SHORT REPORT: A CONSIDERATION OF PRIMAQUINE DOSE ADJUSTMENT FOR RADICAL CURE OF PLASMODIUM VIVAX MALARIA

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Abstract. Relapse of Plasmodium vivax malaria following standard primaquine dosing has been reported from many areas, and more recently from sub-Saharan Africa. In this report we describe eight episodes (in five patients) of treatment failure in non-immune Israeli travelers returning from Ethiopia. Retrospective calculation of the primaquine dose per kilogram of body weight for 23 treatment courses showed a lower total dose per kilogram in heavier patients. The mean calculated dose (95% CI) in the eight failed treatments was 2.5 ± 0.3 mg/kg compared with 4.4 ± 0.5 mg/kg in the 15 successful treatment courses. Weight-adjusted dosing regimens may prevent inadvertent subtherapeutic drug failure, and thus apparent primaquine failure. In these cases, no relapses were observed in those who received > 3.5 mg/kg. Consideration should be given to adjusting the dose of primaquine according to body weight. For those infected by strains from Ethiopia a dose > 3.5 mg/kg is preferable.

Although Plasmodium vivax accounts for less than 10% of the malaria cases in Africa, there has been an increase in recent accounts of infection among travelers to these regions, such as Israelis returning from Ethiopia and U.S. military returning from Somalia. Reports of primaquine failures have also increased, primarily from Papua New Guinea, Southeast Asia, and Central and South America. Relapses following primaquine treatment of strains acquired in Africa have been less well described.

We report eight relapses (in five individuals) of P. vivax malaria in Israeli travelers to Ethiopia despite a standard dose of primaquine. The dose per kilogram of body weight was calculated for each treatment course and the doses resulting in successful treatments were compared with those resulting in relapses.

This study consisted of a retrospective review of the authors’ patient records; the patients had been treated according to accepted clinical guidelines. Therefore, when the matter was referred to the Helsinki Committee of Sheba Medical Center, it was determined that no other ethical review process was necessary.

Charts of 15 Israeli travelers who presented at the Sheba Medical Center with smear-documented P. vivax malaria between January 1995 and June 1998 were reviewed. All had returned from Ethiopia; all had presented at least three months following return, and 12 of 15 had been on rafting tours of the Omo River. They had received mefloquine or doxycycline chemoprophylaxis, and had reported good compliance. None was given primaquine for terminal prophylaxis. Primary attacks were treated with chloroquine followed by 15 mg/day of primaquine (Sanofi-Winthrop, New York, NY) for 14 days. Compliance was assessed by interviews at the completion of the treatment course. None had traveled again to malarious areas.

Five of the 15 malaria patients had relapses between 3 and 10 months after initial treatment, and were treated with chloroquine followed by greater doses or longer courses of primaquine (Table 1). After an additional 3–10 months, three of five patients experienced a third episode of malaria, and were given a third course of a higher dose primaquine (Table 1). There were no further relapses, and the remaining 10 patients remained disease-free on follow-up at 12–36 months.

The five patients that had at least one relapse had initially received lower mean doses of primaquine based on body weight than the 10 patients who did not have a relapse (95% CI; 2.4 ± 0.4 versus 4.0 ± 0.5; P = 0.018, Fisher’s exact test). Comparison of the primaquine doses by weight between the eight courses (in five patients) resulting in relapse and the 15 successful courses showed no relapses when doses > 3.5 mg/kg of primaquine were used (Figure 1). No adverse events were observed and methemoglobin levels, which were measured in patients who were treated with the higher doses, were in the normal range.

The dosage recommendation for radical cure of P. vivax malaria is based on several studies performed during the 1950s. Since then, reports of primaquine resistance or primaquine failure have become fairly common from areas such as Papua New Guinea, Southeast Asia, India, and Colombia. Relapses despite primaquine treatment may reflect changes in primaquine response among formerly susceptible strains, or geographic spread of strains that have long been known to be refractory. However, the term resistance may be misleading. The presence of drug resistance involving antimalarials is generally assessed by the effect a drug has on the asexual parasite density in the blood, or on the time to parasite recrudescence in the presence of adequate antimalarial drug levels in the serum. Because primaquine has little effect on erythrocytic parasites, asexual parasite density cannot be used to demonstrate drug resistance, and thus it is difficult to define true resistance. Controversy exists as to whether drug resistance is indeed the cause for cases of primaquine failure. It has been suggested that resistance to primaquine may actually reflect unrecognized chloroquine resistance with incomplete eradication of the erythrocytic stage rather than the hepatic forms. However, early relapses within one month of appropriate chloroquine and primaquine treatment are characteristic of chloroquine failure, while late relapses usually represent primaquine failure.

Geographic diversity and susceptibility to primaquine ex-
### Table 1
Summary of the 5 patients who failed primaquine treatment

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Weight (kg)</th>
<th>Prophylaxis</th>
<th>First primaquine treatment</th>
<th>Second primaquine treatment</th>
<th>Third primaquine Rx</th>
<th>Treatment course</th>
<th>Total dose</th>
<th>Interval to first relapse</th>
<th>Interval to second relapse</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>97</td>
<td>Mefloquine</td>
<td>15 mg for 14 days</td>
<td>15 mg for 14 days</td>
<td>NA</td>
<td>60 days</td>
<td>3.5 mg/kg</td>
<td>3 months</td>
<td>10 months</td>
<td>Free of attack</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>Mefloquine</td>
<td>15 mg for 14 days</td>
<td>15 mg for 14 days</td>
<td>NA</td>
<td>60 days</td>
<td>3.5 mg/kg</td>
<td>6 months</td>
<td>12 months</td>
<td>Free of attack</td>
</tr>
<tr>
<td>3</td>
<td>85</td>
<td>Mefloquine</td>
<td>15 mg for 14 days</td>
<td>15 mg for 14 days</td>
<td>NA</td>
<td>60 days</td>
<td>3.5 mg/kg</td>
<td>6 months</td>
<td>12 months</td>
<td>Free of attack</td>
</tr>
<tr>
<td>4</td>
<td>95</td>
<td>Doxycycline</td>
<td>15 mg for 14 days</td>
<td>15 mg for 14 days</td>
<td>NA</td>
<td>60 days</td>
<td>3.5 mg/kg</td>
<td>6 months</td>
<td>12 months</td>
<td>Free of attack</td>
</tr>
<tr>
<td>5</td>
<td>66</td>
<td>Doxycycline</td>
<td>15 mg for 14 days</td>
<td>15 mg for 14 days</td>
<td>NA</td>
<td>60 days</td>
<td>3.5 mg/kg</td>
<td>6 months</td>
<td>12 months</td>
<td>Free of attack</td>
</tr>
</tbody>
</table>

#### Figure 1
Failed treatments for *Plasmodium vivax* malaria compared with successful treatments. △ = first malaria attack, successful treatment; ▲ = first malaria attack, failed treatment; ○ = second malaria attack, successful treatment; ● = second malaria attack, failed treatment; □ = third malaria attack, successful treatment.

In addition, the standard fixed dose of primaquine results in doses per kilogram of body weight that are quite variable. For example, a 14-day course of treatment translates into 3.5 mg/kg for a 60-kg patient and 2.3 mg/kg for a 90-kg patient. Thus, inadvertent subtherapeutic dosing may be a cause for primaquine failure in heavy patients. In the Israeli patients, dose-adjustment for body weight resulted in a radical cure for all patients after receiving at least 3.5 mg/kg.

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