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Environmental contamination by *Chlamydia trachomatis* and *Neisseria gonorrhoeae*: is it time to change our infection control practices? Results of a regional study

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KEY MESSAGES

- CT/NG NAATs are highly sensitive and can detect low copy numbers of DNA/rRNA. This gives rise to the potential for false positives from environmental contamination.
- Sexual health clinics should monitor for CT/NG DNA/rRNA surface contamination.
- Chlorine-based cleaning products denature DNA/rRNA and could be a useful tool to reduce the risk of sample contamination in sexual health clinics.
- Clinics should also consider clinic-specific interventions to address environmental contamination.

ABSTRACT

Objectives:

Nucleic acid amplification tests (NAATs) are highly sensitive for the detection of *Chlamydia trachomatis* (CT) and *Neisseria gonorrhoeae* (NG) DNA/rRNA. Previous studies have demonstrated contamination of surfaces in sexual health clinics (SHCs) with CT/NG. False positive results can occur if patient samples are contaminated by environmental DNA/rRNA. This can have a dramatic impact on patients' lives and relationships. Previous attempts to reduce contamination, through staff training alone, have been unsuccessful. We aimed to investigate environmental contamination levels in SHCs and to assess a two-armed intervention aimed at reducing surface contamination.

Methods:

Questionnaires were sent to ten SHCs. Six clinics, with differing characteristics, were selected to participate in sample collection. Each clinic followed standardised instructions to sample surfaces using a CT/NG NAAT swab. Clinics were invited to introduce the two-armed intervention. The first arm was cleaning with a chlorine-based cleaning solution once daily. The second arm involved introducing clinic-specific changes to reduce contamination.

Results:

7/10(70%) clinics completed the questionnaire. Overall, 88/263(33%) swabs were positive for CT/NG. Clinics 1, 3 and 4 had high levels of contamination, with 28/64(44%), 17/33(52%) and 30/52(58%) swabs testing positive respectively. Clinics 2 and 6 had lower levels of contamination, with 7/46(15%) and 6/35(17%) respectively. 0/33(0%) of swabs were positive at Clinic 5 and this was the only clinic already using a chlorine-based solution to clean all surfaces and delivering twice-yearly clinic-specific infection control training. Following both intervention arms at Clinic 1, 2/50(4%,

p<0.0001) swabs tested positive for CT/NG. Clinic 4 introduced each arm separately. After the first intervention 13/52(25%, p=0.003) swabs tested positive and following the second arm 4/50(8%, p<0.0001) swabs were positive.

Conclusions:

Environmental contamination is a concern in SHCs. We recommend that all SHCs monitor contamination levels and, if necessary, consider using chlorine-based cleaning products and introduce clinic-specific changes to address environmental contamination.

INTRODUCTION

Over time the sensitivity of the tests that we use to detect *Chlamydia trachomatis* (CT) and *Neisseria gonorrhoeae* (NG) have increased and the British Association of Sexual Health and HIV (BASHH) now recommend the use of nucleic acid amplification tests (NAATs).[1-3] A potential disadvantage of NAATs, is that low copy numbers of contaminating CT/NG DNA or ribosomal RNA (rRNA) can be amplified, resulting in a false positive test.[3,4] Environmental contamination can occur at any point in sample handling.[3,5,6] False positive CT/NG results can also occur for other reasons, such as the sample being mislabelled, or the assay detecting non-CT/NG genetic material.[4]

We are not aware of any documented cases of fomite transmission from CT/NG. It is generally accepted that the detection of CT/NG DNA/rRNA target sequences are from non-

viable micro-organisms, as there has been no culture growth of CT or NG from clinical environmental surfaces.[7] There is, however, the potential that samples could become contaminated, resulting in false positives.[8] False positive CT and NG results could cause patient distress, relationship difficulties, social stigma, unnecessary antibiotic use and the breakdown of patient/clinician trust.[8,9] We therefore need to minimise this risk.

Clinical laboratories, where DNA is amplified, are required to follow strict guidelines to prevent contamination of samples.[5,6] They conduct specific infection control training for staff, and implement the use of laboratory coats, gloves, regular hand washing and ensure that surfaces are cleaned with disinfectants that denature DNA/rRNA.[5,6] SHCs are a unique environment, outside of the laboratory setting, where a large volume of NAATs are handled by both patients and staff. There is therefore a theoretical risk that if the sample is contaminated with environmental DNA/rRNA, this could be amplified in the laboratory, resulting in a false positive. However, there are currently no speciality specific national guidelines for sample handling and cleaning for SHCs.

Previous studies have demonstrated contamination of clinical surfaces and hands of health care workers, with CT/NG nucleic acid, in SHCs in UK and Europe.[7,9,13-16] Meader *et al.* found CT rRNA to persist for up to 50 days and showed CT contamination levels between 13% and 88% on a variety of surfaces in a SHC.[9] Lewis *et al*. identified CT or NG rRNA on 13%(20/154) of surface swabs in a SHC.[7]

Despite the theoretical risk of false positive results secondary to contamination, there is very little evidence documenting this in the literature.[10] One poster abstract, at the 2013 STI and HIV World Congress, described a potential pseudo-outbreak of gonorrhoea in a Dutch clinic, which resolved after changing to cleaning with chlorine.[14] Meader *et al*. describe how it

would be impossible to estimate the proportion of patients that may have been affected by false positive results.[9] Many patients would not challenge the diagnosis, as often the reason that they are testing is that they deem themselves to be at risk.[9]

Previous studies have failed to show a reduction in contamination with CT/NG DNA/rRNA through cleaning and staff training alone.[13,15,16] These abstracts did not specify which cleaning substances were used.[13,15] 'Sterile' does not mean 'DNA/rRNA target sequence free' and although standard detergents and alcohol wipes render organisms non-viable, they do not denature DNA/rRNA.[8] Chlorine is a widely available substance that denatures DNA/rRNA.[8,9]

This study had two aims. Firstly, to compare CT/NG DNA/rRNA surface contamination levels in SHCs at a regional level. Secondly, to assess the effectiveness of a two-armed intervention aimed at reducing surface contamination.

METHODOLOGY

Questionnaire

Questionnaires were sent to ten SHCs in the South West region of England. Each centre was asked about: annual patient attendances, staff and patient hand hygiene, personal protective equipment (PPE), clinic-specific procedures including how samples are taken, chaperone use, cleaning protocols and staff infection control education. Six clinics were then selected (by consensus decision between authors KO and SR) to gain a range of clinic characteristics (Table 1).

Setting

All six clinics that were selected were specialist National Health Service (NHS) SHCs. The samples were all taken from main clinics, rather than peripheral sites.

Design of the regional surface contamination swab study

A prospective study design was used to collect data between May 2018 to October 2019. KO and SR designed and sent a protocol, to all participating clinics, in order to standardise sample collection. Samples were to be taken from high-touch surfaces in consultation and examinations rooms, as well as patient toilets. The protocol allowed clinics to decide which high-touch surfaces were relevant to their clinical environment, so not every clinic sampled each type of surface (Table 2). Surfaces were tested for CT and NG DNA/rRNA using a NAAT swab. Each SHC utilised the NAAT swab that was routinely used in their clinic (Table 1). Each surface was sampled across its entire surface area, with one swab, for 20 seconds. Hands were cleaned with alcohol gel and new gloves donned between each sample. The trolley, carrying samples, was cleaned prior to entering each room with the wipes routinely used at each site. Samples were labelled as they were taken. To ensure the maintenance of normal clinical practice and comparability between sites, the protocol advised taking samples after a morning clinic and ensuring that only the individual conducting the sampling was aware of when it would take place. KO and two nurses took all the samples at one clinic and SR took all samples at two different clinics. The rest of the sites used their own staff members.

The samples for each site were analysed by their local laboratory. Each laboratory utilises different assays with their own cut-offs for a positive result. Values, such as relative light

units, are not comparable between instruments and are not quantitative. Each laboratory used their own local policy regarding whether they confirmed results.

Design of the two-armed intervention to reduce surface contamination

Clinic 1 and Clinic 4 elected to take part in the second stage of the study which introduced an intervention with two arms. The first arm was the introduction of a standard operating procedure (SOP) to clean all high-touch surfaces in consultation rooms, examination rooms and patient toilets with a chlorine-based solution once daily. Chlorine containing wipes may be prohibitively expensive. It is not feasible to clean all surfaces with a chlorine-based solution after each patient and so the authors elected for a once daily regimen. The second arm was clinic specific and involved a local review of sample handling and the introduction of staff infection control training. This was based on local levels of contamination and patterns of sample positivity within individual clinics.

Clinic 1 is a busy, urban, integrated SHC which reviews on average 55,000 patients per year and sees on average 20 cases of CT and 10 cases on NG per week. Clinic 1 aimed to reduce splash contamination by modifying sample handling, so that staff in the clinic laboratory pipetted urine into the sample pots, rather than male patients undertaking this in the toilets and then passing the processed sample through to the clinic laboratory on a disposable tray. After conducting a local glove hygiene audit (Appendix 1), Clinic 1 introduced a staff education programme which included a seminar and video tutorial on glove hygiene

(available upon request). The seminar highlighted the rationale of daily cleaning with a chlorine-based solution but continuing to clean surfaces between patients with *Clinell*® *universal* wipes to decontaminate and reduce the bacterial load on surfaces. At Clinic 1 both arms of the intervention were introduced simultaneously and then environmental swabs were repeated 10 weeks later, using the same methodology.

Clinic 4 is an integrated SHC serving a rural population and reviews, on average, 16,000 patients per year. The incidence of CT and NG, at the time of the study, was not available due to a change in service provider after study completion. Clinic 4 introduced each arm of the intervention in stages. Sampling was conducted 8 weeks after the introduction of arm 1 and 19 weeks after arm 2. Clinic 4 modified their local sample handling by introducing disposable trays for patients to transport samples, rather than in their hands. Posters were placed inside toilets about how to self-sample, with an emphasis on preventing contamination. Laboratory staff taught clinic staff about contamination, appropriate pipette technique and continued use of *Sanicloth*® multi-surface detergent wipes between patients. The cleaning staff were also engaged and made aware of the rationale of cleaning with a chlorine-based solution.

Analysis

Each clinic sent results to the study co-ordinators. The data was then compared to the information that was provided in the questionnaires to identify any key themes that may explain trends in varying levels of contamination between clinics. Fisher's exact test was used to calculate p-values between the pre- and post-intervention results using IBM SPSS Statistics 24. Equivocal results were included as negative results but acknowledged in the results section for clarity.

Patient participation and ethics

Ethical approval was not required as the study did not involve patient samples.

RESULTS:

Questionnaire

7/10(70%) SHCs responded to the questionnaire. Table 1 summarises the characteristics of the six clinics selected. Pre-study cleaning products varied but only Clinic 5 used a chlorine-based product on all surfaces. All clinics stated that clinical surfaces, such as beds and trolley tops, were cleaned in between patients. Cleaning staff cleaned once a day in all clinics, except for Clinic 5, where this was done twice daily. Clinic-specific infection control training was performed at induction in Clinic 2 and twice yearly in Clinic 5. No other clinics had clinic-specific infection control training.

All clinics used the Hologic Aptima® Combo 2 CT/NG NAAT which detects rRNA, except for Clinic 2, which used the Roche® cobas CT/NG NAAT test which detects DNA.

Samples

Across the six clinics, 88/263(33%) of all swabs were positive for CT and/or NG: 39/156(25%) in the clinical rooms; 43/91(47%) in the patient toilets and 6/16(38%) in the sample handling rooms (Table 2). The percentage of swabs that were positive for CT and/or NG at individual clinics ranged between 0% and 58% (Table 1).

Table 1: Table displaying clinic characteristics and the number of swabs positive for CT/NG (Table created by the authors)

Clinic	**Number of attendances per annum (to nearest 1000)**	**Cleaning product used by cleaners**	**Cleaning product used between patient**	**NAAT test used**	**PPE used when examining patients**	**Frequency of cleaning by cleaners**	**Clinic specific infection control training**	**Chaperone use**	**Number of positive swabs/ total number of swabs taken (%)**
1	55,000	*Taski® Sani 4in1*	*Clinell® universal* wipes	Aptima®	Gloves and apron	OD	No	Usually only used for male clinicians examining female patients	28/64 (44)*
2	25,000	*Windmill Invincible* (floors and hard surfaces), *Warrior* (toilets) *Captain Lemon* (chairs and couches)	*Clinell® detergent* wipes	Roche®	Gloves and apron	OD	Induction	Majority of patients	7/46 (15)
3	5,000	*Taski® 4in1, Jontec 300, multipurpose sprint 200*	*Clinell® universal* wipes	Aptima®	Gloves	OD	No	Usually only used for male clinicians examining females	17/33 (52)
4	16,000	*Selden® V 100, 200, 300*	*Sani® cloth detergent multi-surface* wipes	Aptima®	Gloves	OD	No	All patients	30/52 (58)
5	10,000	*Tristel FUSE®*	*Clinell® universal* Wipes	Aptima®	Gloves and apron	BD	Twice yearly	Usually only used for male clinicians	0/33** (0%)

Room	Location of sample	Positive for CT only/ total swabs (%)	Positive for NG only/ total swabs (%)	Positive for both CT and NG/total swabs (%)
History/ Examination Room	Desk	1/16 (6)	5/16 (31)*	1/16 (6)
	Keyboard/ Mouse	2/26 (8)	3/26 (12)*	0/26 (0)
	Bed Remote	4/19 (21)	1/19 (5)	0/19 (0)
	Light	4/24 (17)	3/24 (13)	0/24 (0)
	Curtain	1/15 (7)	4/15 (27)	1/15 (7)
	Trolley	3/24 (13)	5/24 (21)*	0/24 (0)
	Examination bed	0/4 (0)	0/4 (0)	0/4 (0)
	Door handle	0/13 (0)	0/13 (0)	0/13 (0)
	Sink/tap	0/10 (0)	0/10 (0)	0/10 (0)
	Sample holders	1/5 (20)	0/5 (0)	0/5 (0)
	Total	**16/156 (10)**	**21/156 (13)**	**2/156 (1)**
Toilets	Sink/tap	4/20 (20)	2/20 (10)	1/20 (20)
	Toilet/ toilet handle	6/26 (23)	4/26 (15)	3/26 (12)
	Hatch shelf/handle	4/19 (21)	2/19 (11)*	7/19 (37)
	Door handle	0/14 (0)	2/14 (14)*	1/14 (7)
	Bins/radiator	1/5 (20)	0/5 (0)	1/5 (20)
	Sample shelf	2/7 (29)	3/7 (43)	0/7 (0)
	Total	**17/91 (19)**	**13/91 (14)**	**13/91 (14)**
Sample handling room	Hatch handles	2/5 (40)	0/5 (0)	2/5 (40)
	Sink/tap	½ (50)	0/2 (0)	0/2 (0)
	Work surface	½ (50)	0/2 (0)	0/2 (0)
	Door handles	0/5 (0)	0/5 (0)	0/5 (0)
	Keyboard/mouse	0/2 (0)	0/2 (0)	0/2 (0)
	Total	**4/16 (25)**	**0/16 (0)**	**2/16 (13)**

								examining females	
6	7,000	*Taski® Sprint 200 Pur-Eco SD* and *Sani 4in1 Plus*	*Clinell® universal* wipes	Aptima®	Gloves	OD	No	For the majority of female patients	6/35 (17)***

*1 equivocal NG result from a swab taken from one computer mouse

**1 equivocal NG result from a swab taken from a trolley top in an examination room

*** 2 equivocal NG results. One from toilet door handle and one from a desktop

Table 2: Pre-intervention swab results with respect to surfaces sampled across all six clinics (Table created by authors)

*Indicates an equivocal result

Intervention

Table 3 shows the pre- and post-intervention environmental contamination results from Clinic 1 and 4. Clinic 1 introduced both arms simultaneously and Clinic 4 introduced the arms in stages and repeated sampling after each stage.

Table 3: Swab results pre- and post-intervention (Table created by the authors)

	Pre- intervention Number of positive swabs/number taken (%)	**Post Arm 1** Once daily cleaning with chlorine-based cleaner Number of positive swabs/ number taken (%)	**Post Arms 1 and 2** Once daily cleaning with chlorine + staff education and modification of sample handling (%)
Clinic 1	28/64 (44)	-	2/50* (4) p<0.0001
Clinic 4	30/52 (58)	13/52** (25) p=0.003	4/50*** (8) p<0.0001

*3 equivocal results from a toilet seat, and 2 desktops

**1 equivocal result from a toilet hatch and hatch handle

***2 samples were unfortunately lost between sample collection and processing in the laboratory in this sample set

Table 4 shows the post-intervention results by sample location. Contamination of surfaces sampled in the clinical rooms reduced from 21/63(33%) to 6/63(10%)(p=0.002); from 31/42(74%) to 0/30(0%)(p<0.0001) in patient toilets and from 6/11(55%) to 0/7(0%)(p=0.04) in the sample handling rooms.

Room	Location of sample	Positive for CT only/ total swabs (%)	Positive for NG only/ total swabs (%)	Positive for both CT and NG/total swabs (%)
History/ Examination Room	Desk	3/9* (33)	0/9* (0)	0/9 (0)
	Keyboard/ Mouse	0/8 (0)	0/8 (0)	0/8 (0)
	Bed Remote	0/7 (0)	0/7 (0)	0/7 (0)
	Light	2/9 (22)	0/9 (0)	0/9 (0)
	Curtain	0/4 (0)	0/4 (0)	¼ (25)
	Trolley	0/9 (0)	0/9 (0)	0/9 (0)
	Door handle	0/5 (0)	0/5 (0)	0/5 (0)
	Sink/tap	0/9 (0)	0/9 (0)	0/9 (0)
	Sample holders	0/2 (0)	0/2 (0)	0/2 (0)
	Unlabelled	0/1 (0)	0/1 (0)	0/1 (0)
	Total	**5/63 (8)**	**0/63 (0)**	**1/63 (2)**
Toilets	Sink/tap	0/7 (0)	0/7 (0)	0/7 (0)
	Toilet/ toilet handle	0/9 (0)	0/9* (0)	0/9 (0)
	Hatch shelf/handle	0/7 (0)	0/7 (0)	0/7 (0)
	Door handle	0/2 (0)	0/2 (0)	0/2 (0)
	Bins/radiator	0/3 (0)	0/3 (0)	0/3 (0)
	Sample shelf	0/2 (0)	0/2 (0)	0/2 (0)
	Total	**0/30 (0)**	**0/30 (0)**	**0/30 (0)**
Sample handling room	Hatch handles	0/5 (0)	0/5 (0)	0/5 (0)
	Sink/tap	0/1 (0)	0/1 (0)	0/1 (0)
	Work surface	0/1 (0)	0/1 (0)	0/1 (0)
	Total	**0/7 (0)**	**0/7 (0)**	**0/7 (0)**

Table 4: Post two- armed intervention swab results with respect to surfaces sampled in Clinic 1 and 4 (Table created by authors)

DISCUSSION:

Across clinics there was a high proportion of surfaces contaminated with CT/NG DNA/rRNA, 88/263(33%). However, swab positivity rates varied considerably between sites (0-58%). Patient toilets were the most heavily contaminated area at baseline 43/91(47%), in comparison to 6/16(38%) in the sample handling room and 39/156(25%) in clinical rooms. This is likely to be multi-factorial. SHCs may be moving more towards patient self-sampling in the toilets, rather than clinician-led sampling. Patients may be less familiar with infection control measures and there may be a risk of splash contamination as patients conduct their samples.

Prior to the study, Clinic 5, which reported 0/33(0%) contaminated swabs pre-intervention, used a chlorine-based cleaner, twice daily, on all surfaces in clinic rooms and toilets. Clinic 2 used a chlorine-based cleaner, once daily, on floors and hard surfaces in clinic rooms and used a non-chlorine-based cleaner in the patient toilets. All 7/46(15%) positive swabs from Clinic 2 were taken from the patient toilets. All other clinics used a non-chlorine based cleaner throughout. Chlorine differs from other cleaning products as it denatures DNA/rRNA.[8,9] Clinic 5 was also the only clinic that delivered clinic-specific infection control training twice yearly. These findings suggested to the authors that the use of chlorine-based products and regular infection control training may be useful for reducing contamination.

After the introduction of a two-armed intervention at Clinics 1 and 4, there was a dramatic reduction ($p<0.0001$) in swab positivity (28/64[44%] to 2/50[4%] and 30/52[58%] to 4/50[8%] respectively). The first arm included once daily cleaning with a chlorine-based solution and the second arm included clinic-specific changes to sample handling and infection control training. The initial introduction of chlorine-based cleaning alone, at Clinic

4, reduced contamination from 30/52(58%) to 13/52(25%)(p=0.003). Following the introduction of both interventions at Clinics 1 and 4 low level contamination persisted in the clinical rooms (10%[6/63]), compared to the patient toilets (0%[0/30]) and sample handling rooms (0%[0/7]). This may be because more infection control measures in the second arm of the intervention were targeted towards patient-led contamination.

Strength and weaknesses

This study was conducted across six SHCs with a range of characteristics, including size and settings (Table 1), so the results are likely to be representative of other centres. There are, however, challenges comparing clinics in different geographical locations, as some clinics may see a greater number of patients with CT/NG infection, making them at higher risk of environmental contamination. However, Clinic 1 and Clinic 3, which had 55,000 and 5,000 attendances respectively, had similar levels of contamination (44% and 52% respectively). There is no data available about the number of positive CT and NG cases seen in clinics on the days the samples were taken. However, given the persistence of CT and NG DNA/rRNA beyond a 24-hour period it is unlikely to have had an impact on the results.

The authors attempted to overcome sampling bias by producing a standardised protocol for sample collection. The clinic staffs were blinded to the pre- and post-intervention sampling, so as not to affect cleaning practices. The protocol standardised the sampling time to after a morning clinic. Sampling was not randomised as staffs were specifically asked to sample from rooms that had the highest patient turnover. KO and SR took samples at three clinics

but sampling at the other clinics was not overseen. In between each room the trolleys were cleaned with a non-chlorine-based product, as this was the standard procedure at the time. It is therefore possible that the trolley top surfaces were contaminated with CT/NG DNA/rRNA but samplers were advised to use a non-touch technique, where samples did not touch the trolley top, to reduce this risk. In addition, all swabs from one room were sent within the same sample bag and it is possible that the samples may have contaminated other samples within the bag. The subsequent chlorine cleaning intervention introduced was evidence based.[8,9] The number of swabs that were analysed in Clinic 5, which was the only clinic using a chlorine-based regime on all surfaces, was only 33. Despite fewer swabs being taken at this clinic a finding of 0% contamination is still remarkable in comparison to other clinics in this, and other studies.[7,9,13-15]

It should be noted that the data was collected before the SARS-CoV-2 pandemic. This pandemic has likely altered awareness of infection risk by staff and patients. Clinic cleaning regimes may have also been altered[17] and clinics will likely have had reduced attendances and/or increased self-sampling in patient toilets which may be at more risk of contamination. 43/91(47%) of surfaces sampled in patient toilets in this study were contaminated, which was higher than in clinical rooms 39/156(24%)($p<0.001$), similar to a previous study[7].

Strengths and weaknesses in relation to other studies

This study is the first contamination study in UK SHCs that has been conducted at a regional level and, with 263 swabs taken overall, it is one of the largest studies to date. [7,9,13-16] It is also the first study to show a successful intervention to reduce surface contamination in

SHCs. Previous studies, at single sites, have shown a range of swab positivity (13-88%).[7,9,13-15] The variation between clinics in the literature, and within this study, are likely to reflect local clinic cleaning, sample handling and infection control practices, as well as local prevalence of CT and NG. Lewis *et al*. utilised four swabs to test each surface, whereas this study only used one swab.[7] This study did not have a protocol advising use of negative or positive control swabs but, unlike previous studies, Clinics 1, 2, 5 and 6 all confirmed positive results.

Meaning of the study

This regional study highlights the risk of patient samples being contaminated by environmental CT/NG DNA/rRNA and a successful intervention to reduce this risk. However, it should be noted that this study does not provide evidence that environmental contamination directly causes false positive NAATs. A further study is required to display that negative controls become positive when handled in these contaminated environments. The high proportion of pre-intervention surface contamination (38%[88/230]), averaged across Clinics 1, 2, 3, 4 and 6, is likely multifactorial and may include inadequate patient and staff hand hygiene, splashes of bodily fluid, and in all clinics, apart from Clinic 2, cleaning surfaces with products which do not denature DNA/rRNA.[8] The authors hypothesised that the lack of swab positivity at Clinic 5 was likely a combination of using chlorine-based cleaning products and regular, clinic specific infection control training. The staged introduction of the intervention at Clinic 4 demonstrated that, whilst once daily cleaning with a chlorine-based solution is effective, it is not sufficient to reduce contamination to acceptable levels. The introduction of staff education and modification of sample handling

appears to reduce levels further. While success of the two-armed intervention at Clinic 1 supports our hypothesis that both chlorine and clinic specific changes are needed to reduce contamination, a randomised control trial would be needed to confirm this.

We suggest that all SHCs consider monitoring for environmental contamination with CT/NG DNA/rRNA and implementing changes as necessary. The highest levels of contamination were observed in patient toilets. It may be beneficial to prioritise interventions which address toilet contamination, especially as SHCs may be moving more towards self-sampling. The interventions that were introduced are inexpensive and are simple to incorporate into clinical practice.

Conclusion

This study highlights the potential issue of CT/NG DNA/rRNA contamination in SHCs. Targeted interventions such as staff education, modifying sample handling techniques and cleaning with a chlorine-based solution may be helpful tools for reducing surface contamination. Clinics should assess their local levels of surface contamination and review local clinic procedures to minimise the risk of false positive NAAT results.

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AUTHOR CONTRIBUTIONS

KO and SR conceived the original study, were involved in obtaining samples and wrote the first draft of the manuscript (joint first authors); KO, SR PH, ASN and PM were involved in the study design and planning sample collection; PM and JG supervised CT/NG NAAT testing for specimens collected at their local clinic; KO, SR and PH analysed the data; All authors were involved in data interpretation and revising the first draft of the manuscript.

COMPETING INTERESTS

No competing interests to declare.

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