Cost-saving through microscopy-based versus presumptive diagnosis of malaria in adult outpatients in Malawi

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The cost implications of changing from a policy of presumptive diagnosis to one of microscopy-based diagnosis in the management of uncomplicated malaria in an urban hospital adult outpatient clinic in Malawi were studied. Costs were measured in three separate weeks during the rainy season. In weeks I and II all uncomplicated malaria cases were treated on the basis of a presumptive diagnosis. In week II, blood films were taken but the results were not made available and did not affect drug dispensing. In week III, antimalarial drugs were restricted to parasitaemic patients.

In week I, a total of 7216 prescriptions were written and dispensed, of which 2883 (39.9%) were for antimalarial drugs. The proportion of antimalarial prescriptions fell to 1171/5556 (21.1%) in week II and 357/5377 (6.6%) in week III.

We estimate annual savings from microscopy-directed treatment in this setting to be 52 000 Malawi kwacha (US$ 14 000). This represents 3% of the annual drugs budget for the hospital, and is large enough to justify a change in policy.

Introduction

A diagnosis of malaria in most outpatient clinics in malaria-endemic areas is made on the basis of the presenting signs and symptoms, without microscopic confirmation of parasitaemia, and treatment is based on this 'presumptive diagnosis' (1). Because the clinical presentation of malaria (fever, headache and/or myalgia) is similar to that of other common illnesses, this presumptive diagnosis often results in unnecessary administration of antimalarial drugs (2, 3). The extent of antimalarial drug overuse due to a wrong presumptive diagnosis will influence drug budgets, and could increase the development of drug resistance in the parasite population (4) and the incidence of adverse reactions to antimalarial drugs, as well as delay the determination of correct diagnoses.

The alternative approach is for each malaria treatment to be based on a microscopically confirmed diagnosis. The cost implications of such a policy have been discussed (5, 6), but not measured directly in an adult outpatient setting in a malaria-endemic area. We therefore determined the costs of malaria treatment in the adult outpatients department of a government hospital in Malawi, and examined the effect on drug expenditure of changing from a policy of presumptive diagnosis to microscopy-based diagnosis.

Patients and methods

Site. The study was carried out in the adult outpatients department of the 800-bed Queen Elizabeth Central Hospital in Blantyre, Malawi, and consisted of three phases, each conducted during the third week (Monday to Saturday) of a month during the main malaria transmission season (January to April 1993). The predominant species of malaria in Malawi is Plasmodium falciparum, which causes 90% of symptomatic malaria infections, the other 10% being due to P. malariae.

Chloroquine-resistant P. falciparum is well established in Malawi, and sulfadoxine (500 mg) and pyrimethamine (25 mg) (S–P) is now the routine first-line treatment for uncomplicated malaria infections. National treatment guidelines recommend that adults with a history of fever and no obvious sites of infection should receive treatment for malaria. Prescribers in the outpatients department adhered to these guidelines throughout the course of the study; each patient presumptively diagnosed with malaria...
received a standard prescription for S–P (3 tablets) along with an analgesic/antipyretic drug.

**Week I.** Pharmacy clerks made daily tallies of all prescriptions dispensed by the two outpatient pharmacies, noting the total number of prescriptions as well as the number of prescriptions for antimalarial drugs. The pharmacist monitored the quantities of other drugs (antibiotics, analgesics) issued during both the study week and the preceding week. The normal routine of work in the outpatients department was not affected during this phase.

**Week II.** One medical aide and two microscopists were stationed in the outpatients department, to which the microscopes used for malaria diagnosis in the central laboratory were transferred during the study period. The aide took blood samples by finger-prick and prepared thick blood films, which the microscopists stained and read (magnification, × 1000) for all patients with a presumptive diagnosis of malaria. Each film was graded as positive (sexual malaria parasites seen) or negative (no sexual parasites seen), based on the inspection of 200 fields. Every tenth slide was read by another experienced microscopist (UL or TT) who was unaware of the initial interpretation.

Prescribers in the outpatients department (medical assistants and clinical officers trained in Malawi) were informed of the screening process before week II began. The results were not given to them and their prescriptions were dispensed regardless of the blood film results. Daily and weekly records in the pharmacies were made as described above.

**Week III.** The procedures were identical to weeks I and II except that specific antimalarial treatment was given only to parasitaemic patients. Those without parasitaemia were re-evaluated by the outpatients staff; if no cause for the fever was found, these patients were given a prescription for an analgesic and encouraged to return if they failed to improve within the ensuing 48–72 hours.

**Statistical analysis.** The chi-squared test was used to compare proportions (Epi-Info, version 3.0), and Student’s t-test was used for the comparison of continuous, normally distributed variables (Minitab, version 7.1).

## Results

The number of prescriptions dispensed during each of the three phases (Table 1) was not significantly different, but the proportion of antimalarials dropped significantly from 39.9% in week I to 21.1% in week II and 6.6% in week III. The proportions of "positive" slides in patients presumptively diagnosed with malaria during weeks II and III were similar (29% and 30%, respectively).

Two microscopists and one medical aide were able to manage the average load of 220 slides/day. The discrepancies between their interpretations and those of the other experienced microscopists was <2%. The consumption of antibiotics and analgesics did not differ between weeks I, II and III or between each study week and the week immediately preceding it.

**Costs of microscopic screening.** The salaries for two school-leavers, who were individually trained in the microscopic diagnosis of malaria, and one medical aide were, respectively, 7200 Malawi kwacha (US$ 1818) and 1800 Malawi kwacha (US$ 457), giving a total annual cost for staff salaries of US$ 2275. The outpatients department is closed on Sundays and public holidays.

Based on supplies consumed during weeks II and III (cotton wool, spirit, immersion oil, stains, lancets) and assuming a single use for each lancet and three uses for each microscope slide, the cost of supplies is 0.13 Malawi kwacha (US$ 0.03) per slide. The two microscopes used in the study were already designated for malaria diagnosis; shifting them to the outpatients department did not incur any extra cost. If an average of 1000 blood films is examined each week, the annual cost of supplies required would be 6760 Malawi kwacha (US$ 1707). The total annual cost of screening all patients for a clinical diagnosis of malaria in this setting is estimated to be US$ 3982.

**Costs of drug treatment.** The cost to the Queen Elizabeth Central Hospital Pharmacy for one adult treatment dose of S–P (3 tablets) was 0.66 Malawi kwacha (US$ 0.16) at the time when this study was conducted.

Throughout the three phases of this study, an average of 6300 prescriptions were written each week. During week I, 39.9% of all prescriptions included antimalarials. The cost of dispensing these prescriptions (6300 × 0.399 × 0.16) would be US$ 402/week, or US$ 20 904 annually.

With selective treatment, the proportion of all prescriptions for antimalarials dropped to 6.6%. Thus, the cost of providing antimalarials only to parasitaemic individuals (6300 × 0.066 × 0.16) would be US$ 66/week or US$ 3432 annually. Restricting antimalarial drugs to adults with proven parasitaemias would therefore save US$ 17 472/year in antimalarial drug costs in this setting.

**Total savings.** The savings associated with treatment of only microscopically confirmed malaria cases is
the difference between the estimated saving on drugs (US$ 17 472/year) and the estimated cost of screening (US$ 3982/year). In one year this would amount to a saving of US$ 13 490 or about 3% of the annual drugs budget of the hospital.

Discussion

This study shows that, in the setting of the Queen Elizabeth Central Hospital’s adult outpatients department, a policy of basing antimalarial treatment on microscopic diagnosis costs less than a policy of basing treatment on a presumptive diagnosis of suspected malaria. Part of the savings may be due to greater care on the part of prescribers when they knew that microscopic confirmation was available, the proportion of prescriptions for antimalarial drugs falling by about half from week I to week II. But when antimalarial therapy was restricted to only parasitaemic individuals (week III), the proportion of prescriptions for antimalarials + analgesics fell by 83% from baseline (week I) levels. Those patients with a presumptive diagnosis of malaria who were found to be a parasitaemic in week III received only analgesic drugs unless another cause for the fever was identified. We did not detect a compensatory increase in antibiotic prescriptions during the study weeks; it is therefore unlikely that more expensive “default” treatment would erode the cost savings realized by providing antimalarial drugs only for patients with confirmed malaria parasitaemia.

There are inherent limitations to the microscopic diagnosis of malaria. For example, the absence of parasitaemia in a single blood film does not exclude the possibility of malaria infection since *P. falciparum* is only present in the peripheral blood for a portion of its life cycle. Despite these limitations, the accuracy of diagnosis of malaria is considerably improved by microscopic detection of parasites.

The practice of restricting treatment to parasitaemic individuals, although improving the clinical diagnosis of malaria, delays treatment in malaria patients with ‘false-negative’ blood films. Repeat examination of the peripheral blood 2–3 times over a 24-hour period will generally reveal malaria parasites in infected individuals (I). In non-immune subjects (e.g., children in sub-Saharan Africa, or travelers to malaria-endemic areas) delaying treatment because of a ‘false-negative’ blood film could be fatal because malarial illness can develop extremely rapidly in these individuals (I, 7); presumptive diagnosis and treatment with an effective drug is sometimes justified in such patients. In semi-immune individuals, such as adults living in holoendemic areas, malaria infection rarely progresses to severe and complicated disease; the delay in treatment incurred by one ‘false-negative’ blood film in these patients is unlikely to be detrimental. A policy of directed treatment is therefore safest in a semi-immune population.

A proportion of symptomatic semi-immune individuals have parasitaemias that are unrelated to their symptoms. Treatment directed to these patients may not be wasted, as it may forestall the later development of malarial illness. Since there are no markers by which malaria disease can be distinguished from malaria infection, some degree of diagnostic ambiguity is inevitable. Health care staff must be aware of the need to look for other causes of fever in parasitaemic patients.

The widespread practice of treating uncomplicated malaria on the basis of presumptive diagnoses should be reconsidered in the light of our findings. Whether a policy of directed treatment of malaria is cost-saving depends on the number of patients being treated, the accuracy of the clinical diagnosis, and the cost of the drugs used, set against the costs of training and payments to and supervision of microscopists. Assuming the fixed weekly costs of screening in our study and the decrease in antimalarial prescriptions from 39.9% to 6.6% associated with microscopic screening, a minimum of 560 patients would need to be screened weekly to make the programme cost-effective.

Table 1: Data from pharmacy records and microscopy of blood films during weeks I, II and III in the outpatients study, Queen Elizabeth Central Hospital, Blantyre

<table>
<thead>
<tr>
<th>Week</th>
<th>Total number of prescriptions</th>
<th>No. of antimalarial prescriptions</th>
<th>No. of blood films examined</th>
<th>No. of &quot;positive&quot; films</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>7216</td>
<td>2883 (39.9)*</td>
<td>1174</td>
<td>344 (29)</td>
</tr>
<tr>
<td>II</td>
<td>5556</td>
<td>1711 (21.1)</td>
<td>174</td>
<td>347 (30)</td>
</tr>
<tr>
<td>III</td>
<td>5377</td>
<td>357 (6.6)</td>
<td>346</td>
<td>347 (30)</td>
</tr>
</tbody>
</table>

* Figures in parentheses are percentages.
Other considerations may add to the costs of microscopy. If microscopes must be purchased, an initial outlay will be required; in the present study this would have used a small proportion of the predicted cost saving for the first year. For the purposes of this study, microscopists worked only on malaria diagnosis; in the circumstances of normal hospital practice it is desirable that laboratory staff should rotate their tasks, and the number of individuals trained should be sufficient to make this possible. This will add little to the costs if existing staff are deployed for the purpose. Training, retraining and supervision of microscopists are necessary; these activities may add to the costs of the microscopy service, but may also be seen as necessary and beneficial for the health service in general. In smaller centres, in particular, it may be useful to conduct studies on the value of malaria microscopy in the wider context of general laboratory services.

Microscopic confirmation of parasitaemia can improve the clinical diagnosis of malaria even more significantly than demonstrated in our study. In a paediatric outpatient clinic in central Malawi (2), basing treatment on demonstrable parasitaemia in children with fever/cough would have reduced antimalarial treatments from 89% to 35%, and in febrile children in Mali the reduction would have been from 99% to 62% in the rainy season and from 79% to 5% in the dry season (3). Assuming our fixed costs of screening and treatment, and an average of 6300 outpatients/week, any decrement of >8% in the proportion of antimalarial prescriptions dispensed as a result of microscopic screening would be associated with overall cost savings.

Savings may vary with the season and may be greatest when the intensity of malaria transmission is least (3). The present study was conducted in the season of highest transmission of malaria parasites; our extrapolation of costs may therefore underestimate the savings that could result from microscopy throughout the year.

There are other benefits of a policy of selective treatment. Because fewer patients receive drugs, the incidence of adverse drug reactions is decreased and the spread of drug-resistant parasites may be slowed. The policy also provides a basis for monitoring the activities of prescribers and pharmacy personnel and for recognizing drug-resistant malaria when it occurs.

Résumé

Economies réalisées grâce au diagnostic microscopique du paludisme, par rapport au diagnostic présomptif, chez des malades ambulatoires au Malawi

Les conséquences financières du passage d’une politique de diagnostic présomptif à une politique de diagnostic microscopique pour la prise en charge du paludisme non compliqué dans un service de consultations externes pour adultes d’un hôpital urbain du Malawi ont été étudiées. Les coûts ont été évalués au cours de trois semaines distinctes pendant la saison des pluies. Les semaines I et II, tous les cas de paludisme non compliqué ont fait l’objet d’un diagnostic présomptif et ont été soignés par une dose unique de sulfadoxine (1,5 g) plus pyriméthamine (75 mg) (Fansidar, 3 comprimés). La semaine II, des frottis sanguins ont été réalisés, mais les résultats n’ont pas été communiqués et n’ont pas modifié la dispensation des médicaments. La semaine III, les antipaludiques ont été distribués aux seuls sujets parasitémiques.

La semaine I, 7216 prescriptions au total ont été rédigées et dispensées dans le service de consultations externes; 2883 d’entre elles (39,9%) concernaient des antipaludiques. La proportion des prescriptions d’antipaludiques est tombée à 1171/5556 (21,1%) la semaine II et à 357/5377 (6,6%) la semaine III.

Sur la base de nos observations de ces trois périodes d’une semaine, le coût annuel de l’utilisation du microscope pour le diagnostic du paludisme recouvrirait trois rubriques: les salaires des microscopistes (US$ 1818) par an), le salaire de l’auxiliaire médicale (US$ 457 par an) et les fournitures (US$ 1707 par an), soit au total US$ 3982 par an.

Le coût des médicaments pour un traitement fondé sur le diagnostic présomptif (semaine I) était de US $402 par semaine, tandis que lorsque le traitement était fondé sur l’examen microscopique (semaine III), il tombait à US $66 par semaine, soit une différence de US$ 336 par semaine. Si les modalités de prescription étaient similaires pendant toute l’année, la restriction du traitement par antipaludiques aux adultes ayant une parasitémie prouvée permettrait d’économiser 52 x US$ 336, soit US$ 17 472 par an en frais de médicaments dans l’établissement considéré.

Les économies annuelles résultant de l’adoption d’un traitement fondé sur le diagnostic microscopique du paludisme seraient équivalentes à

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l’économie de médicaments (US$ 17 472) diminuée du coût du service de microscopie (US$ 3982), soit une économie totale annuelle de US$ 13 490. Ce chiffre représente 3% du budget annuel en médicaments pour l'hôpital considéré et est suffisant pour justifier un changement de politique.

References