Malaria-Associated Mortality in Australian and British Prisoners of War on the Thai–Burma Railway 1943–1944

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Abstract. During the building of the Thai–Burma railway in 1943 Australian and British prisoners of war died at high rates from tropical infections and nutritional deficiencies. Mortality records from “F” Force ($n = 7,000$) showed nearly half (44%) of the soldiers perished in a single year, yet only 4% of these deaths were primarily attributed to malaria, with another 7% where malaria was listed as a major contributing cause. Case fatality rates were $< 1\%$, with nearly all soldiers chronically infected with *Plasmodium vivax* > *Plasmodium falciparum*. Separate labor camp point prevalence malaria rates by microscopy ranged from 28% to 69% (median 54%) despite intermittent quinine suppression. During complex public health emergencies, malaria mortality may be disguised by its combination with other common infections and nutritional deficiencies.

The Nips there refused to recognize malaria as an illness. They forced men out to work with fever on them, and many collapsed on the railway track. They had nothing like enough quinine. There had been 70 deaths in 3 days. . .

Robert Hardie, Third Malayan Volunteer Field Ambulance, 1943.¹

Malaria-associated mortality is likely at least as great as deaths directly due to malaria, but how much this contributes to overall tropical mortality is difficult to measure. Medical systems sufficient to measure malaria mortality will also be able to prevent many from dying, and complex public health emergencies often occur beyond the reach of medical assistance. Where malaria has been eliminated, as in British Guyana, the increase in longevity is much greater than one would have predicted based on previously documented malaria deaths.² In the Andaman Islands prison colony in the Bay of Bengal, a remarkable > 60-year data sequence documented the interrelationship between malaria and mortality formally assigned to other infections such as dysentery, diarrhea, tuberculosis, and pneumonia.^{3,4} Malaria-associated mortality was estimated to be up to three times the number of registered malaria deaths and largely explained the total mortality during periodic malaria epidemics.

Malaria does not operate in a vacuum apart from other infectious diseases. Children living in endemic regions usually suffer from a sequential combination of enteric and respiratory infections, which synergistically increase mortality in the younger than 5 years age group. Under extreme conditions, malaria naïve adults can also experience great mortality when faced with chronic malaria, inadequate nutrition, and multiple other enteric and respiratory infections. Such extreme mortality was experienced by Australian and British prisoners of war (POW) forced to build the Thai–Burma railway during the Second World War.^{1,5–9} Their experience under these extreme wartime conditions is examined to discover the likely contribution of malaria-associated mortality to the total number of deaths.

Prisoners of war conditions for Australian and British soldiers following their capture at the surrender of Singapore in February 1942 varied from bad for those who remained in prison in Changi to absolutely hellish for those sent to forced-labor camps in malaria-endemic areas of Southeast Asia.^{5,10} Death was rarely due to a single event but reflected chronic starvation, repeated physical abuse by guards, inability to rest ill POW without having their rations reduced, and a wide combination of tropical infectious diseases that were often inadequately treated because of severe drug shortages. The most desperate circumstances probably occurred during the building of the Thai–Burma railway in 1943–1944. Approximately 13,000 Australian and 30,000 British soldiers traveled from Singapore into the jungle along the Thai–Burma border to construct a rail connection between Bangkok and Rangoon.⁶ A 7,000-soldier contingent known as F Force in 1943 has the distinction of being the worst of a terrible group in terms of physical suffering and mortality.¹¹ Military medical officers and some support staff went with the F Force but had little to offer against malaria other than what medications (largely oral quinine) they could beg or steal from the Japanese Imperial Army.¹² The medical personnel devised ingenious solutions to the many medical challenges under extreme stress, but these interventions paled in comparison to the cholera epidemics, chronic dysentery, respiratory infections, tropical skin ulcers, grossly inadequate diets, and physical abuse affecting the POW.⁵ Despite these great problems, the medical officers managed to keep some records, particularly those of soldiers' causes, dates, and place of death (Figure 1).^{5,9,10} These records were collected at the end of the war for use in the Tokyo War Crimes Tribunal and along with some officer's diaries from the original data of the mortality history reviewed to better appreciate the role of malaria-associated mortality during complex public health emergencies.^{1,5,10,13}

The malaria experience of the F Force was remarkably well documented, given the circumstances.¹⁴ A health officer (T. Wilson) and an entomologist (J. A. Reid) conducted a malaria microscopy and anopheles larval survey under utterly extreme conditions that can only be imagined when one considers that they carried their one microscope slung from a bamboo pole over 400 km of jungle track during the tropical monsoon in 1943 while under armed guard. They managed to test half

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FIGURE 1. Cover of the actual death register used by military medical officers to record deaths in F and H Forces while on the Thai-Burma railway in 1943-1945. From U.K. National Archives record WO361-2234. This figure appears in color at www.ajtmh.org.

($n = 3,400$) of the F Force scattered among five labor camps and one hospital along the railway.^{1,7,14} Field's rapid stain was apparently used for a single blood test per man and results reported as malaria species found on a short (25 high-powered fields as opposed to the standard 100) examination of a thick blood film. The few glass slides available had to be washed and reused; thus, there were no second or confirmation readings.

Before leaving Singapore, new malaria infections were 1.4/1,000 men/month over the 11 months through February 1943. Within months, nearly all men of F Force were infected primarily with *Plasmodium vivax*, which outnumbered *Plasmodium falciparum* 3:1; the ratio of vivax was even higher (6:1) for secondary attacks. Quick microscopy showed 28-69% positivity from 12 sites (median 54%) between May and December 1943.¹⁴ When the survivors of F Force ($n = 3,122$) returned to Singapore in December 1943, a blood survey showed 801 men with microscopically detected parasitemia (25.7%). It is likely that all the soldiers had some degree of infection as 2,942 separate malaria attacks were noted over the first 7 weeks back in Singapore.¹⁴ The influx of parasitemic individuals was sufficient to start a malaria epidemic during the previously safe Changi airport construction project.

Malaria treatment was just enough quinine to control symptoms due to the scarcity of all medications. Typical treatment consisted of 2 g of quinine daily for 10 days when stocks allowed such dosages. A few (unspecified number) cases of blackwater fever were observed. Many men had recrudescences or relapses with 1-2 attacks per month while in Thailand. Limited amounts of plasmoquin and atabrine (200 mg twice/week) were used to suppress symptoms in vital personnel, primarily medical and headquarters staff.¹⁴

Many soldiers of F Force died under the extreme conditions which were exacerbated by malaria. Most deaths were due to disease, particularly a cholera epidemic (637 deaths/1,300 cases), dysentery/diarrhea, skin ulcers (often severe enough to require amputation), and vitamin deficiency diseases (Figure 2).¹⁰ Typically, a series of adverse events would wear down a man's ability to endure the harsh conditions until a final event, usually an infection, killed him (Figure 3). Although malaria was a factor in most deaths, only 4.3% (132/3,087) of deaths were said to be primarily due to malaria, with another 6.7% (206/3,087) of deaths where it was a major contributing cause.¹⁴ Malaria mortality peaked 4 months (May 1943) after entry into the endemic area at about one death/day. Many but not all malaria deaths were confirmed by blood microscopy. Common lethal combinations with malaria included beriberi (thiamine deficiency), dysentery, and tropical skin ulcers.¹⁰

The disconnection between the vast number of malaria infections and few malaria deaths was noted at the time by the medical officers involved, who stated "these figures, which are relatively insignificant in comparison with the death roll for other diseases, tend to minimize unduly the importance of malaria as a contributory cause of death."¹⁴ This reflects the observation that soldiers died not from a single cause but from a combination of insults that sequentially eroded their chances of survival. Malaria was one of these corrosive factors along with stress, starvation, and other tropical infections.

Comparison of POW mortality on the Thai-Burma railway to other related groups is informative. The overall mortality of all Allied POW under the Japanese Imperial Army during the Second World War was close to 1:4.^{8,12,15} The total number of malaria deaths in POW captured in Singapore was estimated at 700.¹¹ Those POW who remained at Changi in Singapore had little malaria exposure and much less starvation; their mortality rates were therefore much lower around 1%.⁸ Asian laborers (most from Malayan plantations) who were also sent to the Thai-Burma railway were much less well documented, but estimates of their mortality are very close to that seen in F Force, 40% or 80,000/200,000.⁶ Civilian internees were generally better treated than POW, and their mortality rates varied from approximately 5% (Malaya, Singapore, Hong Kong, and the Philippines) to 12.8% in the Netherlands East Indies.⁸ Australian soldiers who were not POW had low malaria mortality rates (< 100 deaths during the entire war or case fatality rate < 1/1,000) despite very high malaria infection rates, indicating that even in isolated areas of New Guinea, good medical care was available once evacuation occurred.¹⁶ Modern examples include Indonesian transmigrants traveling from non-endemic Java to hyperendemic Papua. For unexplained reasons, the risk of severe malaria (7.5/100 person years) was much more common in Indonesian adults (2.8-fold higher CI: 2.1-3.8) than children living in the same place.¹⁷

FIGURE 2. Main causes of mortality in Australian and British soldiers (initial $n = 7,000$) in “F” Force working on the Thai-Burma railway in 1943–1944. (A) Diarrheal disease deaths (dysentery being bloody stools and diarrhea being free of gross blood) and combinations per month and (B) nutritional deficiency disease deaths (beriberi is thiamine deficiency) and combinations per month. Black bar shows malarial combinations. Note: B disease scale is one-quarter scale of A. This figure appears in color at www.ajtmh.org.

Fortunately, modern examples of traveler malaria deaths are uncommon and usually occur because of some failure of the medical system in either identifying or treating malaria.

Malaria-associated mortality is an important but difficult to measure entity because a major justification for malaria elimination programs is the disproportional decrease in overall mortality gained when malaria is removed from a population.³ This positive result of malaria elimination has a reverse side in what has been repeatedly observed when malaria resurges

after near elimination.¹⁸ The mortality disasters seen when naive adults are thrust into malaria-endemic areas as with F Force or when a malaria elimination program fails to prevent resurgence of an epidemic will remain a threat until global eradication is eventually achieved. Malaria-associated mortality is likely during complex public health emergencies in malaria-endemic areas.

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FIGURE 3. Monthly mortality from non-diarrheal infections in Australian and British soldiers (initial $n = 7,000$) in "F" Force working on the Thai–Burma railway in 1943–1944. (A) Malarial disease deaths and combinations and (B) other infectious disease deaths per month. Black bars are malarial disease deaths (probable malaria but not all were microscope confirmed). Disease deaths are one-tenth scale compared with all deaths. This figure appears in color at www.ajtmh.org.

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Note: See <https://jramc.bmj.com/content/89/4/149> for Table of POW mortality in F Force in 1943–1944 in Reference 10.

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