

# Intraoperative contamination of suction tips as a source of infection during cesarean deliveries: a pilot study

## Abstract

**Objective:** To assess risk factors for contamination of suction tips during cesarean deliveries, and correlate these with infectious morbidity.

**Study design:** Yankauer tips were cultured during 100 cesarean deliveries. Positive cultures had growth of greater than or equal to 1,000 colonies/mL. We assessed association of positive cultures with multiple variables using student t-tests and Chi-squared.

**Results:** Cultures were positive in 5% of the specimens, and a 21% contamination rate was noted for growth of at least 100 colonies/mL. Culture positivity was associated with ruptured membranes ( $p=0.007$ ), rupture greater than 12 hours ( $p=0.04$ ), cervical dilation greater than 5 cm ( $p=0.04$ ), and use of intrauterine monitors ( $p=0.03$ ). 15% of patients experienced postoperative infection, but we did not identify an association with culture positivity ( $p=0.42$ ). During data collection, we noted a change in routine operative procedure, with surgeons discarding the suction tip after it was cultured.

**Conclusion:** While we identified several variables associated with positive cultures, we did not demonstrate an association with infectious morbidity; perhaps reflecting the discarding of suction tip intraoperatively; accordingly, the clinical implications of our findings remain uncertain. Future RCTs comparing continued use versus discarding the suction tip would allow assessment of its role as a nidus for postoperative infection.

**Keywords:** suction, equipment contamination, postoperative wound infection, cesarean section

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## Introduction

Despite widespread use of sterile technique and prophylactic antibiotics, surgical site infections (SSI) represent the most common adverse event of cesarean deliveries, following urinary tract infections.<sup>1,2</sup> SSI is estimated to occur in 3-15% of patients,<sup>3,4</sup> and includes wound cellulitis or abscess, pelvic cellulitis or abscess, and endometritis.<sup>5</sup>

A fundamental precursor to SSI is microbial contamination of the surgical site.<sup>5</sup> The proposed pathogenesis following cesarean delivery involves inoculation of the incision with cervicovaginal flora.<sup>5,6</sup> The vagina is colonized with multiple bacteria, with more likely to be introduced in laboring patients.<sup>5</sup> Cervical exams and insertion of foreign bodies such as transcervical Foley catheters and intrauterine monitors may increase risk of contamination of the uterine incision.

Yankauer suction devices represent another potential source of contamination. There is a theoretical risk that the bacteria transferred into the cervix and lower uterine segment during labor may contaminate the suction tip while removing blood, amniotic fluid, and meconium from the area of the hysterotomy. This potential contamination is more likely in cases of prolonged labor, ruptured membranes, advanced cervical dilation, and use of intrauterine monitors.

Intraoperative contamination of suction tips has been demonstrated in orthopedic surgery and veterinary medicine, but has not been evaluated in Obstetrics.<sup>7-9</sup> Obstetricians commonly utilize the same suction tip throughout the entire surgery, including closure of the fascia and skin. If contamination does occur, continued use of the

same suction tip may further inoculate the skin and deeper tissues, contributing to postoperative wound infections.

## Materials and methods

This pilot study was approved by the institutional review board at UF Health in Jacksonville, Florida, and a waiver of informed consent was obtained. Starting on January 24, 2014, we began culturing Yankauer suction tips intraoperatively during all cesarean deliveries performed for any indication. All pregnant women undergoing a cesarean delivery at the UF Health Labor and Delivery Unit in Jacksonville, Florida met inclusion criteria. The study was concluded when 100 cultures were obtained. This study included both laboring patients, and those with scheduled elective repeat cesarean deliveries.

Study protocol stated that cesarean deliveries were to be performed in routine fashion, with no changes in protocol or surgical technique. Immediately prior to surgery, the patient's abdomen was prepped in standard fashion with a chlorhexidine gluconate solution. According to standard practices at our institution, no vaginal prep was to be used. Patients were given prophylactic antibiotics prior to skin incision in accordance with ACOG and hospital guidelines, with the antibiotic type and dosage based on BMI and medication allergies. All preoperative antibiotics were administered prior to skin incision. Patients in labor who were known to be Group B *streptococcus* carriers also received their routine prophylactic antibiotics. Patients diagnosed with chorioamnionitis also received additional antibiotic treatment. Delivery of the infant was performed per standard cesarean surgical procedures.

Immediately after closure of the hysterotomy, prior to any irrigation being performed, the suction tip was cultured using the Copan ESwab liquid collection and transport system (COPAN DIAGNOSTICS, Inc. Murrieta, CA). The dry cotton swab of the ESwab kit was used to gently swab the outside and inside of the Yankauer suction tip. The swab was then directly placed into the ESwab transport tube in the liquid Amies medium, and transported to the hospital microbiology department for immediate processing. The microbiology department independently processed all specimens without being supplied with any information regarding the patient or circumstances surrounding her delivery. Per microbiology protocol, if colony counts greater than or equal to 100/mL were identified, up to three unique organisms were identified. A positive culture was defined as growth of greater than or equal to 1,000 colonies/mL.

Data was collected for multiple variables including patient age, body mass index, group B *streptococcus* status and gestational age. Labor was defined as regular uterine contractions with cervical change. Patients were classified as either in labor before surgery or not. For those patients in labor prior to surgery, labor variables were also studied including presence of ruptured membranes prior to time of cesarean, duration of ruptured membranes longer than 12 hours, presence of cervical dilation greater than or equal to five centimeters, number of vaginal exams performed greater than or equal to five, use of intrauterine monitors in labor, use of vaginal hand to assist with fetal head during cesarean delivery, presence of meconium stained fluid, and antibiotics administered other than routine preoperative prophylaxis (i.e., treatment for chorioamnionitis). We also followed each patient's postoperative course for 6 weeks to assess for any infectious morbidity, including wound infections and endometritis.

Data analysis was performed using STATA 11.0 software (StataCorp, College Station, TX). Continuous variables were evaluated using unpaired Student t-tests. Binary variables were evaluated with either Chi-squared or Fisher's exact tests were performed as indicated, with  $p < 0.05$  as statistically significant.

## Result

The study included 100 women who presented for cesarean delivery for any indication. The demographic and labor characteristics of all included patients are summarized in Tables 1 & 2. We found a 5% intraoperative contamination rate of the suction tip during cesarean delivery, using a definition of growth of greater than or equal to 1,000 colonies/mL. The proportion of tips found to have at least 100 colonies/mL contaminations was 21%. Organisms identified included various species of *staphylococcus*, *streptococcus*, *enterococcus*, *bacillus* and *candida*. Details of all cultures with 100 colonies/mL or more are included in Table 3.

We noted a statistically significant association of positive cultures with presence of ruptured membranes ( $p = 0.007$ ), ruptured membranes 12 hours or longer ( $p = 0.04$ ), the use of intrauterine monitors ( $p = 0.03$ ), and cervical dilation greater than or equal to 5cm ( $p = 0.04$ ). Details of the remaining variables analyzed are listed in Table 4 below. We noted that 86 of the patients included in the study presented for postpartum follow-up. Of those 86 patients, 13 were diagnosed with an infectious complication (15.1%). There were 13 cases of postoperative wound infections, including 1 complicated by complete evisceration. There were no diagnosed cases of endometritis or other surgical site infections.

**Table 1** Patient demographic information

Age	
Mean (Range)	28 (16-40)
Race	
Black	57
White	23
Hispanic	10
Other	10
Gestational age	
Mean	38w3d
Range	26w1d -41w5d
Body Mass Index (BMI)	
Mean (Range)	35 (19-86)
Obesity Category (BMI Range)	
Normal (18.5-24.9)	8
Overweight (25-29.9)	25
Obese (30-34.9)	30
Severely Obese (35-39.9)	13
Morbid Obesity (40+)	24

**Table 2** Labor characteristics

Presence of labor prior to cesarean	62	
GBS positive	22	
Ruptured membranes at time of cesarean	37	
Duration of ruptured membranes	Median	7.5hrs
	Range	20min to 8 days
	Ruptured membranes ≥12hrs	9
Cervical dilation ≥ 5cm	34	
Intrauterine monitors	30	
Vaginal exams in labor	Number of exams (range)	2.4 (0–13)
	Number of exams≥5	22
Vaginal hand to assist with cesarean	2	
Meconium stained amniotic fluid	7	
Antibiotics other than routine pre-operative	17	
GBS prophylaxis	14	
Chorioamnionitis treatment	2	
PPROM latency antibiotics	1	

**Table 3** Culture results reported with growth greater than or equal to 100colonies/mL

1	Coagulase negative Staphylococcus 600colonies/ml
2	Enterococcus species >10 000colonies/ml, Yeast, not Candida albicans >10 000colonies/ml
3	Enterococcus species 1000colonies /ml, Alpha hemolytic Streptococcus 1100colonies/ml
4	Enterococcus species 2200colonies/ml
5	Staphylococcus aureus 300colonies/mL
6	Coagulase negative Staphylococcus 1,000colonies/mL
7	Coagulase negative Staphylococcus 100colonies/ml
8	Coagulase negative Staphylococcus 400colonies/ml
9	Coagulase negative Staphylococcus 100colonies/mL
10	Coagulase negative Staphylococcus 100colonies/mL
11	Coagulase negative Staphylococcus 100colonies/mL
12	Coagulase negative Staphylococcus 100colonies/mL
13	Bacillus species, not anthracis 100colonies/mL
14	Coagulase negative Staphylococcus 400colonies/mL
15	Coagulase negative Staphylococcus 300colonies/mL
16	Candida albicans 700colonies/mL
17	Viridans Streptococcus >10,000colonies/mL, Streptococcus agalactiae 200colonies/mL
18	Coagulase negative Staphylococcus 100cols/mL
19	Candida albicans 100cols/mL
20	Coagulase negative Staphylococcus 100cols/mL
21	Coagulase negative Staphylococcus 100colonies/mL

**Table 4** Study variables

Study variable	Chi-squared p-value (*Fisher's Exact p-value)
Patient's Age	0.34
Body Mass Index (BMI)	0.12
Gestational Age	0.92
GBS Positive Status	0.45
Onset of Labor Prior to Cesarean	0.15*
Ruptured Membranes at Time of Cesarean	0.007*
Ruptured Membranes greater than or equal to 12 hours	0.04*
Number of Vaginal exams greater than or equal to 5	0.07*
Cervical Dilation greater than or equal to 5cm	0.04*
Use of Intrauterine Monitors	0.03*
Vaginal Hand Assistance During Cesarean Delivery	>0.99*
Meconium Stained Amniotic Fluid	0.31*
Antibiotics Given other than Routine Pre-op Prophylaxis	0.62*
Postpartum Infectious Morbidity	0.42*

## Discussion

We observed positive cultures for 5% of suction tips, and 21% grew at least 100colonies/mL. We demonstrated associations of culture positivity with several labor variables, but did not identify an association with postoperative infectious morbidity. Ruptured membranes are a known risk factor for SSI. Positive cultures were correlated with ruptured membranes ( $p=0.007$ ), and duration of rupture of at least 12 hours ( $p=0.04$ ). Consistent with reports by Johnson, following membrane rupture, the amniotic fluid is no longer sterile, and its contamination with vaginal flora may lead to further infection of the uterine and skin incisions.<sup>2</sup>

We also found that culture positivity was significantly associated with cervical dilation of at least 5cm ( $p=0.04$ ), and the use of internal monitors ( $p=0.03$ ), likely reflecting ascending contamination of the cervix and uterus with vaginal flora through the labor process.<sup>5,6</sup> We identified a trend toward increasing contamination with more frequent cervical checks, likely reflecting this ascending contaminations as well ( $p=0.07$ ). The number of cervical exams may be underreported, as only checks performed by obstetricians and nurse-midwives were documented in the chart, while those performed by nurses were not. These documented checks were therefore used as an approximation for the number cervical exams.

In instances when the fetal head is at a very low station, a vaginal hand may be used to facilitate cesarean delivery.<sup>10</sup> Although we anticipated that use of vaginal hand assistance during surgery would increase ascending infection and rates of suction tip contamination, we did not identify an association between this occurrence and positive cultures ( $p>0.99$ ), likely reflecting that our study population included only two deliveries requiring vaginal hand assistance.

Most positive cultures were found in patients with onset of labor prior to cesarean delivery, but this association did not reach significance ( $p=0.15$ ). While 7 of the 21 cultures growing 100 colonies/mL or more were from swabs obtained during elective repeat cesarean deliveries performed prior to the onset of labor, none of the cultures with greater than 1,000 colonies/mL were from non-laboring patients.

A recent Cochrane review demonstrated an association between meconium stained amniotic fluid and maternal infections, suggesting that the presence of meconium impairs the maternal immune response and enhances bacterial growth by altering the antibacterial properties of the amniotic fluid.<sup>11</sup> The association between culture positivity and meconium stained fluid in our study did not reach statistical significance ( $p=0.31$ ), likely reflecting inadequate statistical power, as our study population included only 7 patients with documented meconium stained amniotic fluid.

We also did not identify a significant association between positive cultures and GBS positive status ( $p=0.45$ ). This may reflect that GBS positive laboring patients received prophylactic antibiotics, which may have provided additional protection against suction tip contamination.

While we did not identify an increase in the rate of postoperative infections associated with positive suction tip cultures ( $p=0.42$ ), the clinical significance of this finding remains uncertain. Due to unplanned, documented, altered surgical protocol, intake forms indicated that no suction tips were utilized intraoperatively after obtaining the culture swab. Prior to beginning this study, it was routine practice for surgeons to utilize the same Yankauer suction tip for closure of the hysterotomy, fascia and skin. This altered surgical procedure might reflect observation bias (Hawthorne effect). The Hawthorne effect refers to the tendency for individuals to change their

behavior when they are aware of being observed.<sup>12,13</sup> Due to awareness of a research study which highlighted possible increased infection with continued use of the tip, obstetric providers may have altered surgical technique with the intent of minimizing this risk. Since no suction tips utilized after the culture was obtained, we are unable to comment on the potential transfer bacteria from the contaminated tip to more superficial layers of closure leading to postoperative wound infections.

While this pilot study focused on risk factors associated with suction tip culture positivity, future appropriately powered studies should be designed to further evaluate the clinical implications of this contamination, specifically postoperative infections. Future RCTs could compare utilizing and not utilizing the original suction tip after closure of the hysterotomy, as well as the association between tip culture and incidence of postoperative infections. If such associations were identified, this might inform obstetricians with respect to changing out suction tips intraoperatively, new or additional antibiotic coverage, or vaginal prepping prior to surgery.

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## Conflicts of interest

The authors declare there is no conflict of interests.

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