



# Compliance with Malaria Preventive Measures by U.S. Military Personnel Deployed to Liberia in Support of Ebola Control Efforts



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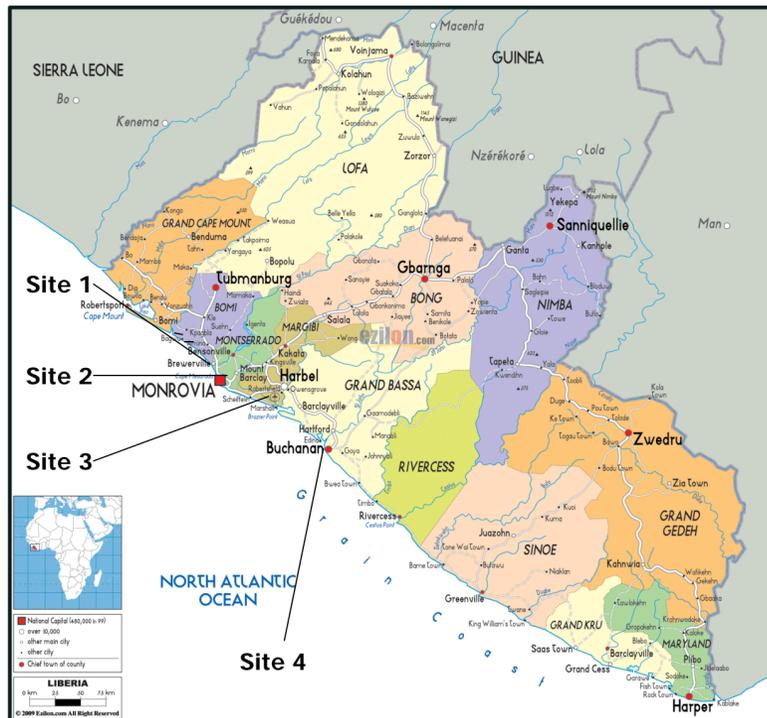
## ABSTRACT

**Background:** The U.S. Government deployed over 2500 military personnel to support ebola control efforts in Liberia, which has one of the highest malaria risks in the world. Compliance with preventive measures among travelers to malarious areas is historically low, with military-specific compliance with chemoprophylaxis reported between 30-55% over the past decade of combat operations. We conducted a survey of military personnel deployed to Liberia to assess compliance with preventive measures in a high-risk malaria area.

**Methods:** Deployed U.S. service members completed a voluntary 25 question anonymous survey administered over a 4-week period. The survey included questions on demographic information, malaria prevention education prior to deployment, and adherence with preventive measures, such as use of DEET on exposed skin, permethrin-treated uniforms and bed nets, and malaria chemoprophylaxis.

**Results:** 1220 individuals (63% of total deployed force during the survey period) completed the survey, which was representative of the overall population, based on age, gender, and military rank. Mean duration of deployment was 66 days, and 63% had received malaria chemoprophylaxis on previous deployments. 99.3% reported receiving education on malaria prevention before leaving the U.S. 53% reported using DEET on most days, 91% reported using treated uniforms, 96% using bed nets, and 96% taking malaria chemoprophylaxis pills every day (98% received atovaquone-proguanil; 1.4% doxycycline). No cases of malaria were detected during deployment. As part of mandated twice daily unit-level ebola monitoring (consisting of temperature checks and review of ebola exposures and symptoms), individuals were also asked about use of antimalarials. 45% of those surveyed indicated that their unit also directly observed them taking their antimalarial daily.

**Conclusion:** Adherence with preventive measures in a high-risk malaria area was among the highest ever observed among a deployed military force of this size. Pre-deployment education, daily unit monitoring while deployed, and the use of atovaquone-proguanil contributed to improved adherence. Similar large-scale monitoring programs may contribute to improved adherence and disease prevention for individuals and populations traveling to high-risk malaria areas.



## METHODS

- A two-page, 25-question, anonymous, voluntary, convenience survey of deployed U.S. service members administered over a 4-week period (January 2015) in Liberia
- Participants completed handwritten survey entries and returned surveys at their convenience to an anonymous collection box
- One survey per participant was collected

•Individuals were excluded if they were not U.S. service members assigned in support of ebola control efforts in Liberia or if they chose not to participate

### Study Objectives

1. Assess overall compliance with pharmacologic and non-pharmacologic malaria prevention measures of a large deployed population of U.S. military service members in a high-risk malaria area
2. Provide real-time, data-driven population health recommendations to deployed commanders on areas for improvement with health protection measures against malaria

## RESULTS

Figure 2. DEET-insect repellent use

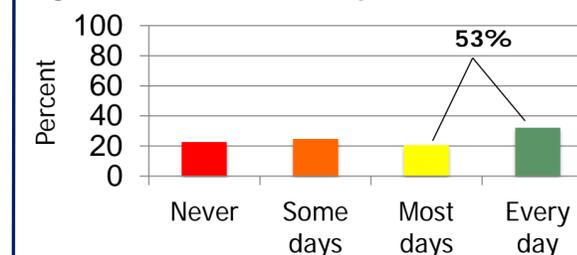


Figure 3. Bed net use

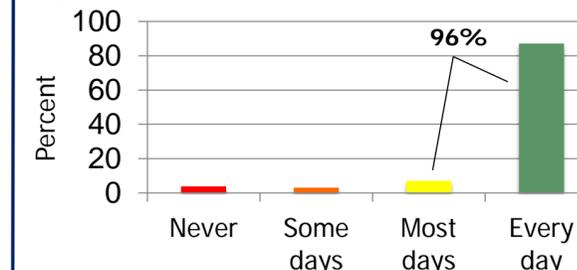
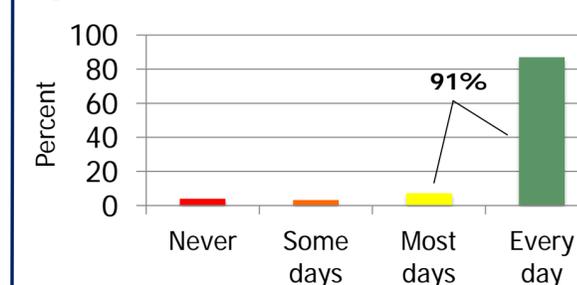


Figure 4. Permethrin-treated uniform use



## BACKGROUND

- West Africa has one of the highest rates of malaria (*Plasmodium falciparum*, in particular) in the world
- Compliance with malaria preventive measures is historically low in travelers and deployed military service members (SMs), with recent U.S. military experiences in Liberia (2003) showing 45% DEET use, 55% malaria chemoprophylaxis adherence, very low bed net use adherence, and a 36% attack rate

•In addition to command emphasis on preventive measures, novel methods, such as text message reminder systems, have been used to improve compliance with malaria chemoprophylaxis

### Liberia 2014-2015

•In response to the unprecedented ebola outbreak in West Africa, the U.S. Government deployed >2500 military service members (SMs) to support the Liberian government in 2014-2015

•U.S. military units in Liberia conducted command-directed unit monitoring of all SMs (temperature checks and assessment for ebola exposures and symptoms) twice-daily throughout deployment

•Febrile SMs were immediately referred for clinical evaluation for malaria and other causes; no cases of malaria were identified during deployment in Liberia; 6 cases of non-falciparum malaria were diagnosed after return to the U.S.

## RESULTS

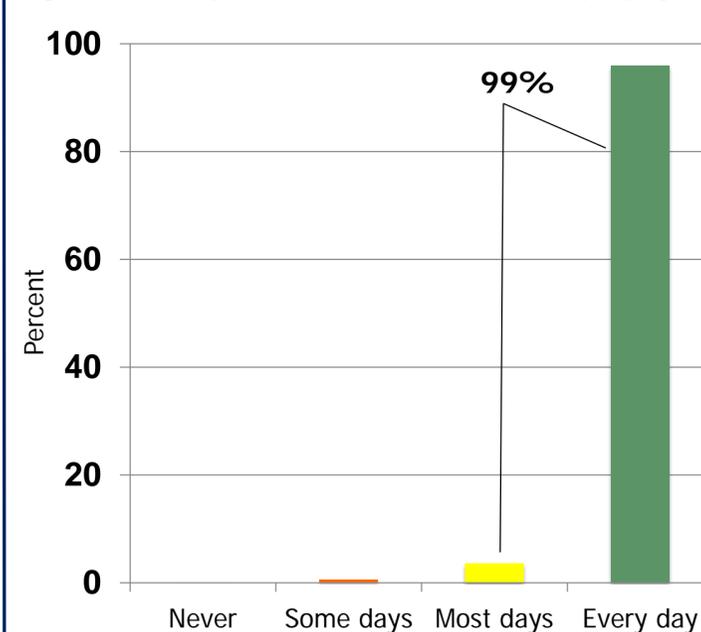
Table 1. Survey representativeness

Variable	Survey Participants n=1220 <sup>#</sup>	Deployed Force n=1942 <sup>#</sup>	P-value
<b>Demographic characteristic</b>			
Age (years)	29	29	-
Male	976 (80%)	1612 (83%)	0.03
Mean duration deployed (days)	66	66	-
<b>Military rank category</b>			
E1-E5	761 (63)	1185 (61)	0.27
E6-E9	208 (17)	350 (18)	0.57
WO-W5	37 (3)	58 (3)	0.94
O1-O3	129 (11)	232 (12)	0.24
O4-O8	73 (6)	117 (6)	0.98
<b>Assignment location<sup>&amp;</sup> in Liberia</b>			
Site 1	335 (28)	641 (33)	.001
Site 2	252 (21)	466 (24)	.03
Site 3	261 (21)	369 (19)	.09
Site 4	358 (29)	466 (24)	.001
<b>Additional Survey Responses</b>			
Prior malaria chemoprophylaxis use	769 (63)	-	-
Received education <sup>*</sup> on malaria risks	1210 (99)	-	-
Received malaria prevention education <sup>*</sup>	1211 (99)	-	-
Unit asked SM if took malaria med	1110 (91)	-	-
Unit observed SM taking malaria med	549 (45)	-	-
Bitten by mosquitoes while deployed	453 (38)	-	-
If bitten, bite occurred at night	204 (45)	-	-

**Table 1 Notes** [Data listed as number (%) unless otherwise stated]  
<sup>#</sup>1220 survey respondents out of 1942 SMs deployed during the survey period=63% of military service members in Liberia at that time  
<sup>&</sup>Deployment sites were geographically distinct locations where individuals slept  
<sup>\*</sup>Education: SM received education prior to departing for Liberia

## RESULTS

Figure 1. Compliance with malaria chemoprophylaxis



**Figure 1-4 Notes**

- Total number of survey respondents: 1220
- Survey participants were asked if, during a typical week while deployed to Liberia, they took their prescribed malaria chemoprophylaxis medication (Fig 1), used DEET (Fig 2), used bed nets (Fig 3), or used permethrin-treated uniforms (Fig 4) never, some days, most days, or every day
- **Breakdown by malaria chemoprophylaxis medication taken: (98.4% Malarone, 1.4% Doxycycline, 0.17% Mefloquine)**

## CONCLUSIONS

- Adherence with preventive measures was among the highest ever observed in a deployed military population of this size to a high risk malaria area, likely contributing to the absence of malaria cases while deployed and the limited number of non-falciparum cases upon return
- Command-directed twice-daily screening for ebola exposures, symptoms and temperature facilitated direct assessment of malaria chemoprophylaxis use
- Pre-deployment education, unit monitoring while deployed, and the use of atovaquone-proguanil contributed to improved adherence
- Similar large-scale monitoring programs may contribute to improved adherence and disease prevention for groups traveling to high-risk malaria area

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