BMJ Open

Performance of syndromic management for the detection and treatment of genital *Chlamydia trachomatis*, *Neisseria gonorrhoeae* and *Trichomonas vaginalis* among women attending antenatal, well woman and sexual health clinics in Papua New Guinea: a cross-sectional study

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To cite: Vallely LM, Toliman P, Ryan C, *et al*. Performance of syndromic management for the detection and treatment of genital *Chlamydia trachomatis*, *Neisseria gonorrhoeae* and *Trichomonas vaginalis* among women attending antenatal, well woman and sexual health clinics in Papua New Guinea: a cross-sectional study. *BMJ Open* 2017;**7**:e018630. doi:10.1136/bmjopen-2017-018630

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2017-018630).

Received 12 July 2017
Revised 15 November 2017
Accepted 22 November 2017

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ABSTRACT

Objective Papua New Guinea (PNG) has among the highest estimated prevalences of genital *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG) and *Trichomonas vaginalis* (TV) of any country in the Asia-Pacific region. Diagnosis and treatment of these infections have relied on the WHO-endorsed syndromic management strategy that uses clinical presentation without laboratory confirmation to make treatment decisions. We evaluated the performance of this strategy in clinical settings in PNG.

Design Women attending antenatal (ANC), well woman (WWC) and sexual health (SHC) clinics in four provinces were invited to participate, completed a face-to-face interview and clinical examination, and provided genital specimens for laboratory testing. We estimated the performance characteristics of syndromic diagnoses against combined laboratory diagnoses.

Results 1764 women were enrolled (ANC=765; WWC=614; SHC=385). The prevalences of CT, NG and TV were highest among women attending ANC and SHC. Among antenatal women, syndromic diagnosis of sexually transmitted infection had low sensitivity (9%–21%) and positive predictive value (PPV) (7%–37%), but high specificity (76%–89%) and moderate negative predictive value (NPV) (55%–86%) for the combined endpoint of laboratory-confirmed CT, NG or TV. Among women attending WWC and SHC, 'vaginal discharge syndrome' had moderate to high sensitivity (72%–78%) and NPV (62%–94%), but low specificity (26%–33%) and PPV (8%–38%). 'Lower abdominal pain syndrome' had low sensitivity (26%–41%) and PPV (8%–23%) but moderate specificity (66%–68%) and high NPV (74%–93%) among women attending WWC, and moderate-high sensitivity (67%–79%) and NPV (62%–86%) but low specificity (26%–28%) and PPV (14%–33%) among SHC attendees.

Conclusion The performance of syndromic management for the detection and treatment of genital chlamydia, gonorrhoea and trichomonas was poor among women in different clinical settings in PNG. New diagnostic strategies are needed to control these infections and to prevent their adverse health outcomes in PNG and other high-burden countries.

Strengths and limitations of this study

- This is the first study to evaluate the performance of syndromic management (based on clinical presentation without laboratory confirmation) for the detection and treatment of genital sexually transmitted infections (STIs) among women in Papua New Guinea.
- Few previous studies have compared the performance of syndromic management among different clinical populations in the same setting.
- The study included the collection of sociodemographic, sexual behavioural and clinical information, and the collection of genital specimens for laboratory-based STI testing.
- We did not investigate bacterial vaginosis, *Candida albicans* or *Mycoplasma genitalium*, and may have underestimated the performance of syndromic management for the detection of STIs and genital infections.

INTRODUCTION

Sexually transmitted infections (STIs) are a major global public health concern.[1] Every year there are an estimated 500 million new cases of curable STIs, the majority of which occur in low-income settings.[2] Adverse outcomes of curable STIs include pelvic inflammatory disease, infertility, ectopic pregnancy, miscarriage, stillbirth, premature labour and low birth weight, and increased risk of HIV acquisition and transmission.[3] The three most common curable genital STIs, *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG) and *Trichomonas vaginalis* (TV), are frequently asymptomatic, particularly in women.[4] Inability to diagnose curable STIs has been a major barrier to their control, because many cases remain undetected and therefore untreated, with the potential for onward transmission. Accurate, nucleic acid-based diagnostic tests are now widely used in high-income countries but are largely unavailable in low-income and middle-income countries (LMICs), where the highest prevalences of these STIs and their associated adverse health outcomes occur.[2] Even more traditional methods, such as microscopy, culture and serology, are not widely available in LMICs, and in any case have low sensitivity for detecting current infection.

In the absence of access to diagnostic STI testing, the WHO in the 1990s developed a syndromic management strategy for diagnosing genital infections based on groups of genital symptoms to guide treatment decisions without laboratory tests.[2] The main syndromic diagnoses in women have been 'vaginal discharge syndrome' (VDS), 'lower abdominal pain syndrome' (LAPS) and 'genital ulcer syndrome', each of which is treated using a combination of antibiotics to cover the most likely underlying infection(s). Syndromic management strategies lead to overtreatment, because there are other, non-sexually transmitted causes of the syndromes; or undertreatment,[5] because they do not address asymptomatic infections that account for the majority of STIs globally.[4] Consequently, despite the wide-scale implementation of syndromic management, this has not been an effective strategy in reducing population-level prevalence, particularly in high-burden settings such as Papua New Guinea (PNG),[6 7] which has among the highest estimated prevalences of genital chlamydia, gonorrhoea and trichomonas of any country in the Asia-Pacific region.[2 7 8]

In this paper, we present findings on the performance of syndromic STI management for the treatment of curable genital STIs among women attending antenatal, well woman and sexual health clinics in PNG.

METHODS

Study design and procedures

We undertook a cross-sectional biobehavioural survey to investigate the STI prevalence and risk factors for infection among women attending routine clinical services in four provinces (Eastern Highlands, Hela, Western Highlands and Central provinces): (1) pregnant women attending routine antenatal clinics; (2) women attending cervical cancer screening services at dedicated well woman clinics; and (3) women attending sexual health clinics. A key objective of the study was to evaluate the clinical performance of syndromic STI diagnosis for the treatment of curable genital STIs among three different clinical populations in this setting. An a priori assumption, based on our earlier systematic review and meta-analysis,[6] was that the prevalence of STIs would vary between women in these different populations and lead to differences in the performance of syndromic management.

All women attending their first clinic visit during the study period (which varied across clinics, between December 2011 and January 2015) were invited to join and were consecutively enrolled into the study following informed consent procedures. Age eligibility criteria varied by clinic type: women aged 18 years or older were recruited at antenatal and sexual health clinics; women aged 30–59 years (the target age group for cervical cancer screening in PNG) were recruited at well woman clinics.

Women took part in a face-to-face interview, conducted by a trained healthcare worker using study-specific case record forms (CRFs) in which sociodemographic, behavioural and clinical information was collected. Locator information and mobile phone contact details were also collected to facilitate subsequent follow-up. Participants in all clinical settings were asked about current genital symptoms and history of STIs. Genital examination was conducted as part of routine clinical assessment among women attending well woman and sexual health clinics only, in accordance with PNG standard guidelines (genital examination is not routinely offered in antenatal clinics).[9] Women attending antenatal clinics provided a self-collected mid-cavity vaginal swab for laboratory-based STI testing (CT, NG, TV); women attending well woman and sexual health clinics provided clinician-collected high vaginal (for TV) and cervical (for CT, NG) swabs. All women provided a venepuncture specimen for point-of-care syphilis screening and HIV counselling and testing.[9] In all clinic settings, women were provided with a date to return for follow-up, when they were given their STI test results, and additional treatment if indicated.[9] Women with clinical features (symptoms and/or clinical examination findings) consistent with one or more STI syndromes were managed according to national guidelines.[9] Clinical findings and treatment provided were recorded in individual client-held health record books and in study-specific CRFs. All participants were advised to return for clinical review to receive their laboratory STI test results, and additional treatment if required. Women with positive STI test results who did not return for scheduled visits were contacted by mobile phone or by clinical research staff in the community, and were advised to reattend for review. All diagnostic tests and antibiotic treatment were provided free of charge.

Laboratory methods

Genital swabs were tested for CT, NG and TV by real-time PCR at the PNG Institute of Medical Research Sexual and Reproductive Health unit laboratory in Goroka, using procedures and methods as previously described.[10] The Sexual and Reproductive Health unit laboratory was enrolled in an external quality assurance programme through the Royal College of Pathologists of Australia for CT and NG PCR.

Data management and statistical methods

Participant study folders (containing completed CRFs and laboratory results slips) were subject to quarterly clinical audits by the study lead investigator (AJV) throughout. Data were entered at each clinical site into a study-specific MS Access database. Database entries were validated against participant study folders for accuracy. Laboratory test results entered into the clinical database were checked for accuracy against source documents (laboratory results slips) for all participants at the end of the study. The performance characteristics (sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV)) of 'vaginal discharge syndrome' and 'lower abdominal pain syndrome' were estimated against laboratory diagnoses of CT, NG and TV, and combinations of two or more STIs were calculated for the three population groups (antenatal clinic, well woman clinic and sexual health clinic). Fisher's exact test was used to compare statistical differences in outcomes of interest between groups. There were no modifications for multiple comparisons. All statistical analyses were performed with Stata V.12.1.

Ethical considerations

Written informed consent (signature or witnessed thumbprint) was obtained from all participants prior to study enrolment. Women were each assigned a unique alphanumeric study identification number from a preprinted study register to ensure anonymity and confidentiality.

RESULTS

During the study period, a total of 1764 women were enrolled at 10 participating clinics (six antenatal clinics, n=765; two well woman clinics, n=614; and two sexual health clinics, n=385; table 1).

Sociodemographic characteristics

Women attending antenatal clinics were significantly younger than those attending well woman or sexual health clinics (table 1). Overall, 89% (1573/1764) of women were married; around half reported attending primary school only (904/1764); and 57% were not in paid employment (920/1764). Women attending sexual health clinics were less likely to be married, or to be in paid employment and had lower educational attainment, compared with women enrolled in antenatal and well woman clinics.

Sexual behavioural characteristics

Overall, around 40% of women (692/1764) reported sexual debut before 18 years of age. Sexual health clinic attendees were more likely to have had a younger age of sexual debut than women attending antenatal or well woman clinics (56.6% vs 34.0% and 34.9%, respectively, P<0.001; table 1). Women attending sexual health clinics were also significantly more likely to report having more than four lifetime sexual partners, more than two sexual partners in the past week, vaginal sex more than four times in the past week and ever having had sex in exchange for gifts or money compared with women attending antenatal or well woman clinics. Sexual health clinic attendees were more likely to report condom use at last vaginal sex compared with women in other clinical settings.

Clinical and laboratory findings

The prevalence of CT, NG and TV was highest among women attending antenatal and sexual health clinics compared with those attending well woman clinics; for example, the prevalence of chlamydia was 22.9%, 21.4% and 7.5%, respectively, in these populations (table 2). Antenatal women and those attending sexual health clinics were also more likely to have two or more STIs compared with well woman clinic attendees (14.2%, 10.6% and 4.8%, respectively; table 2).

The prevalence of VDS was highest among women attending sexual health clinics (73.0%) and well woman clinics (68.7%) compared with antenatal women (20.4%; table 2). LAPS was also less frequently diagnosed among antenatal women (table 2).

Performance of syndromic management

Among antenatal women, syndromic diagnosis (based on clinical symptoms alone) had low sensitivity (9%–21%) and PPV (7%–37%), but high specificity (76%–89%) and moderate NPV (55%–86%) for correctly classifying women as having infection with CT, NG or TV (table 3). Syndromic management alone would have led to considerable overtreatment and underdiagnosis in this population. For example, 38% (60/156) of antenatal women with VDS had any of CT, NG or TV and would have been appropriately treated; 62% (96/156) of women with symptoms but without detectable CT, NG or TV would have been treated unnecessarily; and 82% (267/327) of those with any of CT, NG or TV infection would not have been treated because they did not have vaginal discharge (table 3).

Among women attending well woman clinics, LAPS had low sensitivity (26%–41%) and PPV (8%–23%) but moderate to high specificity (66%–68%) and NPV (74%–93%) for the detection of any laboratory-confirmed STI, or CT, NG, TV individually (table 3). VDS had high sensitivity (72%–75%) and NPV (79%–94%) but low specificity (32%–33%) and PPV (8%–25%). Around one in four women with LAPS (46/200; 23%) had any of CT, NG or TV, and would have been correctly treated based on syndromic management alone; 77% (154/200) of women

Table 1 Sociodemographic characteristics by clinic type

	Total	Clinic attended			
	n (%) 1764	Antenatal n=765	Well woman n=614	Sexual health n=385	P value
Age groups					<0.001
<20 years	99 (5.6)	85 (11.1)	0	14 (3.6)	
20–24 years	300 (17.0)	246 (31.2)	0	54 (14.1)	
25–29 years	295 (16.7)	224 (29.3)	0	71 (18.4)	
30+ years	1070 (60.7)	210 (27.5)	614 (100)	246 (63.1)	
Median age (IQR)	32 (25–37)	25 (22–30)	37 (34–41)	32 (26–37)	<0.001
Marital status					<0.001
Married	1573 (89.2)	719 (94.0)	544 (88.6)	310 (80.8)	
Single	37 (2.1)	22 (2.9)	1 (0.2)	14 (3.6)	
Other	154 (8.7)	24 (3.1)	69 (11.2)	61 (15.8)	
Employment status					
No current paid work	920 (57.2)	591 (77.3)	311 (50.7)	18 (4.7)	<0.001
Gardening/farmer	996 (56.5)	482 (63.0)	382 (62.2)	132 (34.3)	<0.001
Household duties	1464 (83.0)	666 (87.1)	491 (80.0)	307 (79.7)	<0.001
Education					<0.001
No formal education	427 (24.2)	145 (14.6)	172 (28.0)	110 (28.6)	
Attended only primary school (grades 1–8)	904 (51.3)	386 (50.5)	313 (51.0)	205 (53.3)	
Attended secondary school (grades 9–12)	331 (18.8)	207 (27.1)	73 (11.9)	51 (13.3)	
Other (tertiary, tech, vocational)	102 (5.8)	27 (3.5)	56 (9.1)	19 (4.9)	
When did you last have sex					<0.001
Today/yesterday	168 (9.5)	73 (9.5)	54 (8.8)	41 (10.7)	
2 days ago	187 (10.6)	74 (9.7)	49 (8.0)	64 (16.6)	
3 days ago	117 (6.6)	59 (7.7)	33 (5.4)	25 (6.5)	
4 or more days ago	1292 (73.2)	559 (73.1)	478 (77.9)	255 (66.2)	
Vaginal sex in the last week					<0.001
None	702 (39.8)	372 (48.6)	233 (38.0)	97 (25.2)	
Once	623 (35.3)	196 (25.6)	271 (44.1)	156 (40.5)	
Twice	212 (12.0)	100 (13.1)	51 (8.3)	61 (15.8)	
Three times	114 (6.5)	55 (7.2)	28 (4.6)	31 (8.1)	
Four or more times	113 (6.4)	42 (5.5)	31 (5.1)	40 (10.4)	
Condom used last vaginal sex					<0.001
No	1621 (91.9)	718 (93.9)	578 (94.1)	325 (84.4)	
Yes	143 (8.1)	47 (6.1)	36 (5.9)	60 (15.6)	
Number of people had vaginal sex with in the last week					<0.001
None	655 (37.1)	308 (40.3)	229 (37.3)	118 (30.7)	
1 person	1069 (60.6)	447 (58.4)	373 (60.8)	249 (64.7)	
2 or more people	40 (2.3)	10 (1.3)	12 (2.0)	18 (4.7)	
Condom use in the past month					<0.001
Always	24 (1.4)	3 (0.4)	8 (1.3)	13 (3.4)	
Sometimes	298 (16.9)	128 (16.7)	105 (17.1)	65 (16.9)	
Most of the time	32 (1.8)	5 (0.7)	6 (1.0)	21 (5.5)	
Never	1410 (79.9)	629 (82.2)	495 (80.6)	286 (74.3)	

Continued

Table 1 Continued

	Total	Clinic attended			
	n (%) 1764	Antenatal n=765	Well woman n=614	Sexual health n=385	P value
Ever had sex for money/gifts					<0.001
No	1475 (83.6)	723 (94.5)	542 (88.3)	210 (54.6)	
Yes	289 (16.9)	42 (5.5)	72 (11.7)	175 (45.5)	
Age at sexual debut					<0.001
≤18	692 (39.2)	260 (34.0)	214 (34.9)	218 (56.6)	
>18 years	1072 (60.8)	505 (66.0)	400 (65.2)	167 (43.4)	
Lifetime number of sexual partners					<0.001
1 person	805 (45.6)	357 (46.7)	338 (55.1)	110 (28.6)	
2 people	349 (19.8)	165 (21.6)	127 (20.7)	57 (14.8)	
3 people	178 (10.1)	87 (11.4)	49 (8.0)	42 (10.9)	
4 or more people	432 (24.5)	156 (20.4)	100 (16.3)	176 (45.7)	
Ever had anal sex					<0.001
No	1538 (87.2)	685 (89.5)	570 (92.8)	283 (73.5)	
Yes	226 (12.8)	80 (10.5)	44 (7.2)	102 (26.5)	

with LAPS did not have a laboratory-confirmed infection, and therefore would have been treated unnecessarily; and 70% (108/154) of those with any of CT, NG or TV would not have been detected and treated based on a diagnosis of LAPS alone because they did not have appropriate clinical features. Correspondingly, around 27% (114/422) of women with VDS would have been correctly treated; 73% (308/422) of those with VDS would have been unnecessarily treated; and 26% (40/154) of those with any of CT, NG or TV would not have been diagnosed and treated (table 3).

Among women attending sexual health clinics, LAPS and VDS had a moderate to high sensitivity (67%–79%) and NPV (62%–86%) but low specificity (26%–28%) and PPV (14%–33%) for the detection of any laboratory-confirmed STI, or CT, NG, TV individually (table 3). Around 39% (109/282) of women with LAPS would have been correctly treated; 61% (173/282) with LAPS would have been unnecessarily treated; and 25% (36/145) of women with any of CT, NG or TV would not have been diagnosed and treated. Among women with VDS, around 38% (106/281) would have been correctly treated; 62% (175/281) would have been unnecessarily treated; and 27% (39/145) of those with any of CT, NG or TV would not have been diagnosed and treated (table 3).

DISCUSSION

High prevalences of genital CT, NT and TV were observed among women attending antenatal, well woman

Table 2 Syndromic STI diagnosis and prevalence of CT, NG and TV

	Antenatal clinic n=765 (%)	Well woman clinic n=614 (%)	Sexual health clinic n=385 (%)
Lower abdominal pain syndrome	166 (21.7)	200 (32.6)	282 (73.2)
Vaginal discharge syndrome	156 (20.4)	422 (67.8)	281 (73.0)
CT	175 (22.9)	46 (7.5)	78 (21.4)
NG	109 (14.2)	49 (8.0)	63 (16.4)
TV	171 (22.4)	92 (15.0)	54 (14.0)
More than 1 of CT, NG, TV	109 (14.3)	29 (4.7)	40 (10.4)
No STI	438 (57.3)	460 (74.9)	240 (62.3)
Any STI	327 (42.7)	154 (25.1)	145 (37.7)
One STI	218 (28.5)	125 (20.4)	105 (27.3)
Two STIs	90 (11.7)	25 (4.1)	30 (8.0)
Three STIs	19 (2.5)	4 (0.7)	10 (2.6)

CT, *Chlamydia trachomatis*; NG, *Neisseria gonorrhoeae*; STI, sexually transmitted infection; TV, *Trichomonas vaginalis*.

Table 3 Syndromic diagnosis and laboratory-confirmed STIs

Syndromic diagnosis		Any STI, n (%)* Yes	No	Performance (95% CI)	*Chlamydia trachomatis*, n (%)* Yes	No	Performance (95% CI)	*Neisseria gonorrhoeae*, n (%)* Yes	No	Performance (95% CI)	*Trichomonas vaginalis*, n (%)* Yes	No	Performance (95% CI)
Antenatal clinics (n=765)													
LAPS (166/765; 21.7%)	Yes	60 (18.4)	106 (14.2)	Sens: 18% (14% to 23%) Spec: 76% (72% to 80%) PPV: 36% (29% to 44%) NPV: 55% (51% to 59%)	30 (17.1)	136 (23.0)	Sens: 17% (12% to 24%) Spec: 77% (73% to 80%) PPV: 18% (13% to 25%) NPV: 76% (72% to 79%)	15 (13.8)	151 (23.0)	Sens: 14% (8% to 22%) Spec: 77% (74% to 80%) PPV: 9% (5% to 14%) NPV: 84% (81% to 87%)	29 (83.0)	457 (77.0)	Sens: 17% (12% to 23%) Spec: 77% (73% to 80%) PPV: 17% (12% to 24%) NPV: 76% (73% to 80%)
	No	267 (81.7)	332 (75.8)		145 (82.9)	454 (77.0)		94 (86.2)	505 (77.0)		142 (83.0)	457 (77.0)	
VDS (156/765; 20.4%)	Yes	60 (18.4)	96 (22.0)	Sens: 18% (14% to 23%) Spec: 78% (74% to 82%) PPV: 38% (40% to 47%) NPV: 56% (52% to 60%)	37 (21.1)	119 (20.2)	Sens: 21% (15% to 28%) Spec: 80% (76% to 83%) PPV: 24% (17% to 31%) NPV: 77% (74% to 81%)	16 (14.7)	140 (21.3)	Sens: 15% (9% to 23%) Spec: 79% (75% to 82%) PPV: 10% (96% to 16%) NPV: 85% (82% to 87%)	33 (19.3)	123 (20.7)	Sens: 19% (14% to 26%) Spec: 79% (76% to 82%) PPV: 21% (15% to 28%) NPV: 77% (74% to 81%)
	No	267 (81.7)	342 (78.1)		138 (78.9)	471 (79.8)		93 (85.3)	516 (78.7)		138 (80.7)	471 (79.3)	
Well woman clinics (n=614)													
LAPS (200/614; 32.6%)	Yes	46 (29.9)	154 (33.5)	Sens: 30% (23% to 38%) Spec: 67% (62% to 71%) PPV: 23% (17% to 29%) NPV: 74% (69% to 78%)	19 (41.3)	181 (31.9)	Sens: 41% (27% to 57%) Spec: 68% (64% to 72%) PPV: 10% (6% to 14%) NPV: 93% (91% to 96%)	15 (30.6)	185 (32.7)	Sens: 31% (18% to 45%) Spec: 67% (63% to 71%) PPV: 8% (4% to 12%) NPV: 92% (89% to 94%)	24 (26.1)	176 (33.7)	Sens: 26% (17% to 36%) Spec: 66% (62% to 70%) PPV: 12% (8% to 17%) NPV: 84% (80% to 87%)
	No	108 (70.1)	306 (66.5)		27 (58.8)	387 (68.1)		34 (69.4)	380 (67.3)		68 (73.9)	346 (66.3)	
VDS (422/614; 68.7%)	Yes	114 (74.0)	308 (67.0)	Sens: 74% (66% to 81%) Spec: 33% (29% to 38%) PPV: 25% (22% to 29%) NPV: 79% (74% to 84%)	33 (71.7)	389 (68.5)	Sens: 72% (57% to 84%) Spec: 32% (28% to 36%) PPV: 8% (6% to 9%) NPV: 93% (90% to 96%)	37 (75.5)	385 (68.1)	Sens: 75% (61% to 87%) Spec: 32% (28% to 36%) PPV: 9% (7% to 10%) NPV: 94% (90% to 96%)	70 (76.1)	352 (67.4)	Sens: 76% (66% to 84%) Spec: 33% (28% to 37%) PPV: 17% (15% to 18%) NPV: 89% (84% to 92%)
	No	40 (26.0)	152 (33.0)		13 (28.3)	179 (31.5)		12 (24.5)	180 (31.9)		22 (23.9)	170 (32.6)	
Sexual health clinics (n=385)													
LAPS (282/385; 73.2%)	Yes	109 (75.1)	173 (72.1)	Sens: 75% (67% to 82%) Spec: 28% (22% to 34%) PPV: 39% (33% to 45%) NPV: 65% (55% to 74%)	62 (79.5)	220 (71.7)	Sens: 79% (69% to 88%) Spec: 28% (23% to 34%) PPV: 22% (20% to 24%) NPV: 84% (77% to 90%)	46 (27.0)	236 (73.3)	Sens: 73% (60% to 83%) Spec: 27% (22% to 32%) PPV: 16% (12% to 21%) NPV: 84% (75% to 90%)	40 (74.1)	242 (73.1)	Sens: 74% (60% to 85%) Spec: 27% (22% to 32%) PPV: 14% (11% to 18%) NPV: 86% (78% to 92%)
	No	36 (24.8)	67 (27.9)		16 (20.5)	87 (28.3)		17 (27.0)	86 (26.7)		14 (25.9)	89 (26.9)	
VDS (281/385; 73.0%)	Yes	106 (73.1)	175 (72.9)	Sens: 73% (65% to 80%) Spec: 27% (22% to 33%) PPV: 38% (35% to 41%) NPV: 62% (54% to 70%)	61 (78.2)	220 (71.7)	Sens: 78% (67% to 87%) Spec: 28% (23% to 34%) PPV: 22% (19% to 24%) NPV: 84% (76% to 89%)	42 (66.7)	239 (74.2)	Sens: 67% (54% to 78%) Spec: 26% (21% to 31%) PPV: 15% (13% to 17%) NPV: 80% (73% to 85%)	40 (74.1)	241 (72.8)	Sens: 74% (60% to 85%) Spec: 27% (22% to 32%) PPV: 14% (12% to 16%) NPV: 86% (80% to 91%)
	No	39 (26.9)	65 (27.1)		17 (21.8)	87 (28.3)		21 (33.3)	83 (25.8)		14 (25.9)	90 (27.2)	

*Prevalence of any and individual STIs in this population.
LAPS, lower abdominal pain syndrome; NPV, negative predictive value; PPV, positive predictive value; Sens, sensitivity; Spec, specificity; STI, sexually transmitted infection; VDS, vaginal discharge syndrome.

and sexual health clinics in PNG. The performance of syndromic management for the detection and treatment of these infections was poor, particularly among antenatal women where more than 80% of those with laboratory-confirmed CT, NG or TV would not have been diagnosed and treated. These findings reflect the high proportion of asymptomatic infections among women in these clinical populations, and the limited association between clinical findings and laboratory-confirmed genital STIs. Around 43% of women attending their first antenatal clinic visit had genital CT, NG or TV; one in five reported symptoms of abdominal pain or vaginal discharge, and around one in eight reported dysuria or vulval irritation. Despite the high prevalence of both genital infections and genital symptoms, syndromic management had extremely low sensitivity and PPV for the detection of CT, NG or TV, and would have resulted in significant overtreatment and missed diagnoses in this population. These STIs have been associated with increased risk of adverse maternal and neonatal health outcomes, including stillbirth, prematurity and low birth weight, if they are not detected and treated during pregnancy.[11–14] The findings presented in this paper are consistent with earlier studies, which demonstrated inadequate performance of syndromic management for STI detection and treatment in pregnancy, based either on symptoms alone or on symptoms plus clinical examination.[5 8 15–17]

Among women attending well woman clinics and sexual health clinics, VDS had moderate to high sensitivity (up to 79%) and NPV (up to 94%) but low specificity and PPV (both around 30%) for the detection of CT, NG or TV. Around 62%–73% of women with symptoms did not have a laboratory-confirmed infection and would have been unnecessarily treated. LAPS performed less well than VDS, particularly among well woman clinic attendees. Similar results have been reported from studies conducted in other high-burden settings, among women attending sexual health and family planning clinics,[17–19] and among women at increased risk of infection, such as commercial or transactional sex workers.[20–22]

In the current study, we did not investigate bacterial vaginosis (BV), *Candida albicans* or *Mycoplasma genitalium* (MG), and may therefore have underestimated the performance of syndromic management for the detection of STIs and genital infections. A high prevalence of BV (18%–23%) has previously been reported among pregnant women,[6 16] the majority of whom were asymptomatic in this setting.[16] It is possible that women with symptoms of vaginal discharge but without laboratory-confirmed CT, NG or TV in the current study may have had BV. Earlier studies in other settings suggest, however, that the inclusion of BV appears to have little impact on the performance of syndromic management among antenatal women[15 23] or among women attending sexual health or family planning clinics.[22 24 25] MG has been associated with vaginal discharge among women in a variety of settings,[24 26] but its presence and clinical correlates have not been investigated among women in PNG. It is therefore difficult to estimate the impact of undiagnosed MG on the performance of syndromic management in the current study. Research from elsewhere indicates that inclusion of MG has little impact on performance[21 27] and that the majority of MG infections in women are asymptomatic,[28] and therefore not amenable to syndromic management strategies.

In accordance with current PNG national STI guidelines, genital examination was not routinely conducted among women attending their first antenatal clinic visit, and even had we elected to do so would not have been feasible due to a lack of suitable examination rooms and equipment at participating antenatal clinics, as well as limited and overstretched human resources. This may have led to underestimation of the performance of syndromic management in this population, but we consider this unlikely given earlier evidence on the impact on performance if speculum examination is included as part of syndromic assessment.[17]

The performance of syndromic management contrasts markedly with that of newly available, highly accurate molecular STI diagnostic tests that can be implemented at point of care, such as the GeneXpert platform (Cepheid, Sunnyvale, California, USA), which has been shown to be as accurate as laboratory-based PCR tests for the detection of chlamydia, gonorrhoea and trichomonas infection using genital or urine specimens.[29 30] For example, Xpert had 98.7% sensitivity and 99.4% specificity for the detection of CT using vaginal specimens.[29] Test results are available in approximately 90 min for Xpert CT/NG (which simultaneously tests for both chlamydia and gonorrhoea) and 60 min for the Xpert TV test. The platform has been shown to be robust and portable and has already revolutionised the diagnosis and management of tuberculosis in many LMICs, including PNG.[31] We have previously demonstrated the operational feasibility of Xpert point-of-care testing and treatment for CT, NG and TV in antenatal clinics in PNG,[16] and for the detection of high-risk human papillomavirus infection for cervical cancer screening in well woman clinics in this same setting.[16]

The limitations of syndromic management as an effective strategy for the diagnosis, treatment and control of STIs in LMICs have been known for over two decades.[32 33] Recognising these limitations, the WHO recently advocated a transition from syndromic to aetiological STI diagnosis as part of a new and ambitious strategy to eliminate STIs as a public health threat globally by 2030.[34] A major research effort is warranted to evaluate the effectiveness, acceptability, health system implementation requirements and cost-effectiveness of newly available STI diagnostic tests that can be provided at point of clinical care in order to tackle the continuing epidemics of STIs and their associated adverse health outcomes in low-resource settings, and to progress down a pathway towards elimination.

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Acknowledgements We are grateful to all the women who took part in this research and to their families and communities for supporting this project. We would especially like to thank provincial and district health staff and those working in participating clinics, without whom this research would not have been possible.

Contributors LMV supported data collection in antenatal clinics, wrote the first draft of manuscript, and is guarantor. PT supported laboratory testing. CR led and supervised laboratory testing. GR supported laboratory testing. JW supported laboratory testing. JG supported data collection in well woman clinics. JA supported data collection in sexual health and well woman clinics. CO supported data collection in sexual health clinics. GM supported data collection in antenatal clinics. PK supported data collection in sexual health clinics. BK provided support and oversight in data collection at sites in Western Highlands. AK provided support and oversight in data collection at sites in Eastern Highlands. ZK provided laboratory support and testing in Western Highlands. GL provided guidance and support in the design of the study in sexual health and well woman clinics. AK-H provided guidance and oversight in the design and data collection at each clinic type. HW cleaned and analysed the data. PMS provided guidance and oversight in the design of each study. GDLM provided guidance and support in the design of the study in each of the clinic settings. JMK provided guidance and support in the design of the study in each of the clinic settings. AJV designed the studies and data collection tools and monitored data collection for each of the three studies and revised the first draft of the paper. All authors have read and approved the final manuscript.

Funding This research was funded by a research grant from the Government of Papua New Guinea (ICRAS 297/1); a Partnership in Health Program grant from Esso Highlands Limited, an ExxonMobil subsidiary (PiH 264/1.6); and a grant from the Australian Aid Program, PNG (AusAID PNG).

Competing interests None declared.

Ethics approval Ethical approval was obtained from the Institutional Review Board of the PNGIMR (1124; 1111) and the Medical Research Advisory Committee of the PNG National Department of Health in Papua New Guinea (11.34; 11.18; 10.17); and from Human Research Ethics Committees of the Alfred Hospital Melbourne (390/11) and the UNSW Sydney (HC12155; HC11250; HC 12120) in Australia.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

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