Screening for sexually transmitted diseases in rural women in Papua New Guinea: are WHO therapeutic algorithms appropriate for case detection?*

M. Passey,[1] C.S. Mgone,[2] S. Lupiwa,[3] S. Tiwara,[4] T. Lupiwa,[5] & M.P. Alpers[6]

The presence of a large reservoir of untreated sexually transmitted diseases (STDs) in developing countries has prompted a number of suggestions for improving case detection, including the use of clinical algorithms and risk assessments to identify women likely to be infected when they present to clinics for other reasons. We used data from a community-based study of STDs to develop and evaluate algorithms for detection of cervical infection with Chlamydia trachomatis *or* Neisseria gonorrhoeae, *and for detection of vaginal infection with* Trichomonas vaginalis *or bacterial vaginosis.*

The algorithms were derived using data from 192 randomly selected women, then evaluated on 200 self-selected women. We evaluated the WHO algorithm for vaginal discharge in both groups. The prevalences of cervical and vaginal infection in the randomly selected group were 27% and 50%, respectively, and 23% and 52%, respectively, in the self-selected group. The derived algorithms had high sensitivities in both groups, but poor specificities in the self-selected women, and the positive predictive values were unacceptably low. The WHO algorithms had extremely low sensitivity for detecting either vaginal or cervical infection because relatively few women reported vaginal discharge. Simple algorithms and risk assessments are not valid for case detection in this population.

Introduction

Sexually transmitted diseases (STDs) are an important cause of morbidity and mortality worldwide, particularly in resource-poor settings. High rates of STDs have been documented among apparently low-risk women, with reported prevalences in antenatal clinics, family planning clinics and rural community-based surveys in the range 1–29% for *Chlamydia trachomatis*, 3–49% for *Trichomonas vaginalis*, 0.3–22% for *Neisseria gonorrhoeae*, and 0.3–18% for syphilis (*1–3*). The complications and sequelae of these infections affect women more than men, and include ectopic pregnancies, infertility, chronic pelvic pain, postpartum endometritis, cervical cancer, fetal wastage, low birth weight, and congenital or perinatal infections (*1–4*). More recently there has been increasing evidence that STDs increase sexual transmission of human immunodeficiency virus (HIV) (*1, 5–7*).

Although early detection and treatment of STDs can prevent complications and minimize the severity of long-term sequelae, many infections go untreated. Utilization of specialized services for the management of STDs is often low, in part because infections are frequently asymptomatic or produce vague, nonspecific symptoms, particularly among women. Cultural barriers, as well as poor understanding of the significance of symptoms may also reduce care-seeking by women. In order to make services more widely available, it has been suggested that STD screening and management should be incorporated into other primary health services, including family planning, antenatal, and maternal and child health (MCH) clinics (*1–4, 8–14*). Training staff and providing the necessary resources for appropriate management of symptomatic patients presenting for treatment at every level of the health system is clearly better than not having these services available. However, the vast majority of infected women (and possibly men) appear not to present for treatment at all, and there is thus a need for active case detection if infected people are to be identified and treated.

A further constraint is that laboratory diagnosis for STDs, even for syphilis or trichomonal infection, is frequently unavailable in peripheral health facilities in developing countries. In such settings, tech-

* From: Papua New Guinea Institute of Medical Research, P.O. Box 60, Goroka, E.H.P. 441, Papua New Guinea.

[1] Research Fellow. Requests for reprints should be sent to Dr Passey at "Ronyerra", MSF 2002, Armidale NSW, 2350 Australia.

[2] Deputy Director and Research Fellow.

[3] Registered Nurse.

[4] Medical Laboratory Technician.

[5] Principal Technical Officer.

[6] Director.

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niques for detection of chlamydial and gonococcal infection are prohibitively expensive and technically demanding (*14*). In response to the limited availability of laboratory tests, WHO has developed algorithms for the syndromic management of patients presenting for STD treatment (*15*). These algorithms are presented as flow charts (see Figs. 1 and 2), which indicate appropriate management based on the patient's symptoms, signs and risk assessment, and have been developed for various levels of clinical and microscopic capacity. A standard risk assessment has been developed, but it is recommended that this should be tailored to local risk factors if the information is available. However, these algorithms are intended for case management of people specifically presenting for treatment, and were not developed as a screening tool for case detection.

For case detection, screening based on risk assessment (with or without clinical information), followed by presumptive treatment, has been suggested (*1*, *9*, *10*, *12*, *16*). Several studies have appeared in which risk scores for the detection of chlamydial and gonococcal infection in various clinical settings in Africa have been developed and evaluated (*9*, *10*, *12*, *17*). It has also been suggested that the WHO algorithms could be used as a screening tool in family planning, antenatal, and MCH clinics (*18*). This approach has the advantage that training health staff to use the WHO algorithms as a screening tool could be readily combined with training them in their use for symptomatic patients, and would avoid the potential confusion that might arise if different risk assessment tools are used for different purposes. Since these algorithms were developed for the management of symptomatic patients, they are hierarchical in nature, requiring symptoms for entry. While this clearly limits their usefulness for asymptomatic infections, where even mild symptoms are recognized by women attending clinics for other reasons, the algorithms are potentially of benefit.

To the best of our knowledge, evaluation of the WHO algorithms as a screening tool for detection of chlamydial and/or gonococcal infection has only been reported from one non-African country (*19*). This study, among urban, married women in Turkey, found a low sensitivity, particularly for situations in which vaginal examination was not possible. However, the population studied had a relatively low prevalence of chlamydial infection (4.9%).

To date, published studies evaluating various methods for screening for STDs have focused on chlamydial infection with or without concomitant gonorrhoea. Despite high reported prevalences of infection with *T. vaginalis*, as well as the increased risk of pre-term birth, low birth weight (*1*) and HIV transmission (*7*) associated with trichomonal infection, in addition to the immediate morbidity suffered by infected women, no studies have evaluated the vaginal discharge algorithm as a screening tool for detection of trichomonal infection.

We used data collected for a community-based STD study in the highlands of Papua New Guinea to evaluate clinical algorithms as a screening tool for detection of chlamydial, gonococcal, and trichomonal infection in women. Based on a previous analysis of risk factors (*20*), we developed our own algorithms using data from a randomly selected group of rural women and then tested these algorithms in a different group of women from the same community. Additionally we evaluated the WHO algorithms for vaginal discharge (with and without speculum examination) as potential screening tools in both groups of women. The present article describes our findings.

Methods

In 1995 we conducted a cross-sectional survey of a rural and peri-urban population in the Asaro Valley in the highlands of Papua New Guinea to estimate the prevalence of STDs in an adult population of reproductive age; to determine the risk factors for STDs; and to assess treatment seeking. The data on prevalence and risk factors have been reported in detail elsewhere (*20*). The majority of the people in this area are subsistence farmers who grow coffee as a cash crop or labourers on coffee plantations, many of whom are migrants from other parts of the country. The highlands highway, the major route running between the coastal ports and the highland population centres, runs through this valley. The nearest town, Goroka, has a hospital which provides both outpatient and inpatient services and acts as a referral centre for the province's health centres. The hospital has STD, family planning, and antenatal clinics, as well as a weekly outpatient gynaecological clinic. Ethical clearance for the study was obtained from the Medical Research Advisory Committee of Papua New Guinea.

Recruitment of study subjects

Two groups of women were recruited, as outlined below.

Randomly selected women. A cluster-sampling scheme was used to select a random sample of women aged 15–45 years from a population of approximately 20 000 that had been recently censused by the Papua New Guinea Institute of Medical Research (IMR) for another study. Details of partici-

pant recruitment have been described elsewhere (*20*). A total of 201 women (75% of those selected) were interviewed, examined and had laboratory results obtained for them. For the present study, women who were menstruating at the time of the examination were excluded, leaving 192 participants.

Self-selected women. Any woman from the selected study villages who had not been randomly selected, but wished to participate in the study, was included in a second group. These women were interviewed, examined, and tested in the same manner, and immediately following the randomly selected women. In this group there were 222 women who completed the study protocol, with 200 remaining after exclusion of those who were menstruating.

All participants gave their free and informed consent after they were provided with a detailed explanation of the study.

Data and specimen collection

Demographic data, obstetric and sexual history, and current symptomatology were collected from each participant during an interview by a female nurse or physician. Each participant was then seen by a female physician who carried out a brief general and a full gynaecological examination, including speculum and bimanual examinations. Specimens collected included the following: blood for syphilis serology; a cotton-tipped high vaginal swab for detection of bacterial vaginosis by Gram staining; a cotton-tipped endocervical swab for Gram stain and culture of *N. gonorrhoeae*; a Dacron endocervical swab for detection of *C. trachomatis* by polymerase chain reaction (PCR); and amine test, pH determination, and wet mount preparation of vaginal secretions from the speculum, for detection of bacterial vaginosis and *T. vaginalis*. Pelvic inflammatory disease (PID) was diagnosed when three of the following were present: adnexal tenderness, cervical motion tenderness, uterine tenderness, and lower abdominal tenderness.

Laboratory methods

Wet mount preparation of vaginal secretions. These were immediately prepared from the speculum using normal saline, after determination of pH using standard test strips, and carrying out the amine test using potassium hydroxide (*21*). The wet mount was used to detect *T. vaginalis*, whose presence was considered to be diagnostic for trichomonal vaginitis, and for the laboratory confirmation of bacterial vaginosis, which was considered positive if three of the following criteria were present: clue cells on wet mount or Gram stain; pH > 4.5; positive amine test; and the absence of normal flora on a Gram stain of the vaginal fluid.

Gram stain. Smears were stained using standard techniques (*22*). The vaginal swab was used for detection of bacterial vaginosis (see above) and the endocervical swab for detection of Gram-negative intracellular diplococci.

Syphilis serology. The rapid plasma reagin test (RPR) (Murex Diagnostics, Dartford, England) was performed following the manufacturer's instructions and using a cut-off of 1:4. The results of the RPR were confirmed using a *Treponema pallidum* haemagglutination test (TPHA)(Wellcome Diagnostics, Dartford, England). If both tests were positive the woman was considered to have active syphilis.

***Culture for* N. gonorrhoeae.** Endocervical swabs were immediately smeared onto GC media (Difco, Detroit, MI, USA) containing vancomycin inhibitor and onto chocolate agar, and subsequently transported to the laboratory in candle jars, where they were placed in a carbon dioxide incubator at 37 °C and read after 24 h and 48 h. Colonies were Gram-stained and identified further using standard techniques (*22*).

Detection of* C. trachomatis *using PCR. Swabs were immediately placed into phosphate-buffered saline and then transported to the laboratory for processing or storage at −70 °C until they were analysed. Following crude DNA extraction, PCR was performed using the method described by Hayes et al. (*23*) — a two-stage (nested) PCR, which amplifies the gene encoding the chlamydial major outer membrane protein (MOMP).

The gold standards used for comparisons with the clinical algorithms were as follows: for cervical infection, the detection of *C. trachomatis* by PCR or *N. gonorrhoeae* by culture; and for vaginal infection, the detection of *T. vaginalis* by wet mount or bacterial vaginosis by wet mount and Gram stain.

Treatment

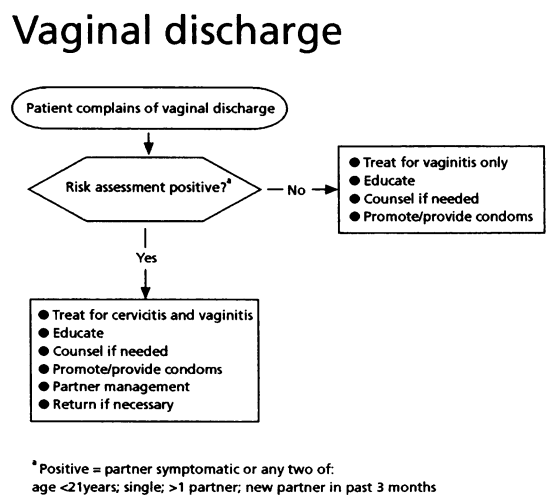
All women were treated immediately based on the clinical findings and the wet mount examination, following the standard treatment used in Papua New Guinea. Additionally, any infections subsequently detected by laboratory tests were treated at a follow-up visit.

Statistical analysis and evaluation of algorithms

To develop our own clinical algorithms, we used risk factors for chlamydial and trichomonal infections that we had identified in a previous analysis of the data for the randomly selected women (*20*). For this, purpose we developed univariate and multivariate logistic regression models using the method of generalized estimating equations developed by Liang & Zeger for analysing clustered binary data (*24*). This method gives robust variance estimates for the regression parameters taking into account the clustered sampling design. Odds ratios (OR) and 95% confidence intervals (CI) were calculated. Risk factors identified in the univariate analysis were assessed singly and in various combinations to determine their sensitivity (proportion of true infections classified as positive by the algorithm), specificity (proportion of truly negative women classified as negative by the algorithm) and positive predictive value (proportion of true positives among those classified as positive by the algorithm) for the diagnosis of cervical infection and vaginal infection, compared to the results obtained using the gold standards (see above). Since we were developing an algorithm that could be used as a screening tool, only variables obtained by interview (and not those from examination or laboratory tests) were considered. Using the sensitivity, specificity and positive predictive value results, we identified the most useful algorithm for each of the outcomes (cervical infection and vaginal infection). These algorithms were then tested on the self-selected group of women by determining their sensitivity, specificity, and positive predictive value for this group.

Evaluated also were the WHO algorithms for vaginal discharge (*15*). Two levels of the algorithm were evaluated (see Figs. 1 and 2); the first level is used in settings where no pelvic or speculum examination is possible; and the second level assumes that speculum and bimanual examinations are possible. The algorithms attempt to differentiate between women who have only vaginal infections and those who also have cervical infections with *C. trachomatis* and/or *N. gonorrhoeae*, by using a risk assessment. We evaluated the WHO algorithms using two risk assessments: the standard assessment (partner symptomatic, or any two of the following: age < 21 years; single; $>$ one sex partner; or new partner in previous 3 months); and the assessment we developed ourselves. For our own risk assessment we used the variables included in our derived algorithm for the detection of cervicitis. The WHO algorithms were applied to the women in each of the two groups in a simulation based on the interview and examination

Fig. 1. **WHO algorithm for vaginal discharge for use when a speculum is not available.**



data, and sensitivity, specificity, and positive predictive values were calculated.

Potential differences between the two groups of women were examined using Pearson's χ^2 test, with Fisher's exact test used when appropriate. All data were analysed using Epi Info 5 software (*25*). Differences were regarded as statistically significant at the $P < 0.05$ level.

Results

Sociodemographic factors and prevalence of STDs

The demographic, behavioural, and clinical characteristics of the two groups are shown in Table 1. In the univariate analysis, the self-selected group was significantly more likely to have had some formal education, have no living children, report a history of STD, and have a symptomatic partner ($P < 0.05$); they were also significantly more likely to report a current abnormal vaginal discharge and to have an abnormal vaginal discharge on examination. There were no differences in marital status between the two groups, with the majority of women in both groups being married as the only wife. A small proportion were co-wives, being married to polygamous men.

The prevalences of STDs and other reproductive tract infections (RTIs) for the two groups are

Fig. 2. **WHO algorithm for vaginal discharge for use with a speculum.**

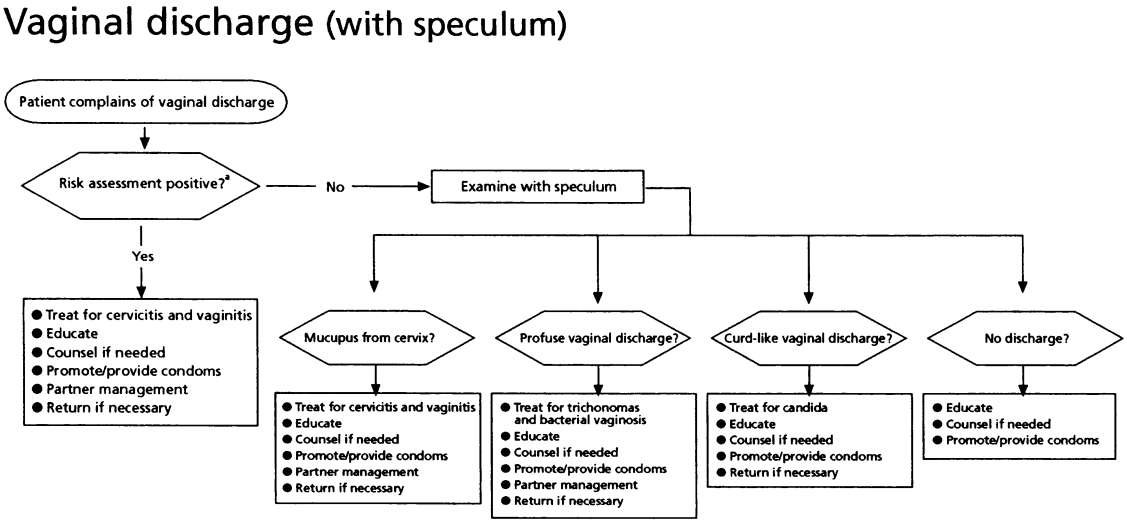


Table 1: **Selected characteristics of the two groups of study women, Asaro Valley, Papua New Guinea**

Characteristic	No. in random group (n = 192)	No. in self-selected group (n = 200)	*P value*
Age ⩽ 25 years	69 (36)[a]	84 (42)	0.26
Marital status			0.80
Married			
Only wife	141 (73)	146 (73)	—
Co-wife	14 (7)	18 (9)	—
Single/separated/widowed	37 (19)	36 (18)	—
Any formal education[b]	81 (45)	102 (58)	0.026
No living children	42 (22)	83 (42)	<0.0001
<4 living children	146 (76)	156 (78)	0.73
Currently pregnant	25 (13)	14 (7)	0.068
Infertile[c]	50 (26)	69 (35)	0.087
Reported STD, ever	61 (32)	90 (45)	0.010
Reported STD in last 3 months	31 (16)	46 (23)	0.11
Genital symptom treated in last 3 months[d]	19 (10)	31 (16)	0.13
>1 partner in last 3 months	12 (6)	10 (5)	0.59
>1 partner in last 12 months	18 (9)	28 (14)	0.13
Partner symptomatic	18 (9)	34 (17)	0.038
Ever used a condom	14 (7)	10 (5)	0.344
Reported current abnormal discharge	42 (22)	63 (32)	0.042
Vaginal discharge on examination	135 (70)	162 (81)	0.019
Profuse vaginal discharge on examination	115 (60)	136 (68)	0.12
Mucopurulent cervical discharge	17 (9)	28 (14)	0.16

[a] Figures in parentheses are percentages.
[b] A total of 36 women had data missing on education: 13 in the random group, 23 in the self-selected group.
[c] Couples were considered infertile if the woman reported that they wanted more children, were trying to conceive, and had had unprotected intercourse for ⩾2 years.
[d] Genital symptoms treated in last 3 months, regardless of whether or not the woman perceived them to be sexually transmitted.

Table 2: **Prevalence of sexually transmitted diseases (STDs) and other reproductive tract infections among the two groups of study women, Asaro Valley, Papua New Guinea**

	No. in random group (n = 192)	No. in self-selected group (n = 200)	P value
Chlamydia trachomatis	51 (27)[a]	45 (23)	0.41
Neisseria gonorrhoeae	3 (2)	2 (1)	0.96
Trichomonas vaginalis	89 (46)	91 (46)	0.95
Syphilis[b]	8 (4)	10 (5)	0.88
Bacterial vaginosis[c]	18 (9)	26 (13)	0.32
Pelvic inflammatory disease[d]	21 (13)	34 (19)	0.17
Any laboratory-confirmed STD[e]	113 (59)	114 (57)	0.79

[a] Figures in parentheses are percentages.
[b] RPR and TPHA tests both positive.
[c] A total of 3 women had missing data: 1 in the random group and 2 in the self-selected group.
[d] Women who were currently pregnant or who had had a hysterectomy were excluded (28 in the random group and 17 in the self-selected group); a further 2 women in the self-selected group had missing data.
[e] Any laboratory-confirmed STD includes *C. trachomatis*, *N. gonorrhoeae*, *T. vaginalis* and positive syphilis serology.

shown in Table 2. Both groups of women had high levels of disease, with 52 (27%) of the randomly selected and 46 (23%) of the self-selected women having cervical infection with either *C. trachomatis* or *N. gonorrhoeae* or both. The prevalence of vaginal infection with *T. vaginalis* and/or bacterial vaginosis was 96 (50%) and 103 (52%) in the two groups, respectively. Nearly 60% of women in each group had some sort of STD, with no significant differences in the level of infection in the two groups, although the self-selected group had a slightly higher level of PID.

Development of algorithms

Cervical infection. In the univariate analysis the following variables, obtained by interview, were significantly associated (positively or negatively) with chlamydial infection: age ≤ 25 years (odds ratio, (OR) = 4.5; 95% confidence limits (CL) = 2.5, 7.9), being married as the only wife (OR = 0.2; 95% CL = 0.1, 0.5), having fewer than four living children (OR = 10.8; 95% CL = 3.4, 34.4); current use of a modern contraceptive method (OR = 0.4; 95% CL = 0.2, 0.8) and reported STD in the previous 3 months (OR = 2.1; 95% CL = 1.1, 4.1). Having had more than one sexual partner in the previous 12 months (OR = 3.2; 95% CL = 0.9, 10.6) was almost statistically significant, as was reporting an abnormal vaginal discharge (OR = 1.6; 95% CL = 1.0, 2.5). All of these variables, with the exception of currently using a modern contraceptive method were assessed among the randomly selected women for inclusion in our algorithm, although having had an STD in the previous 3 months was modified slightly to account for treatment obtained (i.e. STD in the previous 3 months with no treatment). Selected results for these variables singly and in combination are shown in Table 3. Not all the combinations that were assessed are shown.

The last algorithm in Table 3 (any one of the following: age ≤ 25 years; not being an "only wife", or having more than one sexual partner in the previous 12 months) was considered to be most useful, with good sensitivity (81%), although the positive predictive value was low (45%). This algorithm was evaluated in the self-selected women and was also used as the risk assessment for the WHO algorithms.

Vaginal infection. The following variables were associated (positively or negatively) with trichomonal infection in the univariate analysis: being married as the only wife (OR = 0.4; 95% CL = 0.2, 0.8); having some formal education (OR = 0.5; 95% CL = 0.3, 0.8); having no living children (OR = 2.3, 95% CL = 1.1, 4.7); infertility (OR = 2.2; 95% CL = 1.0, 4.5); current use of a modern contraceptive method (OR = 0.5; 95% CL = 0.3, 0.9); having more than one sexual partner in the previous 12 months (OR = 3.3; 95% CL = 1.3, 8.7); and treatment of any genital symptoms in the previous 3 months (whether considered sexually transmitted or not) (OR = 2.7; 95% CL = 1.5, 5.0). All of these variables except use of modern contraceptive methods and treatment in the previous 3 months were assessed for inclusion in our algorithm. Although not significant in the univariate analysis, we also assessed reported vaginal discharge (OR = 1.6; 95% CL = 0.8, 3.1). Sensitivities,

Table 3: **Selected results obtained with the screening algorithm for variables (single and combined) for predicting cervical infection with *Chlamydia trachomatis/Neisseria gonorrhoeae* in 192 randomly selected study women**

Screening algorithm	% positive on algorithm	Sensitivity (%)	Specificity (%)	PPV[a] (%)
Age ⩽ 25 years	36	62	74	46
Not an "only wife"	27	50	82	51
<4 living children	76	96	31	34
Untreated STD in previous 3 months	14	21	89	42
>1 sexual partner in previous 12 months	9	17	94	50
Reported vaginal discharge	22	27	80	33
Any one of the age, marriage, STD or partner variables shown above[b]	53	83	58	42
Any two of the age, marriage, STD or partner variables shown above[b]	22	48	87	58
Any one of the age, marriage, or partner variables shown above[c]	49	81	63	45

[a] Positive predictive value.
[b] The following variables were included: age ⩽ 25 years; not an "only wife"; reporting an untreated STD in the previous 3 months; and reporting more than one sexual partner in the previous 12 months.
[c] The following variables were included: age ⩽ 25 years; not an "only wife"; and reporting more than one sexual partner in the previous 12 months.

specificities and positive predictive values for these variables, singly and in combination, as predictors of vaginal infection in the randomly selected women are shown in Table 4. Not all combinations assessed are shown. The last algorithm in Table 4 (any one of the following: not being an "only wife"; having no living children; being infertile; or reporting an abnormal vaginal discharge), with a sensitivity of 72%, specificity of 57%, and positive predictive value of 63%, was chosen and evaluated in the self-selected group of women.

The results of the evaluation of our algorithms on the self-selected women are shown in Table 5, together with the evaluation of the WHO algorithms on both groups of women.

Discussion

None of the algorithms performed well, although in general, they all performed better at detecting vaginal than cervical infection. The poor performance of algorithms or risk scores as a screening tool for detecting cervical infection has been noted previously (*12*, *17*, *19*, *26*, *27*). Other workers have found them useful, although all such studies have included clinical signs or simple tests in the algorithms, an option that may not always be feasible in primary health care settings (*9*, *10*, *28*, *29*).

Since the WHO algorithms are dependent on the woman reporting a vaginal discharge, they had a low sensitivity for detecting either cervical or vaginal

Table 4: **Selected results obtained with the screening algorithm for variables (single and combined) for predicting vaginal infection with *Trichomonas vaginalis*/bacterial vaginosis in 192 randomly selected study women**

Screening algorithm	% positive on algorithm	Sensitivity (%)	Specificity (%)	PPV[a] (%)
Not an "only wife"	27	36	83	69
No formal education	55	61	51	54
No living children	22	27	83	62
Infertile	26	33	81	64
>1 partner in last 12 months	9	15	96	78
Reported vaginal discharge	22	27	83	62
Any one of the above	83	92	26	55
Any two of the above	44	61	74	70
Any one of the marriage, children, infertility or vaginal discharge variables above[b]	57	72	57	63

[a] Positive predictive value.
[b] The following variables were included: not an "only wife", no living children, infertility and reported vaginal discharge.

Table 5: **Selected results obtained using clinical algorithms for predicing cervical infection with *Chlamydia trachomatis/Neisseria gonorrhoeae*, or vaginal infection with *Trachoma vaginalis*/bacterial vaginosis among randomly selected and self-selected study women**

Screening algorithm	Randomly selected women (n = 192)				Self-selected women (n = 200)			
	% positive on algorithm	Sensitivity (%)	Specificity (%)	PPV[a] (%)	% positive on algorithm	Sensitivity (%)	Specificity (%)	PPV[a] (%)
Cervical infection								
WHO algorithms								
Standard risk assessment[b]								
No speculum	8	10	93	33	11	17	91	36
Speculum	9	12	91	33	16	26	87	38
Derived risk assessment[c]								
No speculum	14	23	90	46	23	37	82	38
Speculum	15	23	89	43	23	37	81	37
Derived algorithm[d]	49	81	63	45	61	76	44	29
Vaginal infection								
WHO algorithms[e]								
No speculum	22	27	83	62	32	34	71	56
Speculum	19	25	88	67	30	32	72	55
Derived algorithm[f]	57	72	57	63	77	83	30	56

[a] Positive predictive value.
[b] The standard risk assessment is provided by WHO with the flow charts and is partner-symptomatic or any two of the following: age < 21 years; single; >1 partner; new partner in past 3 months.
[c] The derived risk assessment is the same as the derived algorithm for cervical infection (see footnote *d*).
[d] The derived algorithm for cervical infection is any one of the following: age ≤ 25 years; not an "only wife"; more than one partner in the previous 12 months.
[e] Only the results using the derived risk assessment are shown here.
[f] The derived algorithm for vaginal infection is any one of the following: not an "only wife"; no living children; infertility; and reported vaginal discharge.

infection in both groups of study women, although the self-selected women more frequently reported a discharge, with a concomitantly higher sensitivity. The majority of women had an abnormal discharge on examination, suggesting that the low reporting, in part reflects a lack of recognition of the discharge by many women. While it is well known that cervical infections are frequently asymptomatic (*1*, *4*, *9*, *10*, *12*), it is less well recognized that trichomonal infections are also often asymptomatic or that infection correlates poorly with reported vaginal discharge. Education and awareness campaigns aimed at improving people's understanding of STDs and their symptoms may help improve this situation.

When the derived risk assessment was used in the WHO algorithms, the sensitivity of the algorithm for detecting cervical infection improved considerably, but was still unacceptably low at 23% and 37% for the randomly selected and self-selected women, respectively. Use of the derived risk assessment also improved the positive predictive value for cervical infection in the random group but not in the self-selected women.

Although the use of a speculum to visualize the cervix slightly improved the sensitivity of the WHO algorithm to detect cervical infection when the standard risk assessment was used, there was no improvement in sensitivity when the derived risk assessment was used. With these algorithms, the advantage of using a speculum lies in the observation of a mucopurulent cervical discharge in women who are negative on the risk assessment. Since only a few women had such a discharge (9% and 14% in the randomly selected and self-selected groups, resp.), there was little benefit gained from this.

Our derived algorithms for both cervical and vaginal infection were much more sensitive than the corresponding WHO algorithms, largely because they are not dependent on the reporting of vaginal discharge. However, our algorithms resulted in an increased proportion of positives with a reduced specificity. The resultant positive predictive values were similar to those for the WHO algorithms, with the exception that the positive predictive value for cervical infection among self-selected women was lower for the derived algorithm. As a result, although the majority of women with cervical or vaginal infections would be detected and appropriately treated if our algorithms were used for case detection, there would also be a considerable number treated needlessly.

For both of the derived algorithms (cervical and vaginal), the specificity and positive predictive value were lower for the self-selected than for the ran-

domly selected women. This arose because in the self-selected group there were more women with some of the identified risk factors (for cervical infection: age ⩽ 25 years and > one sexual partner in the previous 12 months; and for vaginal infection: no living children, infertility, and reported vaginal discharge) but not more infection. The similar rates of infection in the two groups, despite apparently higher risk factors in the self-selected group, was in part accounted for by a greater proportion of the self-selected women having been treated for genital symptoms in the previous 3 months (Table 1). Additionally, the self-selected women who sought treatment were more likely to have attended an STD clinic, rather than a health centre or other health facility (data not shown), and at the time of the study STD clinics were the only ones in Papua New Guinea routinely using doxycycline. This recent treatment presumably reduced the level of infection in the self-selected group. Thus, although the risk factors were identified for the group that most closely represents the general population (randomly selected) it cannot be assumed that the same risks will apply in a self-selected group. Conversely, in other settings where risk factors have been based on a clinic population, they may not be applicable for screening a general population.

The effect of prior treatment on rates of infection also needs to be considered if risk assessments are to be used for screening STDs. Like most other risk assessments, our algorithms were derived from data about prevalent and not incident disease. Many factors can affect prevalence, including both incidence and treatment. Even if a risk assessment is valid when it is first applied to an individual, if that individual is determined to be at risk and consequently treated the infection usually disappears. Repeated application of the risk assessment would increasingly identify people who were no longer infected. Thus any such system will need periodic revisions if it is properly implemented.

Although the derived algorithms were fairly sensitive, none had a high positive predictive value. For an algorithm to be useful for case detection, it is important that the positive predictive value be considerably higher than the prevalence, since otherwise the probability of an identified person having the disease is no greater after than before it is applied. When a disease is highly stigmatized, there is an additional problem associated with misclassifying a person as positive, beyond the cost of unnecessary treatment. In many societies a woman diagnosed with an STD may suffer reprisals from her husband or others, and such a diagnosis carries a considerable burden. She may also be confused by being labelled as high risk and therefore in need of treatment, when she has no symptoms, has not been examined, and has not had any laboratory tests performed. Even if an excellent case detection tool existed, its implementation in primary health care settings may be problematic.

This evaluation has shown that the WHO algorithms for vaginal discharge are not suitable for use as a screening tool for case detection in the study population. We have developed our own algorithms for detecting both cervical and vaginal infection, using readily identifiable risk criteria, and tested them in a different group of women. Although clinical signs may have improved the validity of these algorithms, our aim was to include only data that could be collected by asking a few quick questions in a busy clinic. Unfortunately, although fairly sensitive, these derived algorithms lack specificity and therefore are also not appropriate for use as a screening tool. While vaginal infections should be easily detectable if a speculum examination and wet mount are performed, these tests are not always available in rural health facilities and privacy is frequently lacking. None the less, a wet mount is more frequently feasible than laboratory diagnosis of chlamydial or gonococcal infection, and high priority should be given to the development and evaluation of simple, quick, self-administered tests for all STDs.

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Résumé

Dépistage des maladies sexuellement transmissibles chez la femme, en milieu rural, en Papouasie-Nouvelle-Guinée: les algorithmes thérapeutiques de l'OMS sont-ils adaptés au dépistage?

L'importance du réservoir de maladies sexuellement transmissibles (MST) non traitées, en particulier chez la femme, a suscité sur certain nombre de propositions pour améliorer le dépistage dans les pays en développement. On peut citer l'utilisation d'algorithmes cliniques et l'évaluation

des risques pour repérer les femmes qui peuvent être contaminées. Ces algorithmes sont destinés à être utilisés quand la femme s'adresse au centre de santé pour d'autres motifs. Plusieurs de ces outils ont été évalués en Afrique, mais peu d'évaluations ont été réalisées ailleurs. Nous avons exploité les données d'une étude des MST conduite en communauté dans un secteur rural de la Papouasie-Nouvelle-Guinée pour élaborer et évaluer des algorithmes de dépistage des infections cervicales à *Chlamydia trachomatis* ou à *Neisseria gonorrhoeae*, des infections vaginales à *T. vaginalis* ou des vaginoses bactériennes.

Les algorithmes ont été mis au point avec les données concernant 192 cas sélectionnés au hasard, et évalués ensuite sur un autre groupe auto-sélectionné de 200 femmes. Nous avons également évalué dans les deux groupes l'algorithme OMS pour la prise en charge des pertes vaginales en tant qu'outil de dépistage. La prévalence des infections du col et du vagin dans le groupe choisi au hasard était respectivement de 27% et 50%; dans le groupe autosélectionné, les chiffres correspondants étaient de 23% et 52%. La sensibilité des algorithmes obtenus pour la recherche des infections du col et du vagin était élevée dans les deux groupes (81% dans le groupe sélectionné aléatoirement et 76% dans le groupe autosélectionné, pour les infections cervicales; 72% et 83% respectivement dans les deux groupes, pour les infections vaginales). La spécificité des deux algorithmes était cependant faible dans le groupe autosélectionné (44% pour les infections du col et 30% pour celles du vagin), tandis que la valeur prédictive positive était beaucoup trop basse (29% pour les infections du col et 56% pour celles du vagin). La sensibilité des deux algorithmes était extrêmement mauvaise concernant la recherche des infections du col ou du vagin, en raison de l'absence de corrélation entre écoulement vaginal et infection du col, et de la difficulté pour la femme de repérer les pertes vaginales.

Les méthodes basées sur l'évaluation des risques et les simples algorithmes ne sont pas des outils valides de dépistage des infections cervicales et vaginales dans cette population. Les signes cliniques auraient pu améliorer la validité de ces algorithmes; notre but était toutefois de n'utiliser que les données pouvant être obtenues à l'aide de quelques questions dans un service surchargé. Si les infections vaginales sont facilement décelables grâce à un examen au spéculum et une préparation extemporanée, les examens clinique et microscopique ne sont pas toujours possibles et l'intimité fait souvent défaut dans les centres ruraux. Il reste que la préparation extemporanée est plus souvent réalisable que le diagnostic au laboratoire d'une infection à *Chlamydia* ou à gonocoques, et que la priorité doit être accordée à la mise au point et à l'évaluation d'autotests simples et rapides applicables à toutes les MST.

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