Extra-Genital Testing: What Are We Missing?

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Special thanks to Kyle Bernstein, Ph.D. for sharing his slides with me
Extragenital GC and Ct

• Prevalence
• Public Health Implications
• Importance
  • HIV
  • Resistant gonorrhea
• Future Directions
Chlamydia — Rates of Reported Cases by Sex, United States, 1994–2015*

*2015 Data are preliminary as of May 5, 2016
*2015 Data are preliminary as of May 5, 2016
National Case Based Surveillance

• Person based
  • Extragenital infections may be underestimated

• Site of infection
  • Data not available at national level
GENITAL & EXTRA-GENITAL TESTING CAPACITY AT DHMH LABS - 2016

• NAATs (Chlamydia lab)
  • endocervical swabs
  • male urethral swabs
  • urine first void (male and female)
  • rectal swabs

• Culture tests (GC Lab)
  • Endocervix
  • Urethra
  • Conjunctival
  • Nasopharynx
  • throat
  • rectal
What do we know?
Why do extragenital testing?

- From July 2003 until February 2007, 441 rectal test sets were collected from individuals attending a sexually transmitted disease clinic and three HIV clinics
  - who gave a history of anal intercourse or
  - were women at high risk for *Neisseria gonorrhoeae* or *Chlamydia trachomatis* infections.

- What would we have missed by NOT testing the rectum?
  - Over 60% and 80% of gonococcal and chlamydial infections in MSM
  - Over 20% of chlamydial infections in women

Extragenital Screening in Men Who Have Sex With Men Diagnoses More Chlamydia and Gonorrhea Cases Than Urine Testing Alone

Greta L. Anschuetz, MPH,* Eric Paulukonis, BA,† Ron Powers, BA,† and Lenore E. Ashel, MD*

<table>
<thead>
<tr>
<th></th>
<th>Gonorrhea</th>
<th></th>
<th></th>
<th>Chlamydia</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Urine Negative</td>
<td></td>
<td>Urine Negative</td>
<td></td>
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<tr>
<td></td>
<td>Urine</td>
<td>Pharyngeal</td>
<td>Rectal</td>
<td>Both</td>
<td>Positive</td>
</tr>
<tr>
<td>Washington West Program</td>
<td>1731</td>
<td>1619</td>
<td>1124</td>
<td>80</td>
<td>42</td>
</tr>
<tr>
<td>Health Center #1 STD Clinic</td>
<td>1025</td>
<td>886</td>
<td>639</td>
<td>59</td>
<td>50</td>
</tr>
</tbody>
</table>

% Potentially missed is defined as the number of pharyngeal, rectal, or both infections that would not have been diagnosed if only urogenital testing was available.
Proportion of extragenital gonorrhea and chlamydia infections associated with concurrent negative urethral tests.


21,994 MSM attending 42 STD Clinic in US 2011-2012
Neisseria gonorrhoeae and Chlamydia trachomatis Among Women Reporting Extragenital Exposures

Joshua D. Trebach, BS,* C. Patrick Chaulk, MD,*† Kathleen R. Page, MD,*† Susan Tuddenham, MD, MPH,* and Khalil G. Ghanem, MD, PhD*

Methods: All patients who reported extragenital exposures in the preceding 3 months, who presented for care between June 1, 2011, and May 31, 2013, and who were tested for GC and CT using nucleic acid amplification tests at all sites of

Results: A total of 10,389 patients were included in this analysis (88% African American; mean age, 29 years; 42% women; 7% MSM; 2.5% HIV infected)

• The prevalence estimates of any extragenital GC and CT were as follows:
  • 2.4% GC and 3.7% CT in women
  • 2.6% GC and 1.6% CT in men who have sex with women
  • 18.9% GC and 11.8% CT in MSM.

• Among women, 30.3% of GC infections and 13.8% of CT infections would have been missed with urogenital-only testing.

• Unlike MSM, age ≤18 years was the strongest predictor of extragenital infections in women.

Sex Transm Dis 2015;42:233-239
A summary of studies that assessed prevalence of GC and CT in women

<table>
<thead>
<tr>
<th>Study First Author</th>
<th>Year</th>
<th>Population/Setting</th>
<th>GC Prevalence Throat (95% CI)</th>
<th>GC Prevalence Rectum (95% CI)</th>
<th>CT Prevalence Throat (95% CI)</th>
<th>CT Prevalence Rectum (95% CI)</th>
<th>% missed CT and GC&lt;sup&gt;4&lt;/sup&gt; (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trebach JD, et al. (current study)</td>
<td>2014</td>
<td>Baltimore City Health Department Eastern Health District and Druid Health Center, Maryland</td>
<td>2.09 (1.68–2.57) N=4203</td>
<td>2.95 (1.76–4.62) N=611</td>
<td>2.59 (2.10–3.16) N=3662</td>
<td>8.64 (6.52–11.17) N=602</td>
<td>CT: 13.8% (10.7–17.6) GC: 30.3% (23.4–37.9)</td>
</tr>
<tr>
<td>Van Liere, G et al.&lt;sup&gt;16&lt;/sup&gt;</td>
<td>2014</td>
<td>South Limburg Public Health Service STI clinic, Netherlands</td>
<td>2.3% (1.54–3.23) N=1321</td>
<td>0.9% (0.47–1.58) N=1321</td>
<td>1.4% (0.87–2.23) N=1321</td>
<td>4.8% (3.68–6.06) N=1321</td>
<td>CT: 22.8% (14.72–32.75) GC: 58.5 (42.11–73.68)</td>
</tr>
<tr>
<td>Garner AL, et al.&lt;sup&gt;4&lt;/sup&gt;</td>
<td>2014</td>
<td>Manchester Centre for Sexual Health, UK</td>
<td>0.6% (0.17–1.59) N=642</td>
<td>1.1% (0.03–5.97) N=91</td>
<td>2.5% (1.43–4.02) N=642</td>
<td>6.6% (2.46–13.80) N=91</td>
<td>CT: 12.9% (5.74–23.85) GC: 28.5% (3.67–70.96)</td>
</tr>
<tr>
<td>Ladd J, et al.&lt;sup&gt;17&lt;/sup&gt;</td>
<td>2014</td>
<td>Home testing using iwantthekit.org</td>
<td>N/A</td>
<td>2.4% (0.80–5.60) N=205</td>
<td>N/A</td>
<td>12.7% (8.45–18.03) N=205</td>
<td>N/A</td>
</tr>
<tr>
<td>Jenkins WD, et al.&lt;sup&gt;30&lt;/sup&gt;</td>
<td>2014</td>
<td>Memorial Medical Center Emergency Department, IL</td>
<td>0.66% (0.18–2.38) N=301</td>
<td>N/A</td>
<td>0.66% (0.18–2.38) N=301</td>
<td>N/A</td>
<td>Pharyngeal CT: 0% Pharyngeal GC: 9.09% (2.53–27.81)</td>
</tr>
<tr>
<td>Shaw SG, et al.&lt;sup&gt;18&lt;/sup&gt;</td>
<td>2013</td>
<td>STI center in the United Kingdom</td>
<td>0.28% (0.03–0.49) N=1799</td>
<td>0.64% (0.08–2.30) N=312</td>
<td>1.3% (0.81–1.91) N=1799</td>
<td>7.1% (4.47–10.48) N=312</td>
<td>N/A</td>
</tr>
<tr>
<td>Study First Author</td>
<td>Year</td>
<td>Population/Setting</td>
<td>GC Prevalence Throat (95% CI)</td>
<td>GC Prevalence Rectum (95% CI)</td>
<td>CT Prevalence Throat (95% CI)</td>
<td>CT Prevalence Rectum (95% CI)</td>
<td>% missed CT and GC 4 (95% CI)</td>
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<tr>
<td>Koedijk FDH, et al. 5</td>
<td>2012</td>
<td>STI centers in the Netherlands</td>
<td>1.20% (1.15–1.25) N = 206,513</td>
<td>1.20% (1.15–1.25) N = 207,134</td>
<td>2.70% (2.63–2.77) N = 206,720</td>
<td>9.3% (9.18–9.43) N = 206,720</td>
<td>CT: 12.9% (N/A) GC: 30.0% (N/A)</td>
</tr>
<tr>
<td>Javanbakht M, et al. 6</td>
<td>2012</td>
<td>STD clinics in Los Angeles County, CA</td>
<td>N/A</td>
<td>3.0% (2.27–3.80) N = 2026</td>
<td>N/A</td>
<td>14.6% (12.29–16.32) N = 1203</td>
<td>CT: 25% (19.41–32.14) GC: 18.5% (10.75–28.70)</td>
</tr>
<tr>
<td>Rodriguez-Hart C, et al. 3</td>
<td>2012</td>
<td>Adult film performers</td>
<td>22.32% (15.00–31.16) N = 112</td>
<td>16.96% (10.53–25.22) N = 112</td>
<td>N/A</td>
<td>3.57% (0.98–8.89) N = 112</td>
<td>CT &amp; GC: 15% (N/A)</td>
</tr>
<tr>
<td>Karlsson A, et al. 19</td>
<td>2011</td>
<td>Porsö Health Care Centre and Gällivare Centre for Young Persons, Sweden</td>
<td>N/A</td>
<td>N/A</td>
<td>12% (6.12–20.39) N = 92</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Peters RP, et al. 20</td>
<td>2011</td>
<td>STD Clinic-The Hague</td>
<td>0.8% (0.54–1.14) N = 3750</td>
<td>1.7% (0.96–2.81) N = 876</td>
<td>1.9% (1.48–2.38) N = 3750</td>
<td>8.7% (6.90–10.74) N = 876</td>
<td>N/A</td>
</tr>
<tr>
<td>Study First Author</td>
<td>Year</td>
<td>Population/Setting</td>
<td>GC Prevalence Throat (95% CI)</td>
<td>GC Prevalence Rectum (95% CI)</td>
<td>CT Prevalence Throat (95% CI)</td>
<td>CT Prevalence Rectum (95% CI)</td>
<td>% missed CT and GC (95% CI)</td>
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<tr>
<td>Bachmann LH, et al.</td>
<td>2010</td>
<td>Clinics in AL and IL</td>
<td>N/A</td>
<td>16.46% (9.88–26.15) N=79</td>
<td>N/A</td>
<td>32.14% (23.12–42.72) N=84</td>
<td>Rectal CT: 23.33% (11.79–40.92) Rectal GC: 15.79% (5.52–37.57)</td>
</tr>
<tr>
<td>Tipple C, et al.</td>
<td>2010</td>
<td>UK STI Center</td>
<td>N/A</td>
<td>N/A</td>
<td>1.9% (1.05–3.05) N=805</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Giannini CM, et al.</td>
<td>2010</td>
<td>Adolescent hospital STD Clinic (adolescents) STD Clinic (Adults)</td>
<td>3.5% (1.0–6.2) N=195; 6.8% (3.8–9.9) N=263; 2.5% (1.4–3.5) N=887</td>
<td>N/A</td>
<td>2.9% (0.1–5.7) N=140; 13.4% (3.9–23) N=52; 5.2% (2.7–7.7) N=308</td>
<td>N/A</td>
<td>Adolescents GC: 14–26% (N/A) Adolescents (hospitalized): 11% (N/A) Adults GC: 20–40% (N/A)</td>
</tr>
<tr>
<td>Hunte T, et al.</td>
<td>2010</td>
<td>Miami Dade Health Department STD Clinic</td>
<td>N/A</td>
<td>13.4% (7.33–21.83) N=97</td>
<td>N/A</td>
<td>17.5% (10.55–26.57) N=97</td>
<td>Rectal CT: 6% (0.15–28.69) Rectal GC: 38% (13.86–68.42)</td>
</tr>
<tr>
<td>Barry PM, et al.</td>
<td>2010</td>
<td>San Francisco STD Clinic</td>
<td>N/A</td>
<td>1.7% (1.06–2.54) N=1308</td>
<td>N/A</td>
<td>4.7% (3.65–6.03) N=1308</td>
<td>Rectal GC: 0.1% (0.0–0.43) Rectal CT: 1.0% (0.53–1.69)</td>
</tr>
<tr>
<td>Raychaudhuri M, et al.</td>
<td>2010</td>
<td>STI clinic; UK</td>
<td>N/A</td>
<td>35.83% (27.29–45.10) N=120</td>
<td>N/A</td>
<td>N/A</td>
<td>GC 5.8% (2.38–11.65)</td>
</tr>
<tr>
<td>Study First Author</td>
<td>Year</td>
<td>Population/Setting</td>
<td>GC Prevalence Throat (95% CI)</td>
<td>GC Prevalence Rectum (95% CI)</td>
<td>CT Prevalence Throat (95% CI)</td>
<td>CT Prevalence Rectum (95% CI)</td>
<td>% missed CT and GCΔ (95% CI)</td>
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<tr>
<td>Van der Helm JJ, et al.</td>
<td>2009</td>
<td>Clients of Amsterdam and South Limburg STI outpatient centers</td>
<td>N/A</td>
<td>1.9% (1.1–3.2) N=697</td>
<td>N/A</td>
<td>9.4% (7.7–11.5) N=901</td>
<td>N/A</td>
</tr>
<tr>
<td>Bachmann LH, et al.</td>
<td>2009</td>
<td>Public STD clinic, HIV clinic, university-based HIV clinic; Alabama.</td>
<td>9.1% (6.18–13.17) N=264</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Ostergaard L, et al.</td>
<td>1997</td>
<td>Rudolph Bergh Hospital, Denmark</td>
<td>N/A</td>
<td>N/A</td>
<td>1.53% (0.52–4.40) 3/196</td>
<td>5.61% (3.16–9.77) 1/196</td>
<td>CT: 13.04% (4.54–32.12)</td>
</tr>
<tr>
<td>Jones RB, et al.</td>
<td>1985</td>
<td>Indiana STD clinics</td>
<td>N/A</td>
<td>N/A</td>
<td>3.2% (1.96–4.89) N=626</td>
<td>5.2% (4.04–6.61) N=1227</td>
<td>N/A</td>
</tr>
</tbody>
</table>
High prevalence of extra-genital CT or GC among MSM and transgender women in Lima, Peru

GC and CT infections among MSM in Cape Town, SA
Rebe K et al PLoS One 2015;10:e0138315

- 200 MSM
  - 57 (29%) symptoms
  - 10 (5%) urethral discharge
  - 26 (13%) oropharynx pain
  - 22 (11%) anal discharge or pain
Pharyngeal CT and GC Positivity among MSM – San Francisco 2010

<table>
<thead>
<tr>
<th>Clinical Site</th>
<th>N</th>
<th>CT Positivity (%)</th>
<th>95% CI (%)</th>
<th>GC Positivity (%)</th>
<th>95% CI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV testing site</td>
<td>816</td>
<td>1.1</td>
<td>0.5–2.1</td>
<td>3.4</td>
<td>2.3–4.9</td>
</tr>
<tr>
<td>STD clinic</td>
<td>3949</td>
<td>2.3</td>
<td>1.8–2.8</td>
<td>7.0</td>
<td>6.2–7.9</td>
</tr>
<tr>
<td>Community clinics</td>
<td>505</td>
<td>1.4</td>
<td>0.6–2.8</td>
<td>4.0</td>
<td>2.4–6.1</td>
</tr>
<tr>
<td>Gay men’s health center</td>
<td>6556</td>
<td>1.4</td>
<td>1.2–1.7</td>
<td>5.5</td>
<td>4.9–6.0</td>
</tr>
<tr>
<td>HIV care clinic</td>
<td>633</td>
<td>1.7</td>
<td>0.9–3.1</td>
<td>5.6</td>
<td>3.9–7.6</td>
</tr>
</tbody>
</table>

Prevalence and Incidence of Pharyngeal GC

- Project EXPLORE (MSM)
  - Prevalence 5.5%
  - Incidence 11.2/100 person-years
Rectal CT and GC by HIV Status: San Francisco STD Clinic, 2009

- HIV-infected at higher risk for rectal infections than HIV-uninfected

- RR CT = 1.7 (1.3-2.2)
- RR GC = 1.8 (1.3-2/5)
Rectal and pharyngeal screening without urogenital screening?
Proportion of chlamydial and gonococcal infections among asymptomatic men who have sex with men that would be identified and missed by different screening algorithms—San Francisco City Clinic, 2008–2009

- Urethral screening only: 85.7% identified, 14.3% missed
- Rectal and pharyngeal screening only: 91.4% identified, 8.6% missed
2015 CDC STD Treatment Guidelines

- Sexually active MSM should be screened at least annually for GC and CT at sites of exposure (urethra, rectum, pharynx*)
  - Pharyngeal CT screening not recommended
- MSM at increased risk should be screened every 3-6 months
Rectal Self-Swab
Collection Instructions

Step 1.
Open kit and remove tube and package with green writing. Remove the swab with the **BLUE** shaft. **USE BLUE SHAFT SWAB ONLY.**

Step 2.
Insert swab 1 inch into the anus and turn for 5 – 10 seconds.
If needed, before inserting swab, wet swab with water or saline solution.

Step 3.
Remove cap from test tube. Place swab in test tube. Do not puncture the foil cap.
Break swab shaft at the score mark.

Step 4.
Put cap back tightly on test tube to prevent any leaking. Try not to splash the liquid out the tube.

Step 5.
Discard wrapper and unused swab. **Wash your hands.** Return the tube to the health worker.
Pharyngeal Swab
Collection Instructions

**Step 1.**
Open kit and remove tube and package with green writing. Remove the swab with the **BLUE** shaft. **USE BLUE SHAFT SWAB ONLY.**

**Step 2.**
Instruct patient to open mouth widely. Be sure to make good contact with 5 key areas of the throat (See below).

**Step 3.**
Remove cap from test tube. Place swab in test tube. Do not puncture the foil cap. Break swab shaft at the score mark.

**Step 4.**
Put cap back tightly on test tube to prevent any leaking. Try not to splash the liquid out the tube.

**Step 5.**
Discard wrapper and unused swab. **Wash your hands.**
Transmission Opportunities
Positivity of urethral CT and GC among MSM
San Francisco City Clinic 2007
Bernstein CID 2009;49:1793
Positivity of Urethral CT and GC among MSW – San Francisco City Clinic 2006-10

Figure 1. Urethral Chlamydia trachomatis and Neisseria gonorrhoeae positivity among men who have sex with women who visited the San Francisco City Clinic, 2006–2010.

Population Attributable Risk Percentage for Oropharyngeal Exposure, MSM Seattle 2001-13

- Case-control study of new patient MSM visits
  - Case-MSM visits with urethritis
  - Control – MSM visits with no urethral infections

- Gonococcal Urethritis – 33.8%
- Chlamydial urethritis – 2.7%
- Non-gonococcal, non-chlamydial urethritis – 27.1%

Duration of Extrapenital GC and CT Infections among MSM

• Pharyngeal GC – 114.1-137.8 days
• Rectal GC – 346.0 days
• Pharyngeal CT – 667.1 days
• Rectal CT – 578.7 days
Don’t ask, won’t tell
Don’t look, won’t find
Are STDs Causally Associated with HIV?

STDs → HIV

Mental Health Issues
Sex Work
Lots of UAI
Substance Use
Multiple Partners

STDs → HIV
Cumulative HIV Incidence Among HIV-uninfected MSM, San Francisco City Clinic

17.7%

(J Acquir Immune Defic Syndr 2010;53:537–543)

Rectal Gonorrhea and Chlamydia Reinfection Is Associated With Increased Risk of HIV Seroconversion

Kyle T. Bernstein, PhD, ScM, Julia L. Marcus, MPH, Giuliano Nieri, BA, Susan S. Philip, MD, MPH, and Jeffrey D. Klausner, MD, MPH

Do extragenital STDs → HIV?

• We may never know
  • Randomized trial of infection or treatment of STDs = unethical!
  • Randomized trial of prophylactic treatment of bacterial STDs = unethical (?), abx resistance?
• Marginal structural models of observational data
  • Every visit needs rectal STD testing and HIV testing
  • Sufficient number of HIV seroconversions for appropriately power analysis
Do extragenital STDs → HIV?

• Maybe it doesn’t matter
  • If rectal STDs *cause* HIV, then preventing STDs is good HIV prevention
  • Even if rectal STDs *do not cause* HIV, MSM with rectal STDs are at higher risk for HIV
    • Way to identify high-risk subpopulations for intervention
    • Less subjective marker of risk than self-reported sexual or substance use behaviors
Extragenital GC and Antibiotic Resistance
Prevalence of resistance to penicillin, tetracycline or fluoroquinolone, or reduced cefixime or azithromycin susceptibility by year — Gonococcal Isolate Surveillance Project (GISP), United States, 2000–2014

Azithromycin Reduced Susceptibility (RS) = MIC $\geq$ 1 µg/ml (2000-2004); $\geq$ 2 µg/ml (2005-2014); Cefixime-RS = MIC $\geq$ 0.25 µg/ml;
Fluoroquinolone Resistance (R) = Ciprofloxacin MIC $\geq$ 1 µg/ml; Penicillin-R = MIC $\geq$ 2 µg/ml or $\beta$-lactamase positive; Tetracycline-R = MIC $\geq$ 2 µg/ml

NOTE: Cefixime susceptibility not testing in 2007 and 2008
<table>
<thead>
<tr>
<th>Country, year</th>
<th>Ceftriaxone Therapy</th>
<th>Ceftriaxone MIC (mg/L)</th>
<th>( f_{T&gt;MIC} ) hours(^a)</th>
<th>MLST/NG-MAST</th>
<th>Site of failure</th>
<th>Final successful treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia (n = 2), 2007 [31]</td>
<td>250 mg x 1</td>
<td>0.016-0.03 (Agar dilution)</td>
<td>41.4-50.3</td>
<td>ND/ST5, ST2740</td>
<td>Pharynx</td>
<td>Ceftriaxone 500 mg x 1/ Ceftriaxone 1 g x 1</td>
</tr>
<tr>
<td>Japan (n = 1), 2009 [30]</td>
<td>1 g x 1</td>
<td>4.0(^b) (Etest, XDR)</td>
<td>0</td>
<td>ST7363/ST4220</td>
<td>Pharynx</td>
<td>None(^c)</td>
</tr>
<tr>
<td>Sweden (n = 1), 2010 [34]</td>
<td>250 mg x 1 and 500 mg x 1</td>
<td>0.125-0.25(^b) (Etest)</td>
<td>15.6-32.8</td>
<td>ST1901/ST2958</td>
<td>Pharynx</td>
<td>Ceftriaxone 1 g x 1</td>
</tr>
<tr>
<td>Australia (n = 1), 2010 [32]</td>
<td>500 mg x 1</td>
<td>0.03-0.06 (Agar dilution)</td>
<td>41.3-49.9</td>
<td>ND/ST1407, ST4950 (genogroup 1407)</td>
<td>Pharynx</td>
<td>Azithromycin 2 g x 1</td>
</tr>
<tr>
<td>Slovenia (n = 1), 2011 [36]</td>
<td>250 mg x 1</td>
<td>0.125(^b) (Etest)</td>
<td>24.3</td>
<td>ST1901/ST1407 (genogroup 1407)</td>
<td>Pharynx</td>
<td>Ceftriaxone 250 mg x 1 plus azithromycin 1 g x 1</td>
</tr>
<tr>
<td>Australia (n = 2), 2011 [33]</td>
<td>500 mg x 1</td>
<td>0.03-0.06 (Agar dilution)</td>
<td>41.3-49.9</td>
<td>ST1901/ST225, new variant of ST225</td>
<td>Pharynx</td>
<td>Ceftriaxone 1 g x 1 plus azithromycin 2 g x 1 or Ceftriaxone 1 g x 1</td>
</tr>
<tr>
<td>Sweden (n = 3), 2013-2014 [35]</td>
<td>500 mg x 1</td>
<td>0.064-0.125(^b) (Etest)</td>
<td>32.8-41.3</td>
<td>ST1901/ST3149, ST3149, ST4706 (genogroup 1407)</td>
<td>Pharynx</td>
<td>Ceftriaxone 1 g x 1</td>
</tr>
</tbody>
</table>

\(^a\)Simulation of time of free ceftriaxone above MIC (\( f_{T>MIC} \)) based on mean pharmacokinetic parameter values. Data from Chisholm et al. [52]

\(^b\)Genetic cephalosporin resistance determinants (\( \text{penA, mtrR, penB} \)) elucidated [3, 5-8]

\(^c\)The infection was considered to have resolved spontaneously within 3 months

MIC minimum inhibitory concentration, MLST multilocus sequence typing, NG-MAST \( \text{Neisseria gonorrhoeae} \) multi-antigen sequence typing, ND not determined, ST sequence type, XDR extensively drug-resistant [9]
• 58 participants enrolled and treated: 28 participants received 1200 mg of solithromycin and 31 received 1000 mg
<table>
<thead>
<tr>
<th>Organism and Site</th>
<th>Culture</th>
<th>NAAT</th>
<th>Culture</th>
<th>NAAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neisseria gonorrhoeae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urogenital</td>
<td>22/0</td>
<td>23/2</td>
<td>20/0</td>
<td>20/4</td>
</tr>
<tr>
<td>Rectal</td>
<td>2/0</td>
<td>9/0</td>
<td>2/0</td>
<td>11/0</td>
</tr>
<tr>
<td>Throat</td>
<td>5/0</td>
<td>9/3</td>
<td>3/0</td>
<td>7/1</td>
</tr>
<tr>
<td>Total</td>
<td>29/0</td>
<td>41/5</td>
<td>25/0</td>
<td>37/5</td>
</tr>
<tr>
<td>Chlamydia trachomatis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urogenital</td>
<td>NA</td>
<td>8/1</td>
<td>NA</td>
<td>2/1</td>
</tr>
<tr>
<td>Rectal</td>
<td>NA</td>
<td>1/0</td>
<td>NA</td>
<td>1/0</td>
</tr>
</tbody>
</table>

Outcomes are shown as positive at enrollment/positive at follow-up.
Abbreviations: NA, not applicable; NAAT, nucleic acid amplification test.

a Participants were tested at all potential sites of sexual exposure. Several participants had positive tests for N. gonorrhoeae or C. trachomatis at >1 site.
Future Directions

- Estimates of population burden of disease outside of clinic-based convenience samples
- Epidemiology of sequelae of untreated extragenital infections
  - Biome?
  - Immune response?
- Role of extragenital GC in development of resistance
- Molecular epidemiology of GC
- Avenues of intervention
GENITAL & EXTRA-GENITAL TESTING CAPACITY AT DHMH LABS - 2016

• NAAT tests (Chlamydia lab):
  • endocervical swabs
  • male urethral swabs
  • urine first void (male and female)
  • rectal swabs

• Culture tests (GC Lab):
  • Endocervix
  • Urethra
  • Conjunctival
  • Nasopharynx
  • throat
  • rectal
Thank you