Assessment of Chlamydia trachomatis prevalence by PCR and LCR in women presenting for termination of pregnancy

Suzanne M Garland, Sepehr Tabrizi, Julene Hallo, Shujun Chen

**Objectives:** To determine the prevalence of Chlamydia trachomatis in a patient population presenting for legal termination of pregnancy by polymerase chain reaction (PCR) and ligase chain reaction (LCR), from first catch urine and self administered tampons, and comparing with the traditionally collected endocervical swab tested by both PCR and culture.

**Methods:** Consecutive women attending for legal termination of pregnancy were screened for chlamydia by patient collected first catch urine and tampon, and physician collected endocervical swab.

**Results:** Of 1175 patients with complete samples, there were 33 (2.8%) in whom chlamydia was detected by two or more assays from one or more sample site. Chlamydia was detected equally well by both PCR and LCR in first catch urine (p = 0.25), tampon (p = 0.5), and endocervical swab (p = 0.5). However, both PCR and LCR were significantly better than culture of an endocervical swab (p = 0.0005) for detection of C trachomatis.

**Conclusion:** The prevalence of chlamydia in patients presenting for termination of pregnancy was 2.8%. A simple efficient way of performing screening for chlamydia for women presenting for termination of pregnancy is by first catch urine or tampon, which can be tested by the highly sensitive amplification assays, PCR or LCR.

(Sex Transm Inf 2000;76:173–176)

Keywords: polymerase chain reaction; ligase chain reaction; Chlamydia trachomatis; pregnancy

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**Introduction**

Women with Chlamydia trachomatis genital infection are at a significant risk of post-abortal sepsis. Furthermore, studies have shown that screening and treatment for C trachomatis near the time of the termination, is associated with a decreased risk of pelvic sepsis. Moreover, it is a recommendation by both the Centres for Disease Control (USA) and the National Venereology Committee of Australia that women presenting for elective abortion be screened for chlamydia.

While diagnosis of chlamydia has traditionally been by culture, rapid antigen tests, or DNA probes, recently the more sensitive nucleic acid amplification assays such as polymerase chain reaction (PCR) and ligase chain reaction (LCR) have been utilised. Detection of C trachomatis in women by conventional tests has traditionally required vaginal examinations to collect endocervical cells while for males, urethral swabs are necessary. However, with the increased sensitivity of the amplification tests, collection of clinical samples by non-invasive, patient administered measures have been evaluated and shown to perform at least as well. In particular, detection of chlamydia by LCR or PCR in first catch urine in both females and males has been reported to have a high sensitivity and specificity. Furthermore, we have shown that self administered tampon specimens from women for subsequent PCR detection of C trachomatis, Trichomonas vaginalis, and Neisseria gonorrhoeae have a significantly greater sensitivity than conventional collection and testing procedures.

In this study detection of C trachomatis by PCR and LCR was evaluated in women presenting for termination of pregnancy, by analysing various patient collected samples and comparing the results with endocervical specimens.

**Methods**

**PATIENT POPULATION**

The study population comprised 1245 consecutive patients who attended the pregnancy advisory service, Royal Women’s Hospital, Melbourne, Australia over a 12 month period from August 1996 to July 1997, for legal termination of pregnancy. All patients recruited gave informed consent; of those approached only two refused to participate.

**SPECIMEN COLLECTION**

Patients were initially asked to collect approximately 10 ml of a first catch urine into a standard sterile urine collection container, followed by a tampon specimen (self inserted and immediately withdrawn) which was placed into a sterile specimen jar containing transport medium (0.14 M NaCl, 3 mM KCl, 10 mM HPO₄₂⁻, 2 mM KH₂PO₄). Patients were then assessed by a clinician who performed a pelvic examination including collection of two endocervical samples per patient (that is, for culture and LCR). The ectocervix was first cleaned of any excess mucus using a large cotton swab. The order of the two swabs was randomised throughout the study. Endocervical...
swabs collected for LCR were transported in
medium provided by Abbott Diagnostics
(Abbott Park, IL, USA). For tissue culture iso-
lolation, cotton tipped ENT swabs (Medical
Wire and Equipment Company, Wilts) were
rotated within the endocervical canal, with-
drawn, and placed into SPG transport medium
(218 mM sucrose, 3.8 mM KH2PO4, 7.2 mM
K2HPO4, 4.9 mM l-glutamate, 150 mg/ml
vancomycin, 10 mg/ml amphotericin B, 20
mg/ml gentamicin, pH 7) and transported to
the laboratory on ice within 14 hours of collec-
tion. Specimens were either cultured immedi-
ately or frozen at −70°C until processed.13 For
detection by PCR, an aliquot of the sample
collected for culture was utilised.

**TESTING**

Urine was processed by first collecting 1 ml for
LCR then processed as described by the
manufacturer, while 10 ml of urine was
pelleted for PCR, from which DNA was
extracted utilizing QiaGen Kit (Qiagen, Valen-
cia, CA, USA). Tampon specimens were proc-
essed as previously described.11 For PCR of
endocervical swabs, an aliquot of 100 µl from
each culture had DNA extracted by the Qiagen
system followed by PCR testing.

All first catch urine, tampon samples, and
dermal swabs had PCR and LCR per-
formed for detection of *C trachomatis*. In ad-
dition, the endocervical swabs had standard cul-
ture detection for *C trachomatis*.14 The PCR
method was directed against the major outer
membrane protein (MOMP) of *C trachomatis*
and based on the method of Holland et al,15 and
details are as previously described.11 In addi-
tion to PCR amplification for *C trachomatis*, all
specimens were also amplified for a 260 bp
region of human β globin gene as an internal
positive control for each specimen, to ensure
that sufficient amplifiable DNA was present in
the sample.7 Specimen contamination and
carry over were prevented by using barriered
tips, aliquoting of reagents and performing the
various stages of PCR in different rooms.11 All
LCR assays were performed as directed by the
manufacturer (Abbott Diagnostics).

All endocervical swabs were cultured into
cycloheximide treated HeLa 229 cells in 48
well multiwell trays. Specimens were stained
with fluorescein conjugated antichlamydial
monoclonal antibody (“Pathfinder” Kallestad,
Chaska, MI, USA) and viewed under fluores-
cent microscopy on an inverted fluorescent
microscope (Leitz, Sydney, Australia) as previ-
ously described.14

All assays on clinical samples were per-
formed blinded to the results of one another. A
patient was considered positive for *C trachoma-
tis* if the endocervical sample was positive by
culture and/or at least one of first catch urine,
tampon, or endocervical sample was positive by
PCR and LCR.

In order to resolve discrepant results from
patients where only one test type or sample
type was positive, specimens were subjected to
additional testing. For samples negative by cul-
ture and positive by PCR or LCR, direct
immunofluorescence assay (DFA) was per-
formed on the centrifuged deposit of the cul-
ture sample, when sufficient samples were
available.

Patients positive for *C trachomatis* were
randomised to receive azithromycin 1 g orally
immediately or doxycycline 100 mg twice daily
for 10 days. All patients were invited for follow
up (with repeat samples as above) with their
sexual partners, 2–4 weeks after the procedure.

**STATISTICS**

Paired categorical variables were analysed by a
McNemar Q test using a PROPHET software
package (National Institute of Health, USA).

**Results**

Of the 1245 patients from whom specimens
were collected, 70 had an incomplete set of
specimens (i.e. no endocervical swab, six no
urine, four no tampon). Of these, four patients
were positive for *C trachomatis* in two or more
sites or assays. These four patients had no
dendocervical swab collected, but had a first
catch urine and tampon, of which all were
positive by PCR and LCR and therefore
deemed positive for *C trachomatis* and treated
accordingly.

Of the 1175 patients with a complete set of
samples, 36 patients were positive for *C trachoma-
tis* on at least one test. Thirty three patients
were considered true positives, resulting in an
overall prevalence of 2.8% The breakdown of the
33 positive patients is shown in table 1. Of
the 33 positive patients is table 1. Of
the 35 patients with endocervical swabs
positive by culture, all their other specimens
(first catch urine, tampon, endocervical swab)
were also positive by PCR and LCR (except
tone urine negative by LCR). Ten of the
patients with negative endocervical swabs by
culture were positive in all other samples, by all
other methods. One patient inconclusive on
culture was positive by all other tests, from all
other specimens (the DFA on the culture deposit
also had a low number of elementary bodies).

A further three patients who were culture
negative were also β globin negative and nega-
tive for *C trachomatis* on PCR testing; two of
these were also LCR positive on the endocer-
vical swab, although all three were positive by
PCR and LCR of the first catch urine and
tampon. One further patient negative by
Culture, negative PCR endocervical swab (but
LCR positive endocervical swab), was positive
by both PCR and LCR for both first catch
urine and tampon samples.

There were six patients in whom only one
site or test was positive (two were positive by
both PCR and LCR on first catch urine, while
one other patient was endocervical swab
positive by PCR and LCR and all three there-

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**Table 1**  Results for *C trachomatis* detection by sample site and assay

<table>
<thead>
<tr>
<th>Specimen tested</th>
<th>Positive results</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCR</td>
<td>LCR</td>
</tr>
<tr>
<td>First catch urine</td>
<td>34</td>
</tr>
<tr>
<td>Tampon</td>
<td>31</td>
</tr>
<tr>
<td>Endocervical swabs</td>
<td>27</td>
</tr>
</tbody>
</table>

*ND = not done.*
Table 2 Comparison of PCR and LCR

<table>
<thead>
<tr>
<th></th>
<th>PCR</th>
<th>Tampon</th>
<th>Endocervical swab</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pos</td>
<td>Neg</td>
<td>Total</td>
</tr>
<tr>
<td>LCR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pos</td>
<td>31</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>Neg</td>
<td>3</td>
<td>1141</td>
<td>1144</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>1144</td>
<td>1175</td>
</tr>
<tr>
<td>p Value</td>
<td>0.25</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Table 3 Comparison of culture for endocervical sample to PCR and LCR

<table>
<thead>
<tr>
<th>Culture</th>
<th>PCR</th>
<th>LCR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pos</td>
<td>Neg</td>
</tr>
<tr>
<td>Pos</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Neg</td>
<td>12</td>
<td>1148</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>1148</td>
</tr>
<tr>
<td>p Value</td>
<td>0.0005</td>
<td>0.0005</td>
</tr>
</tbody>
</table>

fore were defined as positive patients and treated accordingly). Of the other three patients, in whom only one site by one test was positive, two were positive by PCR first catch urine alone and one positive by PCR on tampon alone; hence all three of these patients were deemed negative.

There were no patients positive by culture alone. Of the 10 culture negative patients, positive by PCR and LCR, four culture pellets were available for DFA and three showed low number of elementary bodies.

Detection of *C. trachomatis* by PCR or LCR from endocervical swab, first catch urine, or tampon was not statistically different (p = 0.25, 0.5, and 0.5 respectively, see table 2); whereas from endocervical swab, detection by PCR/LCR compared with culture was significantly better (p = 0.0005) (table 3). The positive predictive value (PPV) and negative predictive value (NPV) of PCR of endocervical swab sample compared with culture was 56% and 100% respectively, while for LCR it was 52% and 100% respectively. The PPV and NPV of LCR using the expanded gold standard for endocervical samples as a comparison was 93% and 100% respectively, whereas for PCR it was 100% for both. For the tampon or first catch urine comparison against the expanded gold standard, the PPV and NPV were the same at 100% and 99.8% respectively.

Of the 33 patients defined as positive for chlamydia, 28 returned for follow up after treatment and all were also assessed clinically. Of 13 from whom test of cure samples were collected, none was positive for *C. trachomatis*. There was no difference in outcome for those patients treated with doxycycline compared with azithromycin.

**Discussion**

The prevalence of *C. trachomatis* in women presenting for termination of pregnancy in a teaching hospital in Melbourne, Australia, was calculated at 2.8%. This is lower than the previously determined rate of 4.9% at the same hospital in 1986 and 2% in 1990 (S Garland unpublished observation), both of which were made by culture and for the same hospital population. This decreased prevalence of chlamydia is consistent with that for other female populations screened in Melbourne, and has been noted since the safe sex campaign of the late 1980s. At the Melbourne Sexual Health Centre the chlamydia detection rate in women for 1997 was 1.3% (D Jacobs, personal communication), whereas in 1982 it was 14.6%, 1983 9.1%, 1989 2.7% as determined by culture. As most *C. trachomatis* infection is asymptomatic there is a need to screen at risk patients to reduce the morbidity from infection, as well as to decrease the incidence and prevalence of this pathogen in the population at large. Screening and treatment are particularly important for those women at risk of upper genital tract complication, such as those who are infected and undergo a genital tract surgical procedure—for example, termination of pregnancy. Yet traditional screening procedures for detection of asymptomatically infected patients has necessitated a speculum examination to collect the infected cells of columnar epithelium from the endocervix of which *C. trachomatis* has tropism. Furthermore, using culture techniques it has been shown that 5–30% of infected women have only urethral colonisation, while only 50–60% have both endocervical and urethral infection. The new amplification assays, however, with the advantage of increased sensitivity and less invasive collection of clinical samples, have markedly simplified this approach. In the present study patient collected tampon samples or a first voided urine were shown to be equally suitable for detection of *C. trachomatis* by PCR or LCR, compared with a physician collected endocervical swab using the same detection technology. We have also previously shown a high patient compliance and acceptability to the tampon for sample collection in remote populations where lack of sophisticated services and transport delays in delivery of samples resulted in a detection rate by PCR to be almost double that for conventional methods for chlamydia diagnosis.

Columnar cells are the cell of chlamydia tropism and infection, and we hypothesis that PCR or LCR applied to tampon and/or first catch urine samples detect shed and/or flushed cells infected with chlamydia. This is further supported by the findings of Thomas et al who assessed and found vaginal swabs collected for testing by LCR to be as sensitive for detection of *C. trachomatis* for women also positive in endocervical and urine samples.

Even with the added sensitivity of amplification assays to detect more infections, the quality of the specimen collected is still key to obtaining optimum diagnostic performance. We earlier found, in comparing tampons with endocervical scrapes for HPV DNA detection, that much more cellular DNA was obtained by PCR or LCR applied to tampon and/or first catch urine samples detect shed and/or flushed cells infected with chlamydia. This is further supported by the findings of Thomas et al who assessed and found vaginal swabs collected for testing by LCR to be as sensitive for detection of *C. trachomatis* for women also positive in endocervical and urine samples.
specimens.\(^7\) This is further supported by Welsh et al\(^20\) who recently reported a study where they examined the quality of the cellular component of endocervical samples collected for \textit{C. trachomatis} PCR detection, by also applying direct fluorescence; only 64\% of specimens were considered adequate. They too found that the cellular quality of the sample significantly affected the ability to detect chlamydia.\(^20\)

Therefore, even utilising technology with increased sensitivity, training of staff and patients in techniques of appropriate specimen collection is critical. For amplification assays such as PCR, the inclusion of an internal control such as \(\beta\) globin ensures adequate sample collection.\(^7\)

We recommend screening of \textit{C. trachomatis} in all women presenting for termination of pregnancy. A patient collected tampon or first voided urine for detection by PCR/LCR is appropriate and has high patient compliance.

We thank and acknowledge the clinicians from the Pregnancy Advisory Committee, Royal Women’s Hospital, for collecting the endocervical swab specimens, to Abbott Diagnostics for donating LCR kits, Pfizer for the donation of azithromycin, The Royal Women’s Hospital, Pathology Research and Education Fund for financial assistance, and Jan Matthews for typing the manuscript.

\textbf{Contributors:} SG designed and coordinated the study as well as collated the data, in addition to following patients positive for \textit{Chlamydia} for treatment and review; ST and SG performed all the molecular biology, as well as writing the methods section of the manuscript and collated the results section as this related to the \textit{C. trachomatis} infection in women by using urine specimens. \(J\) Clin Microbiol 1997;35:402–5.


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*Sex Transm Infect* 2000 76: 173-176
doi: 10.1136/sti.76.3.173

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