Title:

Detection of SARS CoV-2 contamination in the Operating Room and Birthing Room Setting: Risks to attending health care workers (a prospective cross-sectional study)

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ABSTRACT (249 words)

Background:

The exposure risks to front-line health care workers (HCWs) who are in close proximity for prolonged periods of time, caring for COVID-19 patients undergoing surgery or obstetrical delivery, is unclear. Understanding of sample types that may harbour virus is important for evaluating risk.

Aim

To determine if SARS-CoV-2 viral RNA from patients with COVID-19 undergoing surgery or obstetrical delivery is present in: 1) the peritoneal cavity of males and females 2) the female reproductive tract, 3) the environment of the surgery or delivery suite (surgical instruments, equipment used, air or floors) and 4) inside the masks of the attending health care workers.

Methods

In this cross-sectional study, conducted at 2 Toronto hospitals, 32 patients with COVID-19 underwent urgent surgery or obstetrical delivery and the presence of SARS-CoV-2 viral RNA in patient, environmental and air samples was identified by real time reverse transcriptase polymerase chain reaction. Air samples were collected using both active and passive sampling techniques. The primary outcome was the proportion of HCW masks positive for SARS-CoV-2 RNA.

Results

SARS-CoV-2 RNA was detected in 20/332 (6%) patient and environmental samples collected: 4/24(16.7%) patient, 5/60(8.3%) floor, 1/54(1.9%) air, 10/23(43.5%) surgical instruments/equipment, 0/24 cautery filters and 0/143(95%CI, 0-0.026) inner surface of mask samples.

Interpretation

While there is evidence of SARS-CoV-2 RNA in the surgical and obstetrical operative environment, the finding of no detectable virus inside the masks worn by the medical teams would suggest a low risk of infection for our health care workers using appropriate personal protective equipment.

TEXT (2387 words)

INTRODUCTION (394 words)

While front line health care workers (HCWs) are at risk of contracting infections when caring for patients with COVID-19[1-3], the risks of HCWs involved in surgery and obstetrics (work involving close, direct and often prolonged patient contact) remains unclear. HCWs involved in surgery or obstetrics may be at risk of SARS-CoV-2 infections through the known vectors of respiratory droplets, aerosols and fomites[4-6], but infections may potentially be transmitted through exposure to the virus originating from the surgical field or the delivery itself.

SARS-CoV-2 is found in the respiratory tract of infected persons[7-10]. Additionally, the virus has been documented to be present in the gastrointestinal (GI) tract and consequently any bowel-related surgery that involves opening the GI tract is thought to pose a risk to medical teams[11,12]. There are also reports of SARS-CoV-2 virus detected in peritoneal fluid from patients with COVID-19 undergoing surgery[13,14]. In the female reproductive tract, SARS-CoV-2 RNA has been identified in amniotic fluid and vaginal swabbing[15-18]. Potentially, if the virus is present on peritoneal surfaces of males or females, in the female reproductive tract or other surgical sites, this virus could be aerosolized via cautery smoke, or, from the release of CO_2 gas from laparoscopic procedures. While there is no current published research on the presence of SARS-CoV-2 in the surgical smoke/ plume, there is existing literature which identified other viruses including human papillomavirus, Human Immunodeficiency Virus-1 and Hepatitis B virus in surgical smoke[19-28].

The risks of aerosolization from the respiratory tract is recognized[29], but the risk of SARS-CoV-2 residing in the surgical site and the subsequent risk of aerosolizing this virus is not well studied. We studied the risk of contamination in the operating room (OR) and birthing suite by evaluating the risk of

aerosolization from the respiratory tract or from the surgical/obstetrical field during surgery or labor and delivery. This information is key to assessing the risks to HCWs who care for such patients and may help guide best practice regarding the use of personal protective equipment and safety in the OR and birthing room.

The objectives are to determine if SARS-CoV-2 RNA from patients with COVID-19 undergoing surgery or obstetrical delivery is present in: 1) the peritoneal cavity (males/females), 2) female reproductive tract, 3) on surgical instruments/equipment, 4) procedure room floors, 5) bioaerosols produced during surgery or obstetrical delivery, and 6) inside surgical masks of the attending HCWs.

METHODS

Study Design

From November 2020 to May 2021, patients with a nasopharyngeal (NP)/mid-turbinate (MT) swab positive for SARS-CoV-2 by RT-PCR (reverse transcriptase polymerase chain reaction), in need of urgent surgery or obstetrical delivery at one of two large academic Toronto hospitals: Sunnybrook Health Sciences Centre (Sunnybrook) or Sinai Health System, were prospectively identified by the surgical/obstetrical clinical teams. This study was approved by both hospitals' Research Ethics Boards.

Patient samples (peritoneal fluid, vaginal, myometrial or placental swabs) were collected in patients providing informed consent. Attending HCW mask sampling was performed with HCW consent. Patient or HCW consent was not required for sampling from the air, floor, surgical instrument or cautery filters. Consenting HCWs agreed to follow up with hospital Occupational Health if SARS-CoV-2 RNA was detected on their mask.

Patient clinical and laboratory data were obtained by chart review and/or participant interview.

Eligibility:

Patients included those who tested positive by NP swab, either symptomatic or asymptomatic within 30 days of diagnosis; or known symptomatic COVID-19 positive patients beyond 30 days of diagnosis.

HCWs included any consenting HCW present in the operating/delivery room, caring for the patient.

Study Samples (Appendix A included for detail):

Patient sampling for laparotomy cases included peritoneal cavity fluid (male or female). Patient samples for obstetrical cases included: vaginal fluid, swabs of the myometrium (at time of caesarean section) and membranous placenta.

Equipment and environmental samples included: swabs of the room floor (within 1 metre from the surgical site, and 2 metres away from the surgical site[6]; collection of the cautery filter; swab of equipment (e.g. endotracheal tube, saw blade, surgical instruments etc); and swab of the inside of the surgical mask worn by HCWs[30-32].

Bioaerosol sampling was obtained via two previously described methods: 1) Active air sampling via the GilAir Plus sampler was used at two locations: as close to the surgical site as possible (within 0.5-1 metres) and 2-3 metres away (Sensidyne®, https://www.sensidyne.com/air-sampling-equipment/gilian-air-sampling-pumps/gilair-plus/)[33], and 2) Passive air sampling was performed using an open Petri dish to collect any viral particles settling by gravity in the dish (within 1-2 metres of the patient, 1 metre off the floor)[31,34-37]. Passive air sampling was added for the last third of the cases due to newly published information[31,34-36].

Laboratory Methods:

All samples were processed at Sunnybrook. Aside from the cautery and active air sample filters, the laboratory staff were blinded to the source of the sample.

Virus detection was performed by real-time RT-PCR using a multi-target assay currently utilized in the laboratory[38].

Additionally, the Ct (cycle threshold) value of the assay as an estimate of the viral load was obtained for all samples where possible, including values from the patient's initial diagnostic swab.

The outcome of interest was SARS-CoV-2 RNA PCR positive samples. Whole genome sequencing was not performed with our surgical/obstetrical samples, but was performed on diagnostic nasopharyngeal swabs when possible, to identify variants of concern (VOC).

Sample Size and statistical analysis:

The primary outcome was the rate of SARS-CoV-2 RNA PCR positive samples from the HCWs masks. The expected outcome was 0% positivity. We planned to study 40 patients with an expected mean of 2-3 HCW masks per patient (or 100 mask samples) which, with an expected positive rate of 0%, would provide a 95% confidence interval range of 0-5% (R Statistical Software: R version 3.5.3, 2019). The study was closed after sampling from 32 patients, with the collection of 143 masks providing adequate data to study the primary outcome. Analysis was performed on all available data.

Descriptive statistics, Shapiro-Wilk normality test, Mann-Whitney U test and 2-sample test for equality of proportions with continuity correction tests were used where appropriate (R Statistical Software: R version 3.5.3, 2019).

RESULTS

Patients:

A total of 32 patients with COVID-19 (Table I), 18 female and 14 male, were enrolled (mean 53.55 years, SD = 18.068, range: 20-88 years): 9 obstetrical patients from Sunnybrook and Sinai Health System, and 23 urgent surgical patients from Sunnybrook. All patients and/or surgical team leads approached to enter this study agreed and provided consent.

Of the 32 patients enrolled, the patient's first SARS-CoV-2 positive nasopharyngeal swab occurred a median of 4 days before their procedure (mean 13.77, range: 0-70 days). 11/32 patients had a repeat NP swab closer to the date of their procedure (median 3, mean 5.08, range: 0-24 days).

Samples tested:

A total of 343 samples were taken for SARS-CoV-2 RNA detection: 11/343 were duplications (1 patient submitted 2 masks; 10/12 endotracheal tubes (ETT) were sampled twice with different methodology: flocked swab (4/12 samples positive for viral RNA) and dental pledget (7/10 samples positive). Twenty of the 332 (6.02%) samples tested positive for SARS-CoV-2 RNA (Table II): 8/12 ETT, 1/6 peritoneal fluid (1/5 caesarean section cases, 0/1 trauma laparotomy case) , 1/7 placentas, 1/4 myometrial swabs, 1/7 vaginal fluid, 2/11 samples from surgical equipment of 11 different surgical cases, 1/7 passive air samples, and 5/60 floor samples There were no positive samples for SARS-CoV-2 RNA from among cautery filters (0/24 cases); active air sampling (0/47, 25 cases) and the inside of HCWs masks (0/143, 95% CI 0-0.026, 32 cases sampled).

In 5 surgical cases, the initial positive diagnostic test was beyond 30 days: 1 caesarean section (30 days) and 4 tracheostomies (50, 54, 62 and 70 days). Four of 5 of these cases (30, 54, 62, and 70 days) had positive ETT samples, and 2 of the 4 ETT positive cases had positive floor samples (54 and 62 days since diagnosis of COVID-19).

VOC were identified in 10 cases. Of the 10 VOC cases: 9 were the Alpha variant (United Kingdom/B.1.1.7), and 1 was either Beta or Gamma variant (South African/B.1.351 or Brazilian/P.1). Of

the 10 VOC cases, the following sites tested SARS-CoV-2 RNA positive: 3/4 endotracheal tubes (75%), 2/18 floor samples (including one sample 2 metres away), 1/5 passive air samples, 2/6 cases where the surgical instruments were tested. There was no significant difference between the proportion of positive samples when comparing the VOC group (n=10) versus unknown/not VOC group (n=22).

The cycle threshold (Ct) value of the initial nasopharyngeal swab positive for SARS-CoV-2 RNA was recorded for 20/32 patients (median: 30.3, mean: 26.65, range: 11.86–37.25). For the VOC group, 9/10 had Ct values recorded (median: 24.41, mean: 24.52 [95% CI: 18.72-30.99], range: 11.86–37.25). For the group that is unknown/not VOC, 11/22 had Ct values recorded (median: 31.10, mean: 28.41 [CI: 25.35-30.33], range: 13.45–35.29). There was no significant difference in Ct values between these two groups (Mann-Whitney U test, p=0.4561). The Ct values of the initial NP swabs were significantly lower (indicating higher viral loads) in those tested who were subsequently found to have any study sample with SARS-CoV-2 RNA (13/32: Ct recorded in 8/13) versus those without any positive study samples (19/32: Ct recorded in 12/19) with a mean Ct 21.72: 95% CI 16.90-27.29 vs mean 29.96: 95% CI 27.07-33.43 respectively (Mann-Whitney U test, p=0.007).

INTERPRETATION

Several studies have documented potential risks of SARS-CoV-2 infection to HCWs in clinic and hospital ward settings and with tracheostomies (an aerosol generating procedure)[1,6,29,39]. To our knowledge, this is the first study evaluating potential exposure risks to HCWs in the operating room with a variety of surgical procedures not known as aerosol generating. The OR is a unique environment as HCWs are in prolonged and very close contact with patients. In our study, we detected SARS-CoV-2 RNA in non-respiratory patient samples (peritoneal fluid, vaginal fluid, myometrium, placenta), surgical

equipment/instruments, and the surgical room environment. No contamination of the surgical masks worn by HCWs was detected.

Our study corroborates earlier studies that have shown evidence of virus in respiratory tract and in surgical/obstetrical fields[12,13,15-18,40-42]. We have documented evidence of SARS-CoV-2 RNA in the GI tract, peritoneal cavity, and female genital tract, all of which could potentially be sources of aerosolized virus/viral particles. We did not find evidence of viral RNA in the orthopedic, cardiac and burn surgical equipment sampled. This may indicate that SARS-CoV-2 does not reside in this type of tissue or at least not present with a viral load high enough for detection.

With our study and others reporting the finding of virus in the peritoneal cavity, use of laparoscopy (which theoretically may be considered an aerosol generating procedure), could result in aerosolization of SARS-CoV-2[11,13,14,43-47].

We used standard techniques for air and floor sampling and found evidence of aerosolization of SARS-CoV-2[6,31,33,34,36]. While the frequency of positive tests was low, this does indicate that aerosolization of the virus does occur in surgery, but the source of the virus (respiratory or surgical/obstetrical fields) is unknown. It is possible that the true positive rates are higher since some contamination was likely below the detection limits of the tests[6,31,33,34,36].

We looked for characteristics of the patients' infections that would increase the risks of detection of viral RNA in the surgical/obstetrical fields or local environment. Higher viral load detected on the initial NP swab (as estimated by Ct threshold) was associated with higher risk of detectable virus in our samples, while the subtype of the SARS-CoV-2 virus was not.

We were unable to determine if the origin of aerosolized/droplet virus was arising from the surgical fields in the smoke plume. Others have not detected SARS-CoV-2 in electrocautery smoke despite using high viral loads in an *in vitro* setting[28]. While the lack of any positive viral RNA found on the smoke

evacuator filters tested would indicate that the viral contamination from the surgical field is absent or below detection limits, these results cannot be used to definitely conclude that surgical smoke does not harbour SARS-CoV-2.

Since infection with SARS-CoV-2 is primarily via the respiratory tract, we chose to sample the inside of HCWs masks to identify viral contamination in close proximity to HCWs' respiratory tract. Face mask sampling has been shown to be effective in detecting *Mycobacterium tuberculosis* contamination (and other viruses)[48-50] and has been used to detect SARS-CoV-2 contamination of masks worn by HCWs exposed to COVID-19 infected patients (0/25 positive, inside surface) and directly from patient masks (6/10 positive)[30]. Others have studied SARS-CoV-2 viral contamination on the outer surface of face shields worn by HCWs attending patients with COVID-19 in labour (one vaginal delivery with all face shields tested being positive)[34]. We sampled the inside of masks and found 0/143 HCWs masks and 0/4 HCWs' face shields to be positive for SARS-CoV-2 RNA. Our study did not detect SARS-CoV-2 RNA on the inner surface of any mask used by HCWs.

The study has some limitations. We do not have information on post-exposure COVID-19 infections among HCWs, nor did we obtain information on HCW vaccination status or previous infections.

We recognize that due to issues of detection limits of the test and sampling issues, that it is possible that not all viral contamination was detected with this study. Detection of SARS-CoV-2 RNA in bioaerosols is recognized to be challenging, being highly dependent upon air flow, exchange rates and source of emissions (reviewed by Borges et al) and it is suggested that parallel sampling with more than one technique may increase sensitivity[51]. We did take measures such as using two different air sampling techniques, increasing the size of floor samples taken for the testing and multiple testing to mitigate these issues. Finally, even though viral RNA was detected, this study did not determine if infectious virus was present.

In the future, there are three important studies to complete: the initial is to determine if the detected environmental viral RNA is infectious; secondly to determine the rates of clinical and sub-clinical infections of HCWs when exposed to patients with COVID-19 undergoing surgery or labour/delivery; and finally, our findings need to be validated externally.

CONCLUSION

There is evidence of SARS-CoV-2 RNA in the surgical and obstetrical patient's operative environment (surgical surfaces and aerosolized). However, the finding of no detectable virus on the inner surface of masks worn by the health care teams in our study reassuringly suggests a low risk of infection when wearing appropriate personal protective equipment.

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Table 1: Patient and case characteristics with results of samples taken

ID #	Age range* (yrs)	Sex	No. days from 1st COVID-19 positive test to surgery (repeat test)	Surgical Division	Procedure performed	VOC	NP swab (Ct value) [a, b]	Positive [c] samples obtained (Ct value)	Active air sampling time (min)	Negative [d] samples	Number of HCW masks [e]
1	30-39	F	3	OB	Caesarean section (spinal anesthesia)	Not tested	- (n/a)	- (none)	74	•peritoneal fluid, placenta, myometrium, •floor	3
2	30-39	F	4	OB	Caesarean section (spinal anesthesia)	Not tested	-	-	137	•peritoneal fluid, placenta, myometrium, •floor	3
3	40-49	F	3	OB	Caesarean section (spinal anesthesia)	Not tested	30.89	•placenta (25.9)	89	•vaginal fluid •patient mask •floor	5
4	20-29	F	30 (24)	OB	Caesarean section (intubation and extubation)	Alpha	18.69	•ETT (25.66)	125	•peritoneal fluid, placenta, myometrium, •floor	6
5	20-29	F	14 (0)	OB	Caesarean section (spinal anesthesia)	Not VOC	34.29	-	Not sampled	•peritoneal fluid, placenta	4
6	30-39	F	3	OB	Caesarean section	Alpha	24.41	•Vaginal fluid (23.45) •Peritoneal fluid (25.1) •myometrium (28.34)	Not sampled	•floor	3
7	30-39	F	1	OB	Vaginal delivery	Not tested	31.31	-	Not sampled	• vaginal fluid •patient mask •floor	3
8	30-39	F	0	OB	Vaginal delivery	Not tested	18.87	-	Not sampled	•vaginal fluid, placenta, •floor	1

9	30-39	F	14 (0)	OB	Vaginal (vacuum) Delivery	Alpha	14.81	-	Not sampled	•vaginal fluid •placenta •integrated visor of mask (obstetrician)	6
10	50-59	F	1	Gyne Oncology	TAH BSO, node dissection (intubation and extubation)	Not tested	32.17	-	146	•ETT •floor	5
11	40-49	F	16	Gyne Oncology	TAHBSO omentectomy (intubation and extubation)	Alpha	11.86	•ETT (25.37) •surgical clamps, scissors (27.13) •floor at 2-metres (28.94)	149	•floor near the OR table	6
12	80-89	F	4	Ortho	L hip hemiarthroplasty (spinal anesthesia)	Not tested	21.44	-	Not sampled	•saw blade •floor	1
13	30-39	F	2	Ortho	Bilat tibial fracture (spinal anesthesia)	Not tested	-	-	176	•drill bit •floor	5
14	50-59	M	22 (3)	Ortho	T10-T12 spinal decompression (arrived in OR intubated and left intubated)	Not tested	29.17	•ETT (22.27)	242	•floor	6
15	70-79	M	2 (0)	Ortho	ORIF cervical spine fracture (arrived in OR intubated and left intubated)	Not tested	-	-	211	•Petri dish UTM (passive air sampling) •floor	5
16	60-69	F	4(2)	Ortho	ORIF ankle, fibula	Alpha	32.35	-	106	•scalpel blade and clamps •Petri dish UTM •floor	5
17	50-59	M	2	Ortho	Humerus fracture (came to OR intubated and left OR intubated)	Not VOC	13.45	•floor (21.97)	97	•scissors and clamps •Petri dish UTM	5

18	70-79	M	26 (5)	Ortho	Superficial and deep compartment irrigation of leg and debridement (arrived in OR intubated and left OR intubated)	Alpha	37.25	-	68	• scalpel blade, scissors and clamps •Petri dish UTM •floor	4
19	50-59	M	1	General Surgery	Laparotomy (came to OR intubated and left intubated)	Not tested	32.7	-	189	•Peritoneal fluid, •floor •face shield (surgeon)	4
20	50-59	F	15	General Surgery	Bilat mastectomy (intubation and extubation)	Not tested	-	-	123	•ETT •floor	5
21	70-79	M	70 (3)	General Surgery	Tracheostomy	Not tested	-	•ETT (21.74)	111	•floor	5
22	60-69	M	50 (5)	General Surgery	Tracheostomy	Alpha	-	-	69	•ETT •floor	5
23	60-69	M	54 (16)	General Surgery	Tracheostomy	Not VOC	-	•ETT (22.53) •floor (28.19)	68	•floor at 2 metres	4
24	70-79	F	62 (2)	General Surgery	Tracheostomy, gastroscopy, insertion of gastrostomy tube	Not VOC	32.94	•ETT (20.7) •floor (20.9)	117	•clamps and scissors •Petri dish UTM	5
25	70-79	M	4	GI	Gastro duodenoscopy	Alpha	18.62	•Gastroscope (30.56)	62	•Petri dish UTM •floor	3
26	60-69	F	2	Burn	Burn reconstruction (intubation and extubation)	Not tested	-	•ETT (24.88)	142	•floor •face shield (surgeon)	7
27	70-79	M	2	Burn	Debridement, graft lower abdomen, thighs (intubation and extubation)	Beta/ Gamma	26.69	•ETT (24.32) •floor (24.97) •Petri dish UTM (28.4)	173	•scalpel blade, scissors and clamps	4
28	20-29	M	2	Plastics	Hand surgery (regional block)	Not tested	35.29	-	136	•floor	5
29	60-69	F	1	Plastics	Debridement and graft	Alpha	36.01	-	217	•dermatome •floor	6

					(arrived in OR intubated and left intubated)						
30	60-69	M	14	Cardiac Surgery	Aortic valve replacement (not extubated)	Not VOC	32.98	-	285	•thoracic retractor •floor	6
31	70-79	M	2	Vascular Surgery	Carotid endarterectomy (intubation and extubation)	Not tested	-	-	178	•ETT •floor •face shield (surgeon)	4
32	40-49	M	0	Neuro Surgery	Decompressive Craniotomy (arrived in OR intubated and left intubated)	Not tested	-	-	77	•floor	4

Legend:

*Age range used to preserve anonymity

Abbreviations:

Yrs, years; VOC, variant of concern; NP, nasopharyngeal; Ct, cycle threshold: the number of cycles required for the fluorescent signal to cross the threshold in RT-PCR (a lower Ct would indicate a higher viral load); HCW, health care worker; M, male; F, female; OR, operating room; bilat, bilateral; ETT, endotracheal tube; n/a, not available; OB, Obstetrics; Ortho, Orthopedic Surgery; TAHBSO, total abdominal hysterectomy bilateral salpingo-oophorectomy; Alpha, Alpha variant (United Kingdom, B.1.1.7); ORIF, open reduction internal fixation; GI, gastrointestinal; Beta/Gamma, Beta or Gamma variant (South African, B.1.351 or Brazilian, P.1), UTM, universal transport medium

[a] The mean Ct value of the initial patient NP swab was 21.72, 95% CI 16.90-27.29 and 29.96 95% CI 27.07-33.43 respectively in the group of patients that had positive samples (evidence of SARS-CoV-2 RNA) and the group that had all samples negative (Mann-Whitney U test, p=0.007).

[b] The mean Ct value of the initial patient NP swab was 24.52 (95% CI: 18.72-30.99) and 28.41 (95% CI: 25.35-30.33) respectively in the group of patients that were known VOC and the group that included known non-VOC and unknown/untested status (Mann-Whitney U test, p=0.4561).

[c] Positive samples refer to the samples collected (patient, instrument, equipment, surface, air and mask) that have the presence of SARS-CoV-2 RNA detected on real time RT-PCR (reverse transcriptase polymerase chain reaction)

[d] Negative samples refer to the samples collected (patient, instrument, equipment, surface, air and mask) that do not have the presence of SARS-CoV-2 RNA detected on real time RT-PCR

[e] A variety of masks were used by HCWs in our cohort including American Society for Testing and Materials (ASTM) level 3 masks, N95 masks, double masks (inner mask sampled) or masks worn under face shields. Of 143 masks: 51 from nurses, 31 from anesthetists, 32 from surgeons and 29 from surgical house staff.

Table II: Positive tests for SARS-CoV-2 RNA (number of positive samples/number of patients or cases sampled)

Surgical Service (No. of cases)	Peritoneal fluid [a]	Vaginal fluid [a]	Myometrial swab [a]	Placenta swab [a] (fetal side)	Surgical instruments [a]	ETT [a]	Cautery filter [a]	Air sample from GilAir pump filter [b]	Petri dish UTM (passive air sampling) [a]	Floor swab [b]	Face shield [a]	Masks [b]
Obstetrics N=9	1/5	1/7	1/4	1/7	--	1/1	0/4	0/5	--	0/14	0/1	0/34
Gynecology Oncology N=2	--	--	--	--	1/ 1	1/ 2	0/2	0/3	--	1/4	--	0/11
Orthopedics/ Trauma N=7	--	--	--	--	0/5	1/ 1	0/6	0/11	0/4	1/14	--	0/31
General Surgery N=2	0/1	--	--	--	--	0/1	0/2	0/4	--	0/4	0/1	0/9
Tracheo-stomy N= 4	--	--	--	--	0/1	3/ 4	0/4	0/8	0/1	2/8	--	0/19
Gastro-enterology N=1	--	--	--	--	1/1	--	--	0/2	0/1	0/2	--	0/3
Burn/Plastic Surgery N=3	--	--	--	--	0/2	2/2	0/3	0/8	1/1	1/8	0/1	0/22
Cardiac/ Vascular Surgery N=2	--	--	--	--	0/1	0/1	0/2	0/4	--	0/4	0/1	0/10
Neuro Surgery N=1	--	--	--	--	--	--	0/1	0/2	--	0/2	--	0/4
Total: 32 patients	**1/6**	**1/7**	**1/4**	**1/7**	**2/11**	**8/12**	**0/24**	**0/47**	**1/7**	**5/60**	**0/4**	**0/143**

Legend:

Abbreviations:

-- (empty cell), sample was either: not taken, not applicable or patient consent was not possible; ETT, endotracheal tube; UTM, universal transport medium

[a] number of positive tests/number of cases sampled

[b] number of positive tests/number of tests performed (e.g. 1-2 tests per surgical/obstetrical case)

APPENDIX A: eMETHODS (Supplement)

For Sample Collection:

GENERAL DETAILS:

Each dental pledget was pre-moistened with up to 3cc of sterile UTM from a newly opened unused 15cc sterile Falcon tube containing 3 cc of UTM, universal transport medium (UTM®, Copan Diagnostics, CA, USA; https://www.copanusa.com/sample-collection-transport-processing/utm-viral-transport/).

Hand hygiene and glove changes were performed between the collection of every sample and the outside surface of each container was wiped off with a CaviWipes™ towelette (https://www.metrex.com/en-ca/caviwipes) and then each sample was stored in a separate new biohazard marked ziploc plastic bag and placed in the fridge at 4° Celsius within 20 minutes. All collected samples were processed at the Shared Hospital laboratory, located at the Sunnybrook site (stored in the interim at -20° and then -80° Celsius).

Sinai Health samples were stored in the fridge locally and transferred to Sunnybrook within 24 hours.

Samples were analyzed by RT-PCR as previously described (Vermeiren C, Marchand-Senecal X, Sheldrake E, et al. Comparison of Copan Eswab and FLOQswab for COVID-19 PCR diagnosis: working around a supply shortage. J Clin Microbiol 2020.)

All the operating rooms (including those in the Birthing area) have 20 air exchanges an hour.

Cycle threshold values (the number of cycles required for the fluorescent signal to cross the threshold in RT-PCR) quantified viral load, with lower values indicative of a higher viral load.

PATIENT SAMPLES

1) PERITONEAL SAMPLE:

Taken by a member of the obstetrical/surgical team: 5-10 cc of peritoneal fluid (if present upon entering the cavity), or, if no fluid seen, 10cc of sterile saline was placed in the peritoneal cavity with a 10cc sterile syringe and then whatever volume of fluid aspirated back into the syringe was placed in an 80cc sterile plastic container.

2) VAGINA:

Taken by a member of the obstetrical team: a vaginal speculum was placed in the vagina before delivery (typically after informed consent and well before active labor, or, before cesarean delivery) and up to 5 cc of pooled vaginal fluid was aspirated with a sterile 10cc syringe. If no vaginal fluid was seen, 10cc of sterile saline was placed in the vagina with a 10cc sterile syringe and then whatever volume of fluid that was aspirated back into the syringe was placed in an 80cc sterile plastic container.

3) MYOMETRIUM:

Taken by a member of the obstetrical team at the time of cesarean delivery, after the baby is delivered and hemostasis managed, a flocked swab (iClean, HCY, Shenzhen, China; https://www.chenyanglobal.com/oropharyngeal-nylon-flocked-swab-product/) was used to wipe the

incised surface of the myometrium and the swab placed immediately in a 15cc sterile plastic Falcon tube containing 3cc of UTM.

4) PLACENTA:

Taken by a member of the obstetrical/research team at the end of the case with a flocked swab which was used to wipe the surface of the membranous placenta and the swab was placed immediately in a 15cc sterile plastic Falcon tube containing 3cc of UTM.

ENVIROMENTAL SAMPLES

5) FLOOR:

Taken by a member of the research team at the end of the case: a sterile dental pledget (3/8" x 1.5" cylindrical sponge, SDP Inc. Montreal, Canada; https://www.sdpmedical.com/en/cylindrical-sponges) was pre-moistened with universal transport media and the floor was swabbed in a location as close to the patient as permits and also 2 metres away. The swabbing was performed in a standardized fashion over a 10x10cm area with 2 perpendicular "S" swipes (or over a 30x30cm area for the last 12 of 32 cases). The pledget was placed immediately in a 15cc sterile plastic Falcon tube containing 3cc of UTM.

6) ENDOTRACHEAL TUBE (ETT):

Taken by a member of the research team at the end of the case after the patient was extubated: a sterile dental pledget or a flocked swab was pre-moistened with UTM and used to wipe the length of the distal half of the ETT and the pledget/swab placed immediately in a 15cc sterile plastic Falcon tube containing 3cc of UTM.

7) SURGICAL INSTRUMENTS / EQUIPMENT:

Taken by a member of the research team at the end of the case: a sterile dental pledget was pre-moistened with UTM and used to wipe the part of the instrument or equipment that was in direct contact with the patient's surgical site. The pledget then placed immediately in a 15cc sterile plastic Falcon tube containing 3cc of UTM.

8) PASSIVE AIR SAMPLE:

3cc of sterile UTM was placed in a sterile 90mm Petri dish which was placed open by a member of the research team at the beginning of the case within 1-2 metres of the patient and in a location that would not interfere with patient care, on a Mayo stand about 1 metre high from the floor. The Petri dish was retrieved at the end of the case and the UTM in it transferred to a sterile Falcon tube.

9) ACTIVE AIR SAMPLE:

A member of the research team set up 2 air samplers at the start of the case: one in a location that was as close as possible to the surgical site (within 1 metre) and without interfering with patient care; and a second one in a location that was 2-3 metres away from the surgical site (and 1-1.5 metres from the floor). Samples were collected with a 37 mm three-piece cassette with 0·8 µm polycarbonate filter, sampling at a rate of 3.5L/min for the duration of the procedure with PCR detection after elution from the filter. The GilAIr pump was turned on when the patient was brought into the OR and the pump was

stopped when the patient left the room. The filter cassette containing sampled air was wiped on its outer casing with a CaviWipes™ towelette and placed in a new biohazard marked ziploc bag.

For obstetrical patients with non-operative delivery, one air sampler was placed within 1 metre of the patient's head and at the level of her mouth; the second sampler was placed approximately 2 metres away from the perineum.

10) CAUTERY FILTER:

If cautery was used, at the end of the case, a member of the research team removed the cautery filter device (marVac grey box, https://www.klsmartin.com/en/products/electrosurgery/smoke-evacuation/) and its surface was wiped with a CaviWipes™ towelette and the filter housed in its original box was placed in a new biohazard marked ziploc bag and then placed in the freezer.

11) MASK SAMPLE:

Masks were swabbed on their inside surface by a member of the research team with a sterile dental pledget that was pre-moistened with UTM – wiping over the inside of the mask twice in the area (up to 10x10cm) that would have been in contact with the nose and mouth. The pledget then placed immediately in a 15cc sterile Falcon tube containing 3cc of UTM.

12) FACE SHIELD:

The outer facing surface of the face shield (at least a surface area of 10 x 15 cm) was wiped with a sterile flocked swab that was pre-moistened with sterile UTM and the swab then placed immediately in a 15cc sterile Falcon tube containing 3cc of UTM.