing. This is indicated within the British National Formulary for obstetric swabbing[12] and the Medicines & Healthcare products Regulatory Agency (MHRA) deemed that this was not a Clinical Trial of an Investigational Medicinal Product (CTIMP). Prior to CS, at the time of urinary catheter insertion (after completion of the regional anesthesia or prior to commencement of general anesthetic), 50 ml of antiseptic was emptied into a sterile pot and a single swab/sponge mounted on a sponge-holder was soaked and used to clean the vagina and cervix for 30 seconds. The chlorhexidine was obtained through the NHS supply chain. No relabeling or modification of the available preparation was needed as the surgeon was not blinded to the intervention. Attempts were made to blind the women as the intervention was applied at the time of the catheter insertion and they should not be aware of the application due to anesthesia. During the 14 day interview, women were asked whether she felt she received the intervention, to assess whether blinding was achievable. The trial could not be blinded to the operator or the clinical care team in theatre providing care to the women due to the nature of the intervention and no suitable sham procedure could be utilized. The research midwife conducting the telephone follow-up interviews was blinded to the treatment allocation. The follow-up schedule included a six-week medical record review and two telephone interviews at 14 and 30 days post-randomization.

Pre-specified outcome measures were defined to assess the feasibility of the trial. As published in the protocol,[13] pre-specified stop/go criteria were outlined based on: the proportion of women randomized into the trial of the 250 recruitment target, the proportion of women who received their allocated intervention, the proportion of women remaining in the trial (i.e. not withdrawn) who successfully completed the planned follow-up process for both the 14- and 30-day telephone interview, and the proportion of women who withdrew from the trial. The stop/go criteria were assessed as follows: **Green light:** recruitment rate >90% of target, adherence rate >75%, follow-up rate >90% and withdrawal rate <15%; **Amber light**: recruitment rate 80-90%, adherence rate 50-75%, follow-up rate 75-90% and withdrawal rate 15-30%; **Red light:** recruitment rate <80%, adherence rate <50%, follow-up rate <75% and withdrawal rate >30%. Other feasibility outcomes (assessed without stop/go criteria) included: the proportion of women approached who were eligible, the proportion of elective/emergency CS recruited, the proportion of women who gave verbal consent out of the number of women who had an emergency CS approached, the proportion of women randomized who could successfully identify which treatment they received, the proportion of complete data for each of the clinical and patient-reported outcomes, and time taken to perform the telephone interviews.

The following clinical and patient-reported outcomes (PRO) were used. These were developed in the absence of a core outcome set; one has since been published and is consistent with the outcomes selected [14]. The endometritis outcomes were collected up to 30 days post-CS to be consistent with the CDC definition. The sepsis-related outcomes were collected until 6 weeks post-CS to be consistent with the national collection of postnatal sepsis guidelines. The day of delivery was regarded as Day 0.

- Proposed primary outcome: Endometritis as per the definitions set out by the CDC. Patients must meet at least one of the following criteria: 1. Patient has organism(s) identified from endometrial fluid or tissue by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment, for example, not Active Surveillance Culture/Testing (ASC/AST). 2. Patient has at least two of the following signs or symptoms: fever (>38.0°C), pain or tenderness (uterine or abdominal), or purulent drainage from uterus.[15]

Secondary outcomes:

- Clinical diagnosis of endometritis (day 0-30) where it is not feasible to establish that this meets the CDC definition or where the diagnosis does not meet the criteria.
- Maternal sepsis (day 0-42) defined according to the NICE sepsis guideline [16]
- Length of hospital stay from randomization to discharge home or transfer to another hospital post-CS, or up to 6 weeks after randomization if not discharged.
- Readmission to hospital after CS post-discharge for suspected or confirmed infection up until 6 weeks postnatally (day 0-42).
- Antibiotics prescribed as an inpatient and hospital prescribed outpatient (day 0-42) and antibiotics prescriptions for suspected/confirmed SSI relating to the woman's CS (uterine, pelvic, abdominal wound, or perineal).
- Level 2 or 3 critical care (or obstetric HDU type care) as a result of an infection until 6 weeks postnatally (day 0-42).

The PRO were determined by the qualitative component of this project and reported as an outcome of this pilot trial.[10]

1. Endometritis (treated) - Antibiotics (excluding non-reproductive infections such as respiratory infections and mastitis) and abnormal period pain or abnormal vaginal bleeding/discharge.
2. Endometritis (untreated) - At least 2 symptoms/signs from: abnormal period pain; abnormal vaginal bleeding/discharge; or patient-reported fever.
3. Incisional infection - Discharge from wound (pus) and antibiotics OR at least 2 signs (pain, redness, heat in skin incision) and dehiscence OR at least 2 signs and antibiotics.

Baseline characteristics are summarized with numbers and percentages for categorical variables, means and standard deviations for normally distributed continuous variables, or medians and interquartile ranges for non-normal continuous variables. Descriptive statistics are used to report feasibility outcomes between treatment arms and by center. Feasibility outcomes were analyzed by pooling both treatment arms and presenting overall estimates with 95% confidence intervals. Women who did not undergo a CS were excluded from all analyses of clinical and patient-reported outcomes. For binary clinical and patient-reported outcome measures, a log-binomial model was used to generate relative risks (and 95% confidence intervals) adjusting for the minimization variables. Continuous clinical and patient-reported outcomes deemed to be normally distributed were summarized using means

and standard deviations and a linear model was fitted to generate mean differences (and 95% confidence intervals) adjusting for the minimization parameters. Continuous outcomes not deemed to be normally distributed were summarized using medians and interquartile ranges and unadjusted differences in medians were produced (and 95% confidence intervals) using bootstrapping methods. All analyses were based on the intention to treat principle using complete case data and were performed using SAS (version 9.4) and Stata (version 14). No subgroup or sensitivity analyses were performed.

This trial was approved by the London - City & East Research Ethics Committee on 24th May 2017 (17/LO/0874) and registered ISRCTN33435996.

3 RESULTS

Participants had a mean age of 32.6 years, 12% of women were in labor at the time of randomization, 17% had rupture of membranes, 15% had a category 1 or 2 CS, 97% had a singleton pregnancy, and 58% of women had had a previous cesarean section. Table 1 provides further details of participant characteristics.

Between November 13th 2017 and March 3rd 2018 (15 weeks), 320 women (128% of target)) were randomly assigned to either vaginal cleansing (n=159) or standard practice of no vaginal cleansing (n=161, Figure 1). The trial over recruited above the 250 sample size due to the introduction of a 4 site and a pre specified minimum recruitment time of at least 12 weeks. The allocated intervention was received by 297 (93%, 95% CI 89-95) of the 320 women. Across three of the four trial sites this figure was at least 96% for each. However, at one site, only 67/83 (83%) participants were confirmed to have received their allocated intervention due to issues recording this information in the medical notes. One woman partially withdrew from the trial due to transfer of care. At 30 days, 319 women remained in the trial and 217 (68%, 95% CI 63-73) of them responded to both the 14 and 30 day telephone interview, with 82% of women being contacted at least once (Table 2). Women were contacted a median of 1 time (IQR 1-2) for each of the 14 and 30 day interviews.

Of 468 women screened, 421 (90%) were eligible. Of these, 320 women were randomized (76% of those eligible) of whom 318 delivered by CS (1 mode of delivery unconfirmed and 1 vaginal delivery). Of the 318 women, 230 (72%) had an elective CS (category 4) and 88 (28%) had an emergency CS (categories 1-3). Of the 88 women who had an emergency CS,

verbal consent was initially given by 32 (36%) women, with the remainder having sufficient time to give written consent. For all who consented verbally, written consent was obtained prior to discharge. Further details of feasibility outcomes are provided in Table 2.

In the VC arm, 2/152 (1.3%) women had endometritis as per the CDC definition compared with 1/155 (0.7%) in the no cleansing arm (RR 2.08, 95% CI 0.19-22.31). A clinical diagnosis of endometritis was reported in 2/152 (1.3%) women in the VC arm compared with 3/155 (1.9%) in the no cleansing arm (RR 0.65, 95% CI 0.11-3.75). Fifteen (9.6%) women received antibiotics for any indication in the VC arm in contrast to 23(14.3%) women in the no cleansing arm (RR 0.69, 95% CI 0.38-1.24). Further details of clinical and participant reported outcomes are provided in Table 3.

4 DISCUSSION

This pilot study demonstrates it is possible to perform an RCT of vaginal cleansing at CS. We have developed study processes that can facilitate verbal consent in an urgent setting allowing recruitment of this high-risk group. This process was acceptable to clinicians and women. The telephone randomization system successfully allocated treatment for recruited women in less than 3 minutes.

The primary objective of this pilot was to assess the feasibility of performing a trial of vaginal cleansing, including an assessment of clinical and patient-reported outcomes and ability to collect them. We have reported these outcomes in this paper, however, the pilot trial was not powered or designed to detect differences in the clinical effectiveness of the intervention. The research question remains important and a full effectiveness evaluation should be performed.

A strength of this study is the development of a verbal followed by-written consent process that facilitated consent of women in urgent situations. This worked well at 2 sites and allowed recruitment of emergency cases at rates comparable to the national split of emergency and elective cesarean sections. Recruitment of emergency and ‘in labor’ women was limited by the availability of research-trained staff 24 hours per day at 2 sites and a larger RCT would require careful site selection, identifying those sites that have established intrapartum research infrastructure such as site A and D. This explains the relatively low overall percentage of women in labor (12%), yet sites A and D have demonstrated that women having an emergency CS can be recruited. As those undergoing not in labor CS were recruited quickly and efficiently, sites in the full RCT would need fixed not in labor and in labor targets.

It is important to collect SSI rates during the full postnatal period, due to the number of infections identified and treated in the community.[17] The telephone process for collecting this data was labor intensive; this process would be unsustainable within a larger trial, as to achieve these follow-up rates 4 attempts at 14 & 30-days were required before a woman was deemed lost to follow-up. Follow-up rates were similar between emergency and elective CS. Having established the importance of collecting data from women who develop infection within the community, it is clear the patient-reported follow-up methods need modification but should form an important part of any future research.

5 CONCLUSION

This was a pilot trial to establish if a larger trial was feasible, through the development of processes for consent, randomization, and follow-up. We have demonstrated a larger trial of vaginal cleansing with chlorhexidine to prevent SSI is possible and acceptable to women/clinicians. Women can be recruited within an intrapartum emergency scenario, with the developed recruitment and consent processes. Women can also be followed up in the community. Cleansing the vagina with an antiseptic is potentially an important additional strategy to reduce SSI, especially in women undergoing a CS in labor. This trial was not designed to access the effectiveness of the intervention, yet it supports the need for further evaluation of vaginal cleansing with an alternative antiseptic to an iodine-based solution, where there are concerns regarding fetal absorption. This trial is acceptable to women and clinicians and can be performed with the developed recruitment and follow-up processes.

Acknowledgments

We would like to acknowledge the research teams, Principal Investigators and lead research midwives at the recruiting sites: Birmingham Women's and Children's Hospital, Birmingham Heartlands Hospital (Dr Sharon Morad and Lucy O'Leary), Princess Royal Hospital Telford (Dr Sheena Hodgett and Helen Millward) and Sunderland Royal Hospital (Mr Kim Hinshaw and Gill Campbell). We would like to also thank Lee Middleton and Jane Daniels who provided methodological support during the funding application.

An independent trial steering committee was appointed to oversee the trial and met regularly throughout the trial; we would like to thank Dr Jennifer Myers, Dr Stephen Kaey, and Elaine Stamp for their oversight.

Contribution to Authorship: VHM co-designed the trial, was PI at the lead site, and wrote the manuscript. CAH provided statistical input to the trial, analyzed the data and contributed to the manuscript. AW managed the trial and contributed to writing the manuscript. NF was the lead research midwife and supported the clinical conduct and recruitment of the trial. AWe lead and conducted the qualitative component of the trial and provided critical feedback on the manuscript. ED assisted with management of the trial and provided critical feedback on the manuscript. PH provided statistical oversight to the trial, supervised the data analysis, contributed to the interpretation of the results and provided critical feedback on the manuscript. PB provided methodological advice during the trial and provided critical feedback on the manuscript. RKM co-designed the trial, was CI and contributed to writing of the manuscript.

Tweetable abstract

A randomized controlled trial of vaginal cleansing with an antiseptic solution prior to elective and emergency cesarean section is feasible.

References

1. NHS Digital, *NHS Maternity Statistics, England 2017-18*. 2018, Health and Social Care Information Centre.
2. Wloch, C., et al., *Risk factors for surgical site infection following caesarean section in England: results from a multicentre cohort study.* Bjog, 2012. **119**(11): p. 1324-33.
3. Mackeen, A.D., et al., *Timing of intravenous prophylactic antibiotics for preventing postpartum infectious morbidity in women undergoing cesarean delivery.* Cochrane Database of Systematic Reviews, 2014(12).
4. Centre for Disease Control and Prevention (CDC). *National Healthcare Safety Network (NHSN) Patient Safety Component Manual* 2018 [cited 2018; Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/pcsmanual_current.pdf.
5. Knight M, N.M., Tuffnell D, Shakespeare J, Kenyon S, Kurinczuk JJ (Eds.) on behalf of MBRRACE-UK,, *Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2013–15.* 2017, Oxford: National Perinatal Epidemiology Unit, University of Oxford.
6. Caissutti, C., et al., *Vaginal Cleansing Before Cesarean Delivery: A Systematic Review and Meta-analysis.* Obstet Gynecol, 2017. **130**(3): p. 527-538.
7. National Institute for Health and Care Excellence (NICE). *Caesarean section Clinical Guideline (CG132)* 2012 [cited 2018; Available from: https://www.nice.org.uk/guidance/cg132.
8. Robuschi, G., et al., *Cord blood iodothyronine and thyrotropin concentrations in newborns of mothers exposed to povidone iodine in the last trimester.* J Endocrinol Invest, 1987. **10**(2): p. 183-6.
9. Tewfik H, I.A., Hanafi S, Fahmy A, Khaled M. Abdelrazak, Ibrahim A Abdelazim, *Preoperative Vaginal Preparation using Povidone Iodine versus Chlorhexidine Solutions in Prevention of Endometritis in Elective Cesarean Section.* Int.J.Curr.Microbiol.App.Sci., 2015. **4**(8): p. 486-492.
10. Weckesser, A., et al., *Women's perspectives on caesarean section recovery, infection and the PREPS trial: a qualitative pilot study.* BMC Pregnancy and Childbirth, 2019. **19**(1): p. 245.
11. Connelly, L.M., *Pilot Studies.* Medsurg Nursing, 2008. **17**(6): p. 411-2.
12. Joint Formulary Committee. *Chlorhexidine*. British National Formulary 2018; Available from: https://doi.org/10.18578/BNF.534548697.
13. Hodgetts Morton, V., et al., *Chlorhexidine vaginal preparation versus standard treatment at caesarean section to reduce endometritis and prevent sepsis-a feasibility study protocol (the PREPS trial).* Pilot Feasibility Stud, 2018. **4**: p. 84.
14. Briscoe, K.E. and D.M. Haas, *Developing a Core Outcome Set for Cesarean Delivery Maternal Infectious Morbidity Outcomes.* Am J Perinatol, 2019.
15. Centre for Disease Control and Prevention (CDC), *CDC/NHSN Surveillance Definitions for Specific Types of Infections*. 2018.
16. National Institute for Health and Care Excellence (NICE). *Sepsis Guideline [NG51]*. 2017; Available from: https://www.nice.org.uk/guidance/ng51.
17. Opoien, H.K., et al., *Post-cesarean surgical site infections according to CDC standards: rates and risk factors. A prospective cohort study.* Acta Obstet Gynecol Scand, 2007. **86**(9): p. 1097-102.

Legends of figures and tables

Figure 1. CONSORT - Participant Flow through PREPS

Table 1. Participant characteristics at randomization

Table 2. Feasibility outcomes by center and for all participants

Table 3. Clinical and participant reported outcomes

382 **Tables**

383 **Table 1: Participant characteristics at randomisation**

		Vaginal Cleansing (N=158)	**No Vaginal Cleansing** (N=161)
Labour Status[1] – no. (%)	In Labour	19 (12)	19 (12)
	Not in Labour	139 (88)	142 (88)
Site[1] – no. (%)	A	68 (43)	72 (45)
	B	42 (27)	41 (26)
	C	27 (17)	28 (17)
	D	21 (13)	20 (12)
Age (years)	Mean (SD)	33.1 (5.6)	32.0 (5.2)
Booking BMI (kg/m²)	Mean (SD)	28.2 (6.8)	28.8 (6.6)
Ethnicity – no. (%)	White	122 (77)	117 (73)
	Asian	24 (15)	25 (16)
	Black	6 (4)	4 (2)
	Other	6 (4)	15 (9)
Diabetes[2] – no. (%)		8 (5)	4 (2)
Hypertension[2] – no. (%)		6 (4)	7 (4)
Autoimmune Disease[2] – no. (%)		3 (2)	2 (1)
Cardiac Disease[2] – no. (%)		0 (-)	1 (1)
HIV infection[2] – no. (%)		1 (1)	0 (-)
Parity – no. (%)	0	40 (25)	48 (30)
	1	68 (43)	56 (35)
	2	33 (21)	34 (21)
	3	11 (7)	20 (12)
	4	5 (3)	3 (2)

		Vaginal Cleansing (N=158)	No Vaginal Cleansing (N=161)
	≥5	1 (1)	0 (-)
Number of previous caesarean sections – no. (%)	0	65 (41)	69 (43)
	1	67 (42)	65 (40)
	2	22 (14)	20 (13)
	3	4 (3)	7 (4)
Previous open abdominal surgery – no. (%)		14 (9)	19 (12)
Gestation at delivery (weeks)	Median [IQR]	39.0 [38.3-39.4]	39.1 [38.4-39.4]
	Missing[3]	1	0
Type of Pregnancy – no. (%)	Singleton	154 (97)	156 (97)
	Multiple	4 (3)	5 (3)
Gestational diabetes[4, 6] – no. (%)		14 (9)	15 (9)
Pregnancy induced hypertension[6] – no. (%)		5 (3)	6 (4)
Pre-eclampsia[6] – no. (%)		3 (2)	7 (4)
HELLP syndrome[5, 6] – no. (%)		0 (-)	0 (-)
Obstetric cholestasis[6] – no. (%)		3 (2)	4 (2)
Ongoing smoker at booking – no. (%)		23 (15)	21 (13)
Used non prescribed recreational drugs in this pregnancy[7] – no. (%)		0 (-)	3 (2)
Alcohol consumption during this pregnancy – no. (%)		1 (1)	1 (1)
	Missing	1	0

[1]Minimisation variable.
[2]Pre-pregnancy medical condition.
[3]One participant with missing gestation data was transferred to another hospital so date baby delivered was not collected.
[4]Gestational diabetes defined as diet, tablet or insulin controlled diabetes developed during pregnancy.
[5]HELLP is an abbreviation of the three main features of the syndrome: Hemolysis, Elevated Liver enzymes, and Low Platelet count.
[6]Medical conditions developed during pregnancy.
[7]Non-prescribed recreational drugs include cannabis and ventolin inhaler.

396
397 **Table 2: Feasibility outcomes by centre and for all participants:**

	Site A	Site B	Site C	Site D	All participants
Number of eligible participants					
Number screened – no.	200	149	70	49	468
Eligible – no. (%)	173 (87)	133 (89)	67 (96)	48 (98)	421 (90) [87-93][1]
Recruitment					
Target sample size – no.	100	75	75	-	250
Participants randomised – no. (%)	141	83	55	41	320 (128) [-][1]
Elective and emergency CS with verbal consent					
CS performed – no.	140	82	55	41	318
Elective CS[3] – no. (%)	74 (53)	78 (95)	50 (91)	28 (68)	230 (72) [67-77][1]
Emergency CS[4] – no. (%)	66 (47)	4 (5)	5 (9)	13 (32)	88 (28) [23-33][1]
Category 1 – no.	9	0	0	0	9
Category 2 – no.	25	2	1	10	38
Category 3 – no.	32	2	4	3	41
Verbal consent – no. (%)	24 (36)	2 (50)	1 (20)	5 (38)	32 (36) [26-47][1]
Written consent – no. (%)	42 (64)	2 (50)	4 (80)	8 (62)	56 (64) [53-74][1]
Adherence					
Received allocated intervention – no. (%)	137 (97)	67 (81)	53 (96)	40 (98)	297 (93) [89-95][1]
Did not receive allocated intervention – no. (%)	4 (3)	2 (2)	2 (4)	1 (2)	9 (3)
Unable to confirm if received allocated intervention – no. (%)	0 (-)	13 (16)	0 (-)	0 (-)	13 (4)
Withdrew from trial intervention – no. (%)	0 (-)	1 (1%)	0 (-)	0 (-)	1 (<1)
Woman's recall of treatment allocation					
Treatment data available – no.	141	69	55	41	306
Correctly identified treatment – no. (%)	5 (4)	2 (3)	1 (2)	2 (6)	10 (4) [2-7][1]
Incorrectly identified treatment – no. (%)	5 (4)	5 (9)	3 (6)	2 (6)	15 (6)
Unable to identify treatment – no. (%)	103 (92)	52 (88)	43 (92)	29 (88)	227 (90)
Missing – no.	28	10	8	8	54
Retention-telephone interviews					

	Site A	Site B	Site C	Site D	All participants
Non-withdrawn participant's able to receive calls[5] – no.	141	82	55	41	319
Participants who had 14-day telephone interview – no. (%)	113 (80)	69 (84)	47 (85)	33 (80)	262 (82) [77-86][1]
Participants who had 14 and 30-day telephone interview – no. (%)	90 (64)	63 (77)	38 (69)	26 (63)	217 (68) [63-73][1]
Time taken to perform the telephone interviews (minutes)					
14 day telephone interview conducted – no.	113	69	47	33	262
Time taken to perform interview *median (IQR)*	5 (5-6)	5 (5-6)	5 (5-6)	4 (4-5)	5 (5-6) [5, 5][2]
Missing– no.	1	1	-	-	2
30 day telephone interview conducted – no.	90	63	38	26	217
Time taken to perform interview *median (IQR)*	2 (2-3)	2 (2-3)	2 (2-3)	2 (2-2)	2 (2-3) [2, 2][2]
Missing– no.	1	-	-	-	1
Withdrawal					
Number of participants withdrawn – no. (%)	0 (-)	1 (1)	0 (-)	0 (-)	1 (<1) [0-2][1]
Type of withdrawal					
Trial Treatment – no.	-	1	-	-	1
Telephone interviews – no.	-	1	-	-	1
Data collection from medical notes – no.	-	0	-	-	0
All data previously collected – no.	-	0	-	-	0

[1]N (%) [95% CI]

[2]Median (IQR) [95% CI]

[3]Elective CS defined as category 4 (to suit woman and the maternity services) CS.

[4]Emergency CS defined as category 3 (early birth without compromise), category 2 (maternal or fetal compromise) or category 1 (threat to the life of the mother or fetus).

[5]One participant withdrew from telephone interviews.

Table 3: Clinical and participant reported outcomes

	Vaginal Cleansing	No Vaginal Cleansing	Treatment effect estimate (95% CI)
Clinical outcomes			
Endometritis by CDC definition – no. (%)	2/152 (1.3)	1/155 (0.7)	2.08 (0.19, 22.31)[1]
Clinical diagnosis of endometritis – no. (%)	2/152 (1.3)	3/155 (1.9)	0.65 (0.11, 3.75)[1]
Maternal sepsis – no. (%)	3/153 (2.0)	3/156 (1.9)	1.06 (0.23, 4.94)[1]
Readmission to hospital – no. (%)	2/156 (1.3)	1/161 (0.6)	2.07 (0.19, 22.30)[1]
Antibiotics (all usage) – no. (%)	15/156 (9.6)	23/161 (14.3)	0.69 (0.38, 1.24)[1]
Antibiotics for suspected/confirmed SSI – no. (%)	12/155 (7.7)	18/161 (11.2)	0.71 (0.36, 1.41)[1]
Critical care due to infection – no. (%)	0/153 (-)	2/157 (1.3)	-
Length of hospital stay (days) - median [IQR]	2 [1-3]	2 [1-3]	0.0 (-0.11, 0.11)[2]
Participant reported outcomes			
Endometritis (treated) – no. (%)	5/111 (4.5)	4/106 (3.8)	1.21 (0.34, 4.36)[1]
Endometritis (untreated) – no. (%)	6/111 (5.4)	4/107 (3.7)	1.43 (0.42, 4.90)[1]
Incisional infection – no. (%)	10/111 (9.0)	19/107 (17.8)	0.52 (0.25, 1.06)[1]
EQ5D5L index score at 14 days post CS[4] *mean (SD, N)*	0.95 (0.08, 131)	0.93 (0.11, 129)	0.02 (-0.003, 0.04)[3]
EQ5D5L health state at 14 days post CS[5] *mean (SD, N)*	83.02 (13.03, 133)	82.18 (14.43, 129)	0.83 (-2.48, 4.14)[3]
EQ5D5L index score at 30 days post CS[4] *mean (SD, N)*	0.97 (0.08, 108)	0.98 (0.06, 103)	-0.01 (-0.03, 0.01)[3]
EQ5D5L health state at 30 days post CS[5] *mean (SD, N)*	87.34 (13.70, 109)	85.88 (13.88, 105)	1.50 (-2.24, 5.24)[3]

Note: denominators are data available for analysis.

[1]Risk ratio. Values <1 favour vaginal cleansing with chlorhexidine. Adjusted for minimisation variables: centre and in labour/not in labour status.

[2]Difference in medians. Values <0 favour vaginal cleansing with chlorhexidine.

[3]Mean difference: values >0 favour vaginal cleansing with chlorhexidine. Adjusted for minimisation variables: centre and in labour/not in labour status.

[4]EQ5D5L index scores range from –0.59 to 1, where 1=perfect health, 0=death and negative scores imply a health status worse than death.

[5]EQ5D5L health state scores range 0 to 100, where 0=worst health you can imagine and 100=best health you can imagine.