Blood Transfusions for Chronic Malaria Anemia in Prisoners of War on the Thai-Burma Railway 1943-5

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Abstract:

Allied Prisoners of War (POW) working on the Imperial Japanese Army's railroad from Thailand to Burma during 1943-5 devised a blood transfusion service to rescue severely ill fellow prisoners who were otherwise unlikely to survive the war. Extant transfusion records (1251 recipients, 1189 donors) in ledger books held by the UK National Archives at Kew were accessed and analysed. Survival to the end of the war in 1945 was determined from Commonwealth War Graves Commission records. The records examined indicate that freshly donated whole blood was manually defibrinated and transfused following cross matches based on POW medic sera. Overall survival to the end of the war was 74% of recipients and 88% of donors. Post-war survival rates were significantly higher for those with malaria (89.3%) than for other diagnoses in transfusion recipients: 52.6% for malnutrition, 59.3% for dysentery, 67.2% for skin ulcers, and 75.4% for other causes (odds ratio 3.97; 95% CI 2.79 - 5.28; P<0.0001). By 1945 the vast majority of blood transfusions were given for severe anemia caused by chronic relapsing vivax malaria. Although the POW situation was admittedly extreme, our data provide evidence that preventing chronic vivax relapses and the resulting severe anemia is associated with higher survival among patients with *Plasmodium vivax* than among those with other morbidities.

Key words: blood transfusion, military, prisoners of war, relapsing malaria, *Plasmodium vivax*

Malaria… indirectly it undoubtedly killed many, exercising its effects by producing anemia with consequent malnutrition of the tissues and also by lowering the resistance to other diseases. This effect of lowering immunity was clearly seen; if a patient with dysentery who was improving steadily developed a malarial relapse, the dysentery also would relapse.[1]

At least a quarter of the approximately 60,000 Allied soldiers captured after the fall of Singapore in 1942 and then forced to construct a railway from Thailand into Burma did not survive the war. Statistics vary depending on pre-capture health status, particular labour contingent assignment and exposure to tropical diseases, but all survivors had suffered from starvation, ill-treatment, and multiple infections particularly malaria.[2] Heroic medical care was provided under dismal conditions with very few supplies and drugs.[3] Most POWs were anemic with a median hemoglobin around 110 gm / l. One important resource the captured medical officers did have access to, however, was whole blood from their prisoner patients. They were able to perform cross-matching from men with known blood types and developed improvised methods of transfusion, including rigging transfusion apparatus from beer bottles and stethoscope tubing.[4] See figure 1. Nearly 3800 blood transfusions were performed in POW camps under sub-optimal conditions with few serious reactions or life-threatening infections despite the near universal presence of malaria parasites.[5] Extant records of this remarkable blood transfusion service were found in the UK National Archives in Kew and have been analyzed.[6] This brief report summarizes the survival outcomes of blood transfusions largely administered for anemia due to chronic relapsing malaria (*Plasmodium vivax*) and the implications for malaria elimination programs.[7]

Two original ledger books (UK National Archives reference numbers WO 347/27 and WO 347/30) of blood transfusion records in the Thai POW camps were located containing details of 1251 recipients and 1189 donors from August 1943 to September 1945, with 2198 documented transfusions in total.[6] This is estimated to be about one-third of all transfusions done during the war across several hospitals (Chungkai, Nakon Pathon). The data (name, rank, unit, service number, hospital ward, blood type, date) were entered into a database and matched by service number to the records of the Commonwealth War Graves Commission (www.cwgc.org) to determine which prisoners had survived until the end of the war in 1945. This work was the basis of a MSc project in Tropical Medicine and International Health from the London School of Hygiene and Tropical Medicine by the first author.[7]

Figure 2 is taken from Imperial Japanese Army figures obtained after the war and shows that the recorded number of POWs in the camps along the railway peaked at 50,000 in April 1943,and that mortality peaked at >2% per month as the construction phase was finishing in September 1943.[8] Blood transfusions by major disease group (malaria, dysentery, skin ulcer / malnutrition) is shown by month in Figure 3 from August 1943 to September 1945. Although initially the disease groups were roughly balanced, by the end of the war the vast majority of all blood transfusions were being given to anemic malarial prisoners. Criteria to be a donor was 130 gm / l hemoglobin and for a blood recipient a common rule was ≤ 90 gm / l which included about 10% of all POW.[4] Officers made up about 10% of the POW population and were 13% of all donors but only 3% of all recipients. Mortality post-blood transfusion to the end of the war varied by disease group being most favourable in malaria of whom 90% survived captivity until at least September 1945. The respective survival rates for those receiving blood whose main diagnosis was malnutrition, dysentery or skin ulcers were 53%, 58% and 69%. Some of this

relative survival deficit may be due to soldiers with multiple problems dying prior to the last year of the war, especially during the peak mortality period in mid-1943. Table 1 summarises the relative survival of transfusion recipients with a malaria diagnosis compared to those with any other diagnosis.

Gastrointestinal disease including cholera was the greatest killer in POW camps along the Thai-Burma railway but malaria made a substantial contribution including some cases of blackwater fever (massive hemolysis) requiring multiple blood transfusions and intravenous fluids/antimalarials.[9, 10] Six of the 48 POW (12%) with a documented diagnosis of blackwater fever died whereas 45 of the 420 total malaria patients (11%) died prior to the end of 1945.[7] Malaria-associated mortality was common where chronic anemia weakened soldiers who might then subsequently die from a variety of other conditions particularly dysentery as noted in the initial quotation. Quinine, which cannot prevent blood-stage relapses of *P. vivax*, was usually the only antimalarial drug available and mostly only enough for the suppression of symptoms such as fever. The ledgers also document administration of some other antimalarials including pamaquine and quinacrine, both of which are mentioned explicitly, or as "plasmaquin" and "atebrin", respectively, in first-hand accounts.[11, 12] Many POW reported multiple often nearly monthly relapses of vivax malaria which may reflect this relative under-dosing of quinine. After 1943 nearly all malaria was due to *P vivax* although it is not clear if these were recrudescences of inadequately cleared blood infections, true relapses from latent parasites in the liver, or a combination of both.[13] Blood transfusions were generally limited to anemic men whose survival was felt to be in doubt as there was limited capacity of the medical staff allowing only a few transfusions per day. Medical officers controlled access to the scarce resource of whole blood transfusions limiting them to those POW thought most likely to benefit. These POW medical

officers were convinced that blood transfusions saved lives and the numbers appear to support their view even if it is difficult to designate an adequate comparison group once overall mortality dropped to low levels in 1945.

Blood for transfusion was a key intervention carried by Allied medical rescue teams sent to POW camps at the end of the war in September 1945.[14] Yet there are contrasting data indicating that moderate anemia may actually be protective particularly against severe falciparum malaria.[15] One possible example of this from the Second World War was the extreme mortality (26%) of Japanese POW from Nauru who were brought to Bougainville for trans-shipment back to Japan.[16] They had escaped malaria on non-endemic Nauru but once they arrived in Bougainville, they suffered much greater mortality that other Japanese POW that had previously been infected with malaria. This seemed more than just lack of immunity and may indicate that there is a fine reduction-oxidation balance in the body that can be exceeded during severe malaria infections.[16]

Modern studies in Indonesia indicate that chronic vivax malaria is still lethal and often expressed as severe anemia.[17] Blood transfusions remain life-saving for children in Sub-Saharan Africa with severe anemia but the relationship to malaria is not a simple one with some degrees of transfusion being counter-productive.[18] The mortality due to vivax malaria can be subtle and may only be appreciated when malaria is completely eliminated from an area, and a drop in mortality usually ascribed to other infectious diseases such as pneumonia may be observed.[19] The POW camps of the Thai-Burma railway were an admittedly extreme example of men pushed to their physiological limits being rescued by transfusion. Blood transfusions were beneficial not only as a cure for anemia but also as a psychological boost of being ‘blood brothers’ with one’s comrades in shared suffering. Blood was a valuable and intensely personal gift that soldiers gave to help their fellow soldiers survive a terrible war.[20] The faded ledger books from Thailand note

the importance of blood transfusions as a symbol of hope that lives could be extended until that suffering was relieved by the end of the war. The current 'war' to eliminate the malaria parasite must continue until all transmission ceases in order to remove the enormous but often hidden anemia stress that chronically relapsing malaria places on marginalized tropical populations.[21]

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Table 1. Comparison of post-transfusion survival in 420 recipients with a malaria diagnosis compared to 769 recipients with other diagnoses.

	Survived (%)	Died (%)	All	Odds ratio (95% CI)	P value
Malaria Diagnosis	375 (89.3)	45 (10.7)	420	3.97 (95%CI 2.79 - 5.28;)	P<0.001
Other Diagnosis*	521 (67.8)	248 (32.2)	769		
Total	896	293	1189		

* Malaria may have been an unrecognized co-morbidity in some of the “other diagnosis” group.

Figure captions:

Figure 1: Photo of blood transfusion being given to POW in Nakon Pathon, Thailand in 1945. Australian War Memorial AWM photo 100970 copyright expired, now in the public domain.

Note to the editor: This is a poor-quality photo reproduction of a composite done at the time the prisoners had been recently released. It is the best available and I think despite the grainy appearance captures the primitive conditions under which most transfusions occurred and ask that it be included as an accurate record of what happened during a truly terrible episode of a war.

Figure 2: Total number of Allied (Australian, Dutch, UK, USA) Prisoners of War (POW) on the Thai-Burmese railway and all-cause mortality in POW as percent of total force per month. Data from Imperial Japanese Army post-war sources.[8]

Figure 3: Monthly blood transfusions conducted at the POW camp in Thailand 1943-5 as recorded in the contemporaneous log books noting the disease classification of the hospital ward of the recipient: malaria, dysentery / diarrhea, skin ulcer / malnutrition.[6, 7]

Figure 1:

Figure 2:

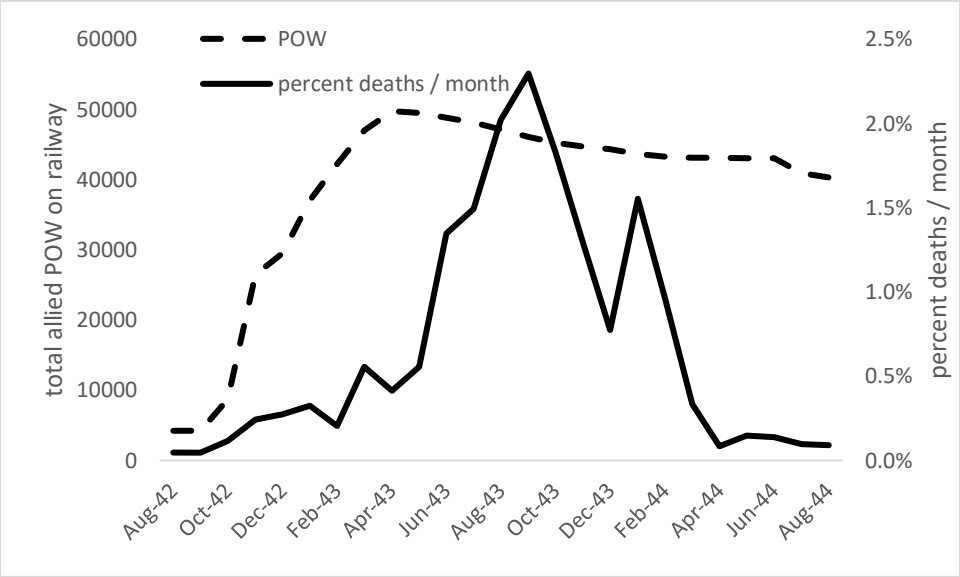
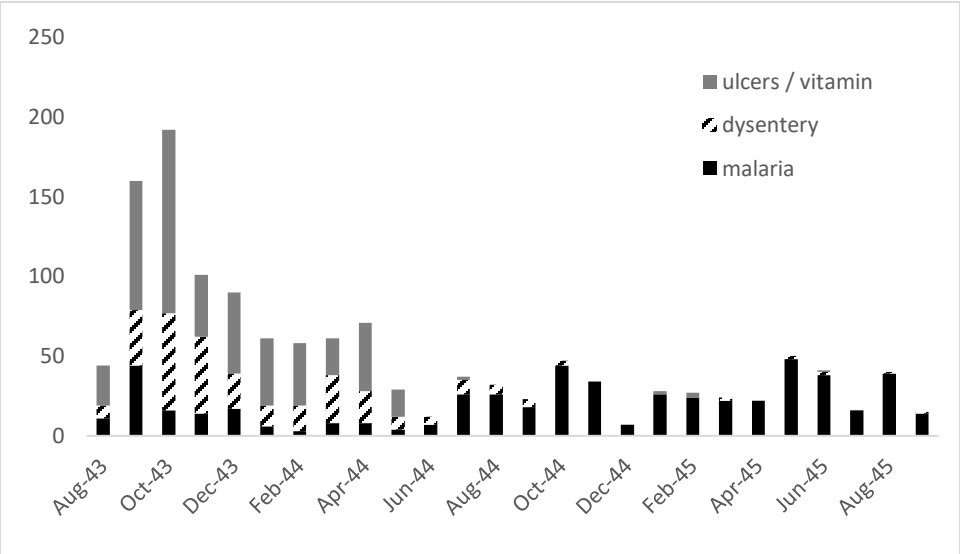

POW
percent deaths / month
total allied POW on railway
percent deaths / month
60000
50000
40000
30000
20000
10000
0
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
Aug-42
Oct-42
Dec-42
Feb-43
Apr-43
Jun-43
Aug-43
Oct-43
Dec-43
Feb-44
Apr-44
Jun-44
Aug-44

Figure 3:


250
200
150
100
50
0
ulcers / vitamin
dysentery
malaria
Aug-43
Oct-43
Dec-43
Feb-44
Apr-44
Jun-44
Aug-44
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Dec-44
Feb-45
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Jun-45
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