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Does test-based prescription of evidence-based treatment for malaria improve treatment seeking and satisfaction? Findings of repeated cross-sectional surveys in Papua New Guinea

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ABSTRACT

Introduction The presumptive treatment of febrile illness with antimalarial medication is becoming less common in low-income and middle-income countries as access to reliable diagnostic tests improves. We explore whether the shift towards test-based antimalarial prescription, and the introduction of highly efficacious artemisinin combination therapies (ACTs), reduces critical delays in seeking treatment for febrile illness or increases patient satisfaction.

Methods We conducted countrywide repeat, cross-sectional surveys in 118 randomly selected primary healthcare services in Papua New Guinea. The clinical case management of 1765 consecutively presenting febrile patients was observed and exit interviews were completed at discharge. This was done prior to implementation of test-based ACT prescription (2011) and at 12 (2012) and 60 months (2016) postimplementation. We conducted multiple logistic regressions. Treatment response time was dichotomised as <24 hours from symptom onset vs 24+ hours. Satisfaction was dichotomised as a 'high' vs 'low' rating based on participant response to a visual, 7-point Likert-type scale.

Results 62% (322/517) of febrile patients reported seeking treatment within 24 hours of symptom onset in 2011 compared with 53% (230/434) in 2012 and 42% (339/814) in 2016. Adjusted ORs for reporting a treatment response time <24 hours in the postimplementation surveys were 0.77 (95% CI 0.48 to 1.26) and 0.45 (95% CI 0.31 to 0.65), respectively when compared with the preimplementation period. 53% (230/533) of febrile patients reported 'high' satisfaction with the service received in 2011 compared with 32% (143/449) in 2012 and 35% (278/803) in 2016. Adjusted ORs for reporting high satisfaction in the postimplementation surveys were 0.52 (95% CI 0.32 to 0.85) and 0.65 (95% CI 0.39 to 1.10), respectively when compared with the preimplementation period.

Conclusion Nationwide implementation of test-based ACT prescription in Papua New Guinea has increased the likelihood of critical treatment seeking delays and decreased patient satisfaction with the service received.

Key questions

What is already known?

- Health worker access to reliable malaria diagnostic tests and effective artemisinin combination therapies (ACTs) has increased substantially in malaria endemic low-income and middle-income countries.
- The practice of presumptively treating all febrile patients with antimalarials has reduced markedly following the widespread adoption of diagnostic-test based ACT prescription protocols.

What are the new findings?

- Our results show that the introduction of diagnostic test-based ACT prescription in Papua New Guinea increased the likelihood of treatment seeking delays following the onset of febrile symptoms beyond the 24 hours threshold recommended by the WHO.
- The increase in treatment delay may be related to dissatisfaction with the quality of healthcare provided to the growing proportion of febrile patients with a test confirmed non-malarial illness.

What do the new findings imply?

- The study findings suggest that improvements in the quality of care provided to test patients with confirmed malaria may still lead to a degradation in the perceived quality of overall febrile case management if patients with non-malaria febrile illness do not receive an equivalent standard of care.

INTRODUCTION

A step change in malaria case management has recently taken place in many low-income and middle-income countries. The practice of presumptively treating all febrile patients with antimalarials has declined as access to reliable malaria rapid diagnostic tests has improved.[1–3] In addition, older antimalarial regimens have been replaced with more effective and well tolerated artemisinin-based

combination treatments (ACTs).[4 5] This shift towards test-based ACT prescription represents substantial improvement in the quality of care for malaria and potentially other febrile illnesses. For example, the introduction of a test-based malaria case management protocol almost invariably results in reduced antimalarial prescription,[6–9] implying many febrile patients previously 'presumed' to have malaria and treated accordingly are now receiving alternative diagnoses (and medications) based on the absence of detectable malaria parasitaemia.

It is not known whether the improved quality of care represented by the introduction of test-based ACT prescription has had 'knock on' positive effects such as earlier clinic presentation following the onset of febrile symptoms or greater patient satisfaction. These are important considerations. Receiving an ACT prescription quickly, ideally within 24 hours of symptom onset, is critical to preventing progression from uncomplicated to severe malaria and possible death.[5 10] Treatment delay, or even outright failure to seek formal treatment, are common in cases of suspected malaria[11 12] and delays in treatment seeking have been attributed to dissatisfaction with the quality of care available.[13 14] An associated improvement in either treatment satisfaction or more responsive treatment-seeking behaviour following the introduction of test-based ACT prescription would, therefore, represent further gain on investment in malaria diagnostics, medications and health worker training beyond that obtained by the immediate benefit to the patients with (confirmed) malaria.

This paper explores whether the introduction of test-based ACT prescription reduces critical delays in seeking treatment for febrile illness or increased patient satisfaction. Drawing on data obtained during repeat, countrywide cross-sectional surveys of randomly selected primary healthcare facilities in Papua New Guinea, the study evaluated whether patients with symptoms of febrile illness: (1) seek treatment earlier following implementation of a test-based ACT prescription protocol; (2) report greater satisfaction with the service received following implementation of a test-based ACT prescription protocol.

METHODS

This paper presents data from three repeat, countrywide, cross-sectional health facility surveys conducted in the years' 2011, 2012 and 2016. The 2011 survey was completed when the presumptive treatment of all febrile patients with sulphadoxine-pyrimethamine and either amodiaquine or chloroquine was standard practice. The 2012 and 2016 surveys were completed following nationwide implementation of a diagnostic test-based ACT (artemether-lumefantrine) prescription protocol in late 2011. All surveys were conducted as part of a long-term evaluation of the Papua New Guinea National Malaria Control Program. A full description of the evaluation programme, including a detailed description of the health facility survey methodology, is presented elsewhere.[15]

Study setting

Papua New Guinea has a population of 7.3 million people. It has 22 provinces divided into four geographic regions (Highlands, Momase, Southern and Islands). Malaria is endemic in large parts of the Momase, Southern and Islands regions.[16] Lower average temperatures prevent stable local transmission throughout most of the Highlands region, although imported cases and epidemics occur.[16] Malaria prevalence in the general population has reduced substantially across Papua New Guinea since a countrywide distribution programme of free, long-lasting insecticidal nets commenced in 2004.[17] Most health services are delivered through government-providers and church-providers via an extensive health facility network with approximately 6 doctors per 100 000 population.[18] This network comprises seven levels of service provision including primary-care (levels 1–4), secondary-care (levels 5–6) and tertiary-care (level 7), with the structure and function of each level informed by National Health Service Standards.[19] Suspected malaria accounted for approximately 30% of all outpatient presentations to primary healthcare facilities in Papua New Guinea in the 10-year period prior to the 2011 health facility survey.[20] The Papua New Guinea National Department of Health implemented a test-based ACT prescription protocol in late 2011, replacing the former presumptive treatment model. The percentage of febrile patients tested for malaria infection subsequently rose from 17.5% to 73.5% between 2010 and 2016, the percentage receiving antimalarials fell from 96.9% to 30.5%, with 100% of confirmed uncomplicated malaria cases receiving an ACT by 2012 (up from 3.9% in 2010).[21] The Government of Papua New Guinea introduced a free healthcare policy in 2014 which, by law, should have removed all health service-related fees incurred by the patient at primary healthcare level; however, this was not universally implemented in practice.[22] No other national treatment policies or programmes that may have significantly impacted on malaria or febrile case management were implemented during the study period nor were any significant changes to primary healthcare service structure, provision or access implemented.

Study sample

A stratified sampling approach was used to select health facilities, with two primary healthcare facilities (n=44) sought from each province using a simple random sampling procedure. The sampling frame was a list of all operational primary healthcare facilities as provided by the Papua New Guinea National Department of Health (n=689). West New Britain province was intentionally excluded from the 2012 and 2016 surveys due to the disappearance of a field team within this province during a related, household-level malaria indicator survey in August 2011.[23] All febrile patients meeting eligibility

criteria attending selected health facilities during survey periods were recruited consecutively. The sample size, which took into account financial and operational constraints, was adequate for detecting a 20% change in reported treatment response times or patient satisfaction between survey years at a 95% level of significance with 80% power.

Survey procedure

The 2011 and 2012 surveys were carried out from June to November in the respective survey year, while the 2016 survey was carried out from February to July. The shift in dates for the 2016 survey was the result of scheduling conflicts. Seasonal incidence data would suggest malaria transmission was highest at the time of the 2016 survey.[24] A two-to-three-member field team spent 3 days at each facility completing a range of survey instruments. Patients were considered eligible for participation if they were outpatients presenting with febrile symptoms, reported a recent history of fever and had not been treated for malaria infection in the past 14 days (to exclude 'treatment review' cases). Eligible patients were identified on first contact with a health worker or, if circumstances allowed, by screening in the waiting area prior to first contact with a health worker. Data presented in this paper are derived from passive observation of clinical case management and structured, interviewer-administered questionnaires completed with febrile patients at time of service exit. The exit questionnaire was available in English and *Tok Pisin*, the local *lingua franca*. Prior to any health facility visit, the respective provincial and district health authorities were informed of the study objectives, sites and timetable and asked to commission a health officer to accompany the field team. Oral informed consent was sought from the officer in charge at all participating health facilities and from all participating clinicians and patients prior to clinical observation and/or interview.

Measures

Treatment seeking response time was measured by asking patients to estimate, to the nearest hour, the length of time that passed between the first sign of illness and arrival at the health facility. Patient satisfaction was measured by a 7-point, Likert-type scale depicting simple facial expressions ranging from very happy to neutral to very sad (figure 1). Participants were shown the scale as they departed the health facility and were asked to select the face that came closest to expressing how they felt about their visit today. A visual scale was preferred given an adult literacy rate of approximately 60%.[25] The visual scale was adapted from an applied social research methods series[26] and extensively pilot tested with febrile patients recruited from non-participating primary healthcare services.

Data analysis

All data were double entered into DMSys V.5.1 (Sigma Soft International). Stata/SE V.14.1 was used for data analysis. Analysis was limited to survey participants for whom both passive observation and exit interview data were available, as paired data were required for the 'satisfaction' analyses. Participants with missing data on any of the variables included in the regression models (described below) were excluded from the respective analyses as were the small number of participants (n=10) who reported a travel time to the health facility of greater than 6 hours.

Factors potentially predictive of a prompt treatment response were examined by multiple logistic regression. The dependent variable was treatment response time as reported by participants at the time of exit interview (<24 hours vs ≥24 hours). Nine independent variables were assessed for possible inclusion in the model. These included year of survey (2011, 2012 and 2016) as a measure of standard malaria case management practice (2011=presumptive, 2012=test-based ACT prescription, 12 months postimplementation, 2016=test-based ACT prescription, 5 years-implementation) and eight potential confounding variables: participant sex (male vs female); participant age (<5 years, 5–15 years, 16+ years); geographical location of the health centre (highlands region vs lowlands/coastal/islands and urban vs rural); distance travelled to the health facility (in hours); transportation cost (cost vs no cost); diagnostic test and ACT stock (in stock vs not in stock) and health facility fee (fee charged vs no fee charged). All data were obtained from the exit interview, with the exception of diagnostic test and ACT stock which was established via an audit of the health facility resources. Only those variables that were independently associated with 'response time' at the level of p<0.3 were included in the final model.

Factors potentially predictive of high treatment satisfaction were examined by multiple logistic regression analysis. The dependent variable was treatment satisfaction as reported by participants at the time of exit interview ('high' satisfaction defined as a rating of A or B on

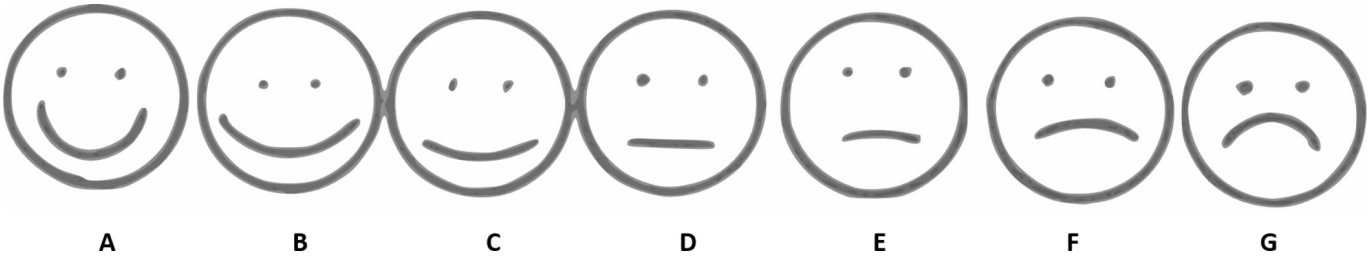

Figure 1 The visual 'satisfaction scale' (from left to right 'most' to 'least' happy).

the visual scale vs 'lower' satisfaction defined as a rating of C-G). Two models were run. Survey year (2011, 2012 and 2016) was included as a measure of standard malaria case management practice in both. However, to better understand the impact of test-based ACT prescription on patient satisfaction, two additional 'practice' indicators were included. Model one (binary variable, correct practice vs other) was a measure of 'correct practice' in accordance with test-based ACT prescription protocols in which correct health worker practice was defined as providing a diagnostic test for malaria infection and either: (1) an ACT prescription if diagnostic test was positive; (2) or no antimalarial prescription if diagnostic test was negative. All other scenarios were defined as 'other'. Model two (binary variable, correct practice vs other) was a measure of correct practice for malaria confirmed patients only. In this model, the designation of 'correct practice' was limited to those patients who received an ACT in accordance with test-based ACT prescription protocols. All other scenarios were defined as 'other'. This distinction was made to test whether satisfaction is highest in the subgroup of febrile patients who receive a confirmation of malaria infection by a reliable diagnostic test and an effective antimalarial medication (ACT). Potential confounding variables in both models included: participant sex (male vs female); participant age (<5 years, 5–15 years, 16+ years); geographical location of the health centre (highlands region vs lowlands/coastal/islands and urban vs rural); distance travelled to the health facility (in hours); transportation cost (cost vs no cost); health facility fee (fee charged vs no fee charged) and respondent status (ie, who provided the satisfaction rating: patient vs caregiver of patient). All data were obtained from exit interview, with the exception of the two additional 'correct practice' variables which were derived from clinical observation. Only those variables that were independently associated with 'high' treatment satisfaction at the level of p<0.3 were included in the final model. All logistic regressions were adjusted for possible clustering at the health facility level using the Stata 'cluster' command.

RESULTS

Sample

Across the three survey periods, clinical observations were completed for a total of 1883 febrile patients collectively attending 121 primary healthcare facilities (table 1). Paired observation/interview data were available for 1765 (94%) patients from 118 (98%) health facilities. Sample characteristics grouped per each of the independent and dependent variables included in the following regression analyses are presented in table 2.

Table 1 Sample size by survey year and overall

Sample		2011	2012	2016	Overall
Observations only	No. patients	612	439	832	1883
	No. facilities	44	38	39	121
Paired observations/ Exit interviews	No. patients	517	434	814	1765
	No. facilities	42	38	38	118

Treatment seeking response time

The percentage of febrile patients attending a health facility and reporting a treatment delay of 24 hours or more increased across all three survey periods, rising from 37.7% in 2011 to 58.3% in 2016 (table 2). The median treatment seeking response time (and IQR in brackets) by survey period was: 2011=19 hours (IQR 34), 2012=24 hours (IQR 40), 2016=48 hours (IQR 53) and overall=24 hours (IQR 50). Five independent variables met the criteria for inclusion in the multiple logistic regression, of which three reached statistical significance (table 3). Febrile patients were 23% less likely to seek treatment for febrile illness within 24 hours of symptom onset in the 12-month period immediately following the implementation of test-based ACT prescription and 55% less likely in the period 5 years postimplementation. The odds of a treatment response time less than 24 hours were 51% lower for patients aged 16 years or older and decreased by 41% for every hour increase in distance to the health facility. A fifth independent variable, transportation cost also met inclusion criteria, although was not included in the full model as no transport cost data were collected in the 2011 survey. An additional multiple logistic regression analysis was run including the transport cost variable, but excluding 2011 data (online supplementary table 1). Findings mirror those presented in table 3.

Treatment satisfaction

The percentage of febrile patients reporting a 'high' satisfaction rating decreased between the first and second survey periods, dropping from 43.1% in 2011 to 31.9% in 2012, before rising to 34.6% in 2016 (table 2). The median treatment satisfaction rating (and IQR in brackets) for all survey periods and overall was 3 (IQR 2). Five independent variables met the criteria for inclusion in the first multiple logistic regression (model 1, table 4), of which one was statistically significant. The odds of reported high satisfaction were 48% lower in the period immediately postimplementation of test-based ACT prescription (2012) as compared with the period preimplementation (2011).

Five independent variables met the criteria for inclusion in the second multiple logistic regression (model 2, table 4). A single statistically significant association was identified, with the odds of reported high satisfaction 47% lower in the period immediately post-test and treat implementation (2012) as compared with the period preimplementation (2011).

DISCUSSION

This paper sought to examine the relationship between improved malaria case management practice, treatment seeking response times and patient satisfaction in a low-income and middle-income country context. To the best of

Table 2 Sample characteristics by study variables*

Variable type		2011	2012	2016	Overall
Dependent variables					
Response time	<24 hours	322 (62.3)	230 (53.0)	339 (41.7)	891 (50.5)
	24+hrs	195 (37.7)	204 (47.0)	475 (58.3)	874 (49.5)
Satisfaction score	1–2 'high'	230 (43.2)	143 (31.9)	278 (34.6)	651 (36.5)
	3–7 'lower'	303 (56.9)	306 (68.1)	525 (65.4)	1134 (63.5)
Independent variables					
Correct practice (model 1)	No	506 (96.0)	148 (38.3)	253 (31.2)	907 (52.6)
	Yes	21 (4.0)†	238 (61.7)	559 (68.8)	818 (47.4)
Correct practice (model 2)	No	535 (99.8)	323 (83.3)	658 (80.5)	1516 (87.1)
	Yes	1 (0.2)	65 (16.7)	159 (19.5)	225 (12.9)
Sex	Male	254 (49.1)	236 (54.4)	429 (52.7)	919 (52.1)
	Female	263 (50.9)	198 (45.6)	385 (47.3)	846 (47.9)
Age	<5 years	274 (53.0)	217 (50.0)	319 (39.2)	810 (45.9)
	5–15 years	88 (17.0)	89 (20.5)	166 (20.4)	343 (19.4)
	16+ years	155 (30.0)	128 (29.5)	329 (40.4)	612 (35.7)
Respondent status	Patient	191 (37.2)	124 (28.6)	336 (41.3)	651 (37.0)
	Caregiver	323 (62.8)	309 (71.4)	477 (58.7)	1109 (63.0)
Region	Highlands	81 (15.7)	89 (20.5)	155 (19.0)	325 (18.4)
	Other	436 (84.3)	345 (79.5)	659 (81.0)	1440 (81.6)
Location of health facility	Rural	338 (65.4)	359 (82.7)	606 (74.5)	1303 (73.8)
	Urban	179 (34.6)	75 (17.3)	208 (25.5)	462 (26.2)
Distance to health facility	Hours‡	0.5 (1.0)	0.6 (0.66)	0.5 (0.75)	0.5 (0.75)
Transport cost	Cost incurred	–	140 (32.4)	222 (27.4)	362 (29.1)
	No-cost incurred	–	292 (67.6)	589 (72.6)	881 (70.9)
Health facility fee	Paid	308 (59.6)	235 (54.2)	356 (43.7)	899 (50.9)
	Not required	209 (40.4)	199 (45.8)	458 (56.3)	866 (49.1)
Diagnostic tests and ACT in stock	No	480 (92.8)	39 (9.0)	288 (35.4)	807 (45.7)
	Yes	37 (7.2)	395 (91.0)	526 (64.4)	958 (54.3)

*Number (%) unless otherwise stated.
†While not widely implemented, a small number of health facilities had the necessary resources to provide test-based ACT prescription in 2011.
‡Median (IQR).
ACT, artemisinin combination therapy.

the authors' knowledge, this is the first study to explore whether the substantial investments supporting the widespread implementation of test-based ACT prescription have had 'knock on' positive effects such as reducing critical delays in seeking treatment for febrile illness below the 24 hours threshold recommended by the WHO[10] and/or enhancing patient perception of often maligned primary healthcare services.

A negative and statistically significant association between seeking treatment for febrile illness within 24 hours of symptom onset and implementation of test-based ACT prescription at the primary healthcare level was found. Febrile patients were 23% less likely to seek treatment for febrile illness within 24 hours of symptom onset in the 12-month period immediately following the implementation of test-based ACT prescription and 55% less likely in the period 5 years postimplementation. Other factors that may have influenced treatment seeking decision making such as transport costs, health facility charges and diagnostic test and ACT stocks were accounted for in the model and no other significant changes to primary healthcare provision were known to have been implemented during the study period.

The apparent increase in delayed (>24 hours) treatment seeking for febrile illness in the 5-year period postimplementation of test-based ACT prescription is an unexpected and worrying finding. Test-based ACT prescription guidelines have been adopted in 96 out of 97 countries with ongoing malaria transmission,[3] yet an association with treatment delay has not been previously

Table 3 Factors associated with a treatment response of <24 hours

Predictor variable		AOR (95% CI)	P values
Survey year	2011	1.00	
	2012	0.77 (0.48 to 1.26)	0.31
	2016	0.45 (0.31 to 0.65)	<0.01
Patient age	<5 years	1.00	
	5–15 years	0.73 (0.56 to 0.96)	0.02
	16+ years	0.49 (0.38 to 0.62)	<0.01
Location of health facility	Highlands	1.00	
	Lowland/ Coastal/ Islands	1.23 (0.84 to 1.82)	0.29
Distance to health facility	Hours	0.59 (0.50 to 0.69)	<0.01
Diagnostic tests and ACT in stock	No	1.00	
	Yes	0.86 (0.60 to 1.22)	0.39

ACT, artemisinin combination therapy; AOR, adjusted OR.

reported in the published literature. Findings from repeat cross-sectional household surveys do not indicate any change in the percentage of individuals seeking treatment for febrile illness in Papua New Guinea over the past decade.[27] The increased delay, therefore, does not appear to be a consequence of proportionately more or fewer febrile patients seeking assistance from the formal health sector. A more likely explanation may be the relative success of the national malaria control programme, which has overseen a dramatic reduction in general population prevalence and clinical incidence over the past decade.[17 28] In response to this success, the perceived 'threat' of malaria infection may have reduced in a population already somewhat indifferent to the disease[29] and the motivation to promptly seek treatment correspondingly diminished. These findings need to be confirmed elsewhere before more conclusive statements can be made in this regard, although they suggest greater investment in public health messaging encouraging prompt treatment seeking in cases of febrile illness may be needed in the context of declining malaria transmission.

The relationship between the implementation of test-based ACT prescription and patient satisfaction was inconclusive. Febrile patients were 48% less likely to report 'high' satisfaction with the treatment received in the 12-month period immediately following implementation of the new protocol (2012) as compared with preimplementation (2011) and, despite some improvement, were still 35% less likely to do so 5 years postimplementation (2016). While it is perhaps not surprising for satisfaction levels to drop during an initial period of change in health service provision (eg, due to patient expectations or health worker competency), it is concerning that reported satisfaction did not at least return to preimplementation levels given the step change in malaria case management quality the transition to test-based ACT prescription represents. However, a somewhat different picture emerged when the 'correct practice' analysis was limited to confirmed malaria cases who received an ACT (model 2). Febrile patients with a test confirmed malaria infection and who received an ACT were 56% more likely to provide a high satisfaction rating as compared with all other patients. Thus, the findings suggest the implementation of test-based ACT prescription impacts patient satisfaction in varying ways, depending on the outcome of the malaria diagnostic test and the resulting treatment

Table 4 Factors associated with a 'high' treatment satisfaction rating

		Model 1		Model 2	
Predictor variable		AOR (95% CI)	P values	AOR (95% CI)	P values
Correct health worker practice	No	1.00		1.00	
	Yes	1.09 (0.77 to 1.54)	0.62	1.56 (0.93 to 2.63)	0.09
Patient age	<5 years	1.00		1.00	
	5–15 years	0.80 (0.58 to 1.09)	0.16	0.77 (0.57 to 1.05)	0.10
	16+years	0.88 (0.69 to 1.12)	0.29	0.87 (0.68 to 1.12)	0.28
Location of health facility	Highlands	1.00		1.00	
	Lowland/Coastal/Islands	0.78 (0.50 to 1.19)	0.25	0.77 (0.48 to 1.22)	0.27
Location of health facility	Rural	1.00		1.00	
	Urban	1.18 (0.77 to 1.83)	0.45	1.24 (0.79 to 1.94)	0.35
Year of survey	2011	1.00		1.00	
	2012	0.52 (0.32 to 0.85)	<0.01	0.53 (0.33 to 0.84)	<0.01
	2016	0.65 (0.39 to 1.10)	0.11	0.66 (0.41 to 1.06)	0.08

Model 1: Correct health worker practice defined as providing a diagnostic test for malaria infection and either: (1) an ACT prescription if diagnostic test was positive; (2) or no antimalarial prescription if diagnostic test was negative; Model 2: Correct health worker practice defined as prescribing an ACT in response to test-confirmed malaria infection.
ACT, artemisinin combination therapy; AOR, adjusted OR.

pathway. Patients who test negative for malaria infection and are (correctly) not prescribed an antimalarial appear to be less satisfied with this outcome as compared with patients who test positive and receive the appropriate medication.

Arguably, the difference in reported satisfaction may be related to the subsequent diagnosis and treatment of test confirmed non-malaria febrile illness patients. Previous studies in Papua New Guinea suggest that health workers rarely conduct further investigations once malaria has been ruled out as a cause of febrile illness[30] and that antibiotics are widely overprescribed to this patient group.[31] Coupled with the fact that diagnostic tools to assist in the accurate identification of fever aetiology (other than malaria) are scarce in resource-poor settings,[32] then it is quite likely that many patients with non-malaria febrile illness, despite being appropriately managed according to test-based ACT prescription guidelines, may experience some degree of dissatisfaction with subsequent case management (which may be related to health worker behaviour and/or patient perceptions of the appropriateness of the diagnosis and treatment received). In other words, once malaria infection has been ruled out and the patient 'exits' the clearly defined malaria case management protocol and 'enters' a less well defined non-malaria febrile illness protocol, satisfaction declines. If substantiated, this finding raises the further possibility that the increasing delay in seeking treatment for febrile illness may be related to growing dissatisfaction with febrile case management at the primary healthcare level. Any gains in service improvement achieved through better quality malaria case management may, therefore, be offset by a perceived degradation in the treatment provided for other, non-malarial, febrile illnesses. This apparent imbalance in perceived treatment quality is likely to worsen as the global malaria burden continues to decline,[3 33] unless patients with non-malaria febrile illness receive a standard of care equivalent to test-confirmed malaria cases.

The reported study was not without limitation. The calculation of treatment seeking response time was based on patient self-report which may have been subject to recall bias. Interviewers were trained in techniques to assist accurate recall to minimise this risk. The possibility of self-medication or seeking treatment from an alternative source prior to presentation at the health facility was not accounted for, although recent household survey data suggest self-medication with antimalarials is uncommon in Papua New Guinea as is seeking assistance from somewhere other than a health facility.[27] Treatment satisfaction was based on a single measure which examined patient's satisfaction in a broad, rather than subject-specific, sense. However, the same measure was consistently used across time and there was little to suggest patient experience on dimensions outside of diagnosis, prescription and treatment counselling (eg, health worker attitudes, waiting times, physical environment) differed in any way between survey participants attending the same healthcare facility at the same time period. A free healthcare policy was introduced in 2014 which should have resulted in the removal of all service fees at primary healthcare level, although some facilities included in the survey continued to charge a service fee. The influence of this policy could have impacted patient satisfaction in either direction: those who received free healthcare may have reported greater satisfaction while those who did not may have been aggrieved. In either case, health facility charges were accounted for in the regression models. Participating clinicians were aware that they were being observed and may have altered their clinical practice accordingly. The expected effect of any such bias would be towards perceived 'better' practice. Similarly, exit interview responses may have been subject to some form of social desirability bias. The 2016 survey was completed at a different time period as compared with the 2011 and 2012 surveys. Seasonal incidence data indicate malaria transmission would have been highest during the 2016 survey.[24] This may have had some impact on rapid diagnostic test and ACT stocks, although is unlikely to have influenced health worker behaviour. Arguably, any influence on treatment seeking behaviour would have been towards faster treatment seeking response times during the higher malaria transmission season which was not apparent in the study findings. Finally, the sample excluded secondary-care and private-sector health facilities and may not be representative of malaria case management in these settings.

CONCLUSION

Investment in test-based ACT prescription does not improve treatment seeking response time or increase levels of treatment satisfaction among patients with febrile illness. Rather, the findings presented in this study raise the possibility that treatment seeking response times for febrile illness may worsen over time following the implementation of test-based ACT prescription due to dissatisfaction with the subsequent service received by patients with a confirmed non-malaria febrile illness. Test-based ACT prescription protocols should, therefore, be introduced alongside robust algorithms and resources to support the accurate identification and treatment of non-malarial febrile illnesses to offset these potentially detrimental outcomes. Greater investment in public health messaging encouraging prompt treatment seeking in cases of febrile illness may also be needed in contexts of declining malaria transmission. Additional research is needed to validate these findings and to identify and test appropriate solutions. In-depth qualitative studies examining community and health worker response to febrile illness in contexts of declining malaria transmission would be especially valuable.

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REFERENCES

1. WHO,FIND,CDC. *Malaria rapid diagnostic test performance: results of WHO product testing of malaria RDTS, Round 3 (2010-2011)*. Geneva: World Health Organisation, 2011.
2. Incardona S, Serra-Casas E, Champouillon N, *et al*. Global survey of malaria rapid diagnostic test (RDT) sales, procurement and lot verification practices: assessing the use of the WHO-FIND Malaria RDT Evaluation Programme (2011-2014). *Malar J* 2017;16:196.
3. World Health Organisation. *World Malaria Report 2016*. Geneva: WHO, 2016.
4. Nosten F, White NJ. Artemisinin-based combination treatment of falciparum malaria. *Am J Trop Med Hyg* 2007;77(6 Suppl):181–92.
5. World Health Organisation (WHO). *Guidelines for the Treatment of Malaria*. Third ed. Geneva: WHO, 2015.
6. Pulford J, Kurumop SF, Ura Y, *et al*. Malaria case management in Papua New Guinea following the introduction of a revised treatment protocol. *Malar J* 2013;12:433.
7. Thiam S, Thior M, Faye B, *et al*. Major reduction in anti-malarial drug consumption in Senegal after nation-wide introduction of malaria rapid diagnostic tests. *PLoS One* 2011;6:e18419.
8. Yukich JO, Bennett A, Albertini A, *et al*. Reductions in artemisinin-based combination therapy consumption after the nationwide scale up of routine malaria rapid diagnostic testing in Zambia. *Am J Trop Med Hyg* 2012;87:437–46.
9. Kyabayinze DJ, Asiimwe C, Nakanjako D, *et al*. Use of RDTs to improve malaria diagnosis and fever case management at primary health care facilities in Uganda. *Malar J* 2010;9:200.
10. World Health Organisation. *Management of severe malaria - A practical handbook*. 3rd ed. Geneva: WHO, 2013.
11. Battle KE, Bisanzio D, Gibson HS, *et al*. Treatment-seeking rates in malaria endemic countries. *Malar J* 2016;15:20.
12. Shah JA, Emina JB, Eckert E, *et al*. Prompt access to effective malaria treatment among children under five in sub-Saharan Africa: a multi-country analysis of national household survey data. *Malar J* 2015;14:329.
13. Akin JS, Hutchinson P. Health-care facility choice and the phenomenon of bypassing. *Health Policy Plan* 1999;14:135–51.
14. Kahabuka C, Kvåle G, Moland KM, *et al*. Why caretakers bypass Primary Health Care facilities for child care - a case from rural Tanzania. *BMC Health Serv Res* 2011;11:315.
15. Hetzel MW, Pulford J, Maraga S. Evaluation of the global fund-supported national malaria control program in papua new guinea, 2009-2014. *P N G Med J* 2014;57:7–29.
16. Müller I, Bockarie M, Alpers M, *et al*. The epidemiology of malaria in Papua New Guinea. *Trends Parasitol* 2003;19:253–9.
17. Hetzel MW, Pulford J, Ura Y, *et al*. Insecticide-treated nets and malaria prevalence, Papua New Guinea, 2008-2014. *Bull World Health Organ* 2017;95:695–705.
18. The World Bank. *PNG Health Workforce Crisis: A Call to Action*. Washington, DC: The World Bank, 2011.
19. Government of Papua New Guinea. *National Health Service Standards for Papua New Guinea 2011-2020*. Port Moresby: PNG, 2011.
20. PNG National Department of Health. *Health Sector Review, 2001-2009*. Port Moresby: National Department of Health, 2009.
21. Kurumop S, Tandrapah A, Hetzel M. *The Papua New Guinea National Malaria Control Program: Health facility surveys, 2010-2016*. Goroka: Papua New Guinea Institute of Medical Research, 2016.
22. Bank W. *Service Delivery by Health Facilities in Papua New Guinea*. Washington: World Bank, 2018.
23. Hetzel MW, Pulford J, Tandrapah T, *et al*. Missing in the line of duty. *P N G Med J* 2014;57(1-4):94–102.
24. Park JW, Cheong HK, Honda Y, *et al*. Time trend of malaria in relation to climate variability in Papua New Guinea. *Environ Health Toxicol* 2016;31:e2016003.
25. UNICEF, 2017. Available from: https://www.unicef.org/infobycountry/papuang_statistics.html [Accessed 2017 Oct 25].
26. Fowler F. *Improving survey questions: design adn evaluation*. London: Sage Publications, 1995.
27. Hetzel M, Saweri O, Kuadima J. *Papua New Guinea Malaria Indicator Survey 2016-2017: Malaria Prevention, Infection, and Treatment. Goroka: Papua New Guinea Institute of Medical Research*. Goroka: Papua New Guinea Institute of Medical Research, 2018.
28. Hetzel MW, Reimer LJ, Gideon G, *et al*. Changes in malaria burden and transmission in sentinel sites after the roll-out of long-lasting insecticidal nets in Papua New Guinea. *Parasit Vectors* 2016;9:340.
29. Pulford J, Oakiva T, Angwin A, *et al*. Indifferent to disease: a qualitative investigation of the reasons why some Papua New Guineans who own mosquito nets choose not to use them. *Soc Sci Med* 2012;75:2283–90.
30. Pulford J, Kurumop S, Mueller I, *et al*. The impact of the scale-up of malaria rapid diagnostic tests on the routine clinical diagnosis procedures for febrile illness: a series of repeated cross-sectional studies in Papua New Guinea. *Malar J* 2018;17:202.
31. Saweri OP, Hetzel MW, Mueller I, *et al*. The treatment of non-malarial febrile illness in Papua New Guinea: findings from cross sectional and longitudinal studies of health worker practice. *BMC Health Serv Res* 2017;17:10.
32. Chappuis F, Alirol E, d'Acremont V, *et al*. Rapid diagnostic tests for non-malarial febrile illness in the tropics. *Clin Microbiol Infect* 2013;19:422–31.
33. Murray CJ, Rosenfeld LC, Lim SS, *et al*. Global malaria mortality between 1980 and 2010: a systematic analysis. *Lancet* 2012;379:413–31.