

## ORIGINAL ARTICLE

# Flight Lieutenant Peach's observations on Burning Feet Syndrome in Far Eastern Prisoners of War 1942–45

N.T. Rookroft<sup>1</sup>, E. Mayhew<sup>2</sup>, M. Parkes<sup>3</sup>, W.A. Frankland<sup>4</sup>, G.V. Gill<sup>5</sup>,  
D. Bouhassira<sup>6</sup> and A. S. C. Rice<sup>7</sup>

From the <sup>1</sup>Royal Navy General Duties Medical Officer, RFA ARGUS, UK, <sup>2</sup>Department of Bioengineering and Department of Surgery and Cancer, Imperial College, London, UK, <sup>3</sup>University of Liverpool, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, UK, <sup>4</sup>Consultant Allergist, 46 Devonshire Close, London W1G 7BG, UK, <sup>5</sup>Liverpool School of Tropical Medicine and University of Liverpool, United Kingdom and Consultant Physician, Aintree University Hospital, Liverpool, UK, <sup>6</sup>INSERM U-987, Centre d'Evaluation et de Traitement de la Douleur, Hôpital Ambroise Paré, APHP, Boulogne-Billancourt, France and <sup>7</sup>Department of Surgery and Cancer, Imperial College, London, United Kingdom and Chelsea and Westminster Hospital NHS Foundation Trust, London, UK

Address correspondence to Nathaniel Rookroft, Medical Officer, RFA ARGUS, BFPO 433, UK. email nrookroft@gmail.com

## Summary

**Introduction:** 'Burning Feet Syndrome' affected up to one third of Far Eastern Prisoners of War in World War 2. Recently discovered medical records, produced by RAF Medical Officer Nowell Peach whilst in captivity, are the first to detail neurological examinations of patients with this condition.

**Methods:** The 54 sets of case notes produced at the time were analysed using modern diagnostic criteria to determine if the syndrome can be retrospectively classed as neuropathic pain.

**Results:** With a history of severe malnutrition raising the possibility of a peripheral polyneuropathy, and a neuroanatomically plausible pain distribution, this analysis showed that Burning Feet Syndrome can now be described as a 'possible' neuropathic pain syndrome.

**Conclusion:** After 70 years, the data painstakingly gathered under the worst of circumstances have proved to be of interest and value in modern diagnostics of neuropathic pain.

## Introduction

In the Asia-Pacific theatre of World War II, an estimated 132 000 Allied military personnel were captured by Japanese forces and incarcerated as Far East Prisoners of War (FEPOW).<sup>1</sup> The mortality rate of European and Australian FEPOW was ~27%, seven

times that of Allied POW held by the Germans.<sup>2</sup> Morbidity and mortality were high amongst FEPOW as a result of arduous physical labour in the adverse environment of tropical jungle, compounded by a policy of brutality, starvation, neglect, and consequent disease. This maltreatment occurred throughout

Received: 7 August 2016; Revised (in revised form): 24 August 2016

© The Author 2016. Published by Oxford University Press on behalf of the Association of Physicians.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact [journals.permissions@oup.com](mailto:journals.permissions@oup.com)

the region and was inflicted on civilian and military detainees alike, with the building of the notorious 'Death Railway' between Thailand and Burma (Siam) being one of the best known events. Whilst the majority of prisoners were local Asian civilians, the plight of British, Australian and Dutch military captives has been recorded in most detail, most of whom were captured during the 1941–2 South East Asia campaigns which culminated in the surrender of Singapore.

The focus of this historical review is 'Burning Feet Syndrome' (BFS), which afflicted between 10 and 33% of prisoners.<sup>3</sup> Although retrospective accounts of BFS were published by surviving FEPOW medical officers in the immediate post-war period,<sup>4,7</sup> these were largely based on the authors' post-captivity recollections as no contemporaneous medical records of individual cases were thought to have survived. This situation changed in 2007 when the late Nowell Peach was interviewed as part of the Liverpool School of Tropical Medicine FEPOW oral history study.<sup>1,8</sup> He revealed the existence of a series of case notes recording 54 cases of BFS, including detailed symptom descriptions and neurological examinations, which he had recorded whilst in captivity in Java. This review is primarily an analysis of the data in Peach's case records, in particular it reassesses its neuropathic pain aspects using 21st century diagnostic criteria for painful peripheral neuropathy.

## Hardship and malnutrition

Following capture, FEPOW were distributed to camps across Asia, where unlike POW in other theatres who were protected by the Geneva conventions, 'humiliation, gross under-feeding, and savage regimentation were the daily routine'.<sup>5</sup>

The Australian medical officer Sir Edward 'Weary' Dunlop wrote of his experiences, indicating that 'only those who were present can comprehend the seeming hopelessness of it as their bodies wasted and their friends died'. The combination of extreme malnutrition, poor sanitation, a hostile jungle environment, and the high physical workload provided conditions in which diseases were rife. Dunlop characterized the battle against sickness as a 'new war', 'for physical and moral survival'.<sup>9</sup>

The combined effects of deliberate neglect by their captors, and imprisonment in remote areas at the end of supply lines led to severe multifactorial malnutrition. The diet was almost entirely rice-based; grossly deficient in proteins, fats and vitamins, especially of the B-complex.<sup>5,7,10</sup> Medical officers repeatedly raised the issue with the Japanese authorities, and despite their admission that rations were insufficient, little heed was paid to requests.<sup>7</sup> Vitamins were seen by their captors as inessential 'luxuries'.<sup>5</sup>

Clinical avitaminosis was anticipated but took around 4 months for signs to appear across the camps.<sup>7</sup> Dunlop reported that the dermatological condition pellagra was the most common disorder, and beriberi occurred in all forms, yet scurvy and vitamin A deficiency were uncommon.<sup>5</sup> In conversation in September 2015, Frankland however recalled only two cases of pellagra in his three and half years of captivity, although he was held in a camp where vegetables were grown for much of this time. From around July 1942 Allied medical officers found FEPOW presenting with a new and unique set of BFS symptoms, which appeared to differ from recognised and more common nutritional disorders.

## Burning feet syndrome

BFS had been described in situations of malnutrition since 1826<sup>11</sup>. Known to FEPOW by a variety of colloquial names including 'happy feet'<sup>6</sup> and 'electric feet',<sup>10</sup> the term BFS generally only started to appear in post-war medical literature. Hitherto, BFS had received sporadic attention, generally viewed as an 'obscure tropical affliction consigned to a few lines of small print in tropical disease texts'.<sup>3</sup>

Referring to the burden of illness in FEPOW, Simpson wrote that 'diseases were so gross and numerous in a single individual that the picture of a single malady was hopelessly confused'.<sup>7</sup> However, a clear picture of BFS is presented in the various post-war accounts, which are remarkably consistent when it is considered that camps were located across Asia and written by doctors with little to no communication with each other, or with those in the outside world. Dunlop gave a succinct symptomatic description of BFS as an 'intense burning of the feet and an exquisite sensitiveness which scarcely enables them to walk, and they cannot sleep or get any rest'.<sup>5</sup>

Usually occurring 3–5 months after capture, and often following a debilitating bout of infection such as dysentery or malaria,<sup>4</sup> the condition usually started with a dull ache in the feet, specifically over the metatarsal region, and progressed to a 'severe burning sensation' and hyperaesthesia.<sup>6</sup> This was followed by a more severe, but intermittent, 'sharp' or 'shooting' type pain, 'like toothache'<sup>12</sup> which radiated into the heels and sometimes up the shins.<sup>4</sup> The pains were always distal and symmetrical in distribution and a small minority of cases (6.4%) reported tingling or numbness in their hands.<sup>4,7</sup>

Glusman commented that the sensory gain phenomena of plantar hyperesthesia and hyperalgesia were universal 'in all but the earliest and mildest cases'<sup>3</sup> and Cruickshank recorded hypersensitivity to pinprick and light touch in about 22.2%.<sup>4</sup> There are multiple accounts describing how patients would often be found 'shifting their position from one foot to the other' when standing, 'usually wincing with pain as each foot touches the ground'.<sup>6</sup>

Simpson described how the hyperaesthesia was 'superficial in some cases, but usually deep muscle tenderness'. With progression, the hyperaesthesia 'tended to be replaced by hypoaesthesia', often with a patchy distribution of the two.<sup>7</sup>

Apart from occasional excessive sweating,<sup>4,5</sup> accounts generally described no changes in the appearance or circulation to the feet when compared with controls. Preservation of tendon reflexes was the rule; however there were differences between reports, with some finding an increase in deep reflexes.<sup>4,7,12</sup>

As is the case for many painful neuropathies, pain was particularly troublesome at night and often associated with insomnia.<sup>10</sup> Patients were described as sitting in a squatting position, gripping their toes and massaging their feet 'for hours on end'.<sup>4,6</sup> During the day, some men reported being comparatively free from pain.<sup>7</sup> Relief was sought by some through immersing the feet in buckets of water, whilst others reported that walking helped. These men would often walk a 'long nocturnal vigil' to minimize the pain, with a characteristic gait 'reminiscent of a man with bad corns'.<sup>7</sup>

## Cause of BFS

No longer an 'obscure tropical affliction', BFS was becoming a significant health problem in POW camps across the region. Simpson, who found up to 300 of between 1500 and 2000 men affected, wrote how 'in the average case of this syndrome, the

malady dominated the whole man's life<sup>7</sup>. Large numbers of BFS patients were found also found by Cruickshank in Singapore<sup>12</sup> and Page in Hong Kong and the Philippines.<sup>6</sup> Others reported a much lower prevalence: in 551 cases of dietary associated scrotal dermatitis seen in Changi camp in Singapore, Frankland, noted only six cases with painful feet.<sup>13</sup> In 1943 he relocated to a camp at Blakang Mati (an island off Singapore, now called Sentosa), and in personal communication (September 2015) he recalls few cases of burning feet or scrotal dermatitis, perhaps attributable to FEPOW being allowed to grow their own vegetables.

Although most medical officers had not experienced BFS previously, its presentation as a painful dysaesthetic polyneuropathy was described 'remarkably consistently by different authors', often in distinct terms from the peripheral paraesthesiae of thiamine deficient beri-beri.<sup>10,12,14</sup> Ascribing a single aetiology for BFS in FEPOW suffering from severe starvation, multiple avitaminoses, and co-existing tropical infections was difficult, and no overall consensus exists. Nevertheless, most doctors reached the conclusion that the poor diet, resulting in a specific B-vitamin deficiency, was to blame, largely because BFS often presented alongside signs of other B-vitamin deficiency diseases which were well recognised by the doctors. Glusman recorded 58% of BFS patients had an associated vitamin deficiency, reporting an 'invariable' association with malnutrition.<sup>3</sup>

Simpson noticed other factors which supported this view. The condition was less common in officers who possessed money and could supplement their diet with eggs and Kacang Hijau beans.<sup>7</sup> Page and Glusman both noted that in groups of FEPOW who received barley in addition to their rice ration, there was a 'paucity of new patients, and a low rate of relapse'.<sup>3,6</sup>

When compared with the other doctors who wrote about BFS, Cruickshank recognised the condition because he was aware of a study by Landor and Pallister in 1935, in which inmates in Malayan jails suffering from BFS reported resolution of symptoms once Marmite (a yeast extract) and autoclaved yeast, rich in the heat stable factors of the vitamin B-complex, were added to their diet.<sup>4,15</sup>

Once the link to dietary deficiency had been made, the next obstacle was to determine the exact cause. But with scarce resources, and other nutritional deficiencies requiring treatment, rigorous trials of individual vitamins proved challenging.

## Research

Archibald Cochrane had conducted his first successful controlled trial in a POW camp at Salonika, Greece, when he demonstrated that prisoners with wet beri-beri given B-vitamins in the form of yeast reported symptomatic improvement.<sup>16</sup> Rudimentary trials of therapy with individual B-vitamins for BFS were attempted in the Far East.

Parenterally or intrathecally administered Thiamine (B<sub>1</sub>) was investigated to ascertain its effect in the treatment of BFS, although because of limited supplies the doses were probably subtherapeutic.<sup>4,6</sup> The limited thiamine available was prioritized for cases of 'frank beriberi' because of the prevailing belief of effectiveness. However, in six cases of BFS treated by Cruickshank there was no recorded improvement,<sup>4</sup> and Glusman found it 'not effective'.<sup>3</sup>

Nicotinic acid (B<sub>3</sub>) was tried and whilst effective at treating pellagra, which regularly coexisted, appeared ineffective for BFS.<sup>3</sup> However, Cruickshank reported that 98/119 patients treated with intravenous Nicotinic acid for 5–10 consecutive days showed at least some improvement.<sup>4</sup> Churchill and

Frankland both reported similar findings in a small number of cases.<sup>10,13</sup>

A paper from India reported that pantothenic acid (B<sub>5</sub>) rapidly cured 53 patients of BFS.<sup>17</sup> However, a 1957 clinical trial conducted in a rural community in Ceylon (Sri Lanka) found no benefit from pantothenic acid in BFS.<sup>18</sup>

## Treatment and prognosis

Treatment of BFS varied and depended largely on the meagre resources available in individual POW camps. In general, when permitted by the Japanese Army, patients avoided duties involving standing or walking. In severe cases bedrest was advised, however the temporary symptomatic relief afforded by walking, especially at night, made this difficult to enforce. When the Japanese started to relocate many POW to labour camps after 1943 follow up of patients became impossible.

Once the link to B-vitamins was made, sources such as rice-polishings, soya beans, and green leaves were used to supplement diets when possible.<sup>4</sup> If appropriate nutrition could be provided, prognosis of BFS was good. By July 1943, after an improvement in diet in Cruickshank's camp at Changi (Singapore), the disease had almost disappeared.<sup>4</sup> In his series of 27 cases however, Churchill reported that oral administration of Marmite and nicotinic acid were not associated with symptomatic improvement, but in 'milder cases rice-polishings seemed to be effective'.<sup>10</sup> Simpson reported that a daily administration of Kacang Hijau beans (a legume used extensively in the Far East) improved symptoms in 4–6 weeks,<sup>7</sup> and that after a week or two of general dietary supplementation with these beans no further new cases of BFS developed.

After liberation in 1945 symptoms of nutritional neuropathies soon resolved in most FEPOW; however, BFS symptoms were reported to persist in a small group of patients after repatriation despite resumption of an adequate diet.<sup>4</sup> A 1982 follow-up study investigated the health of 898 surviving FEPOW.<sup>14</sup> Of these, 49 (5.5%) were classified as having a persistent nutritional neuropathy attributable to their FEPOW period. A further 38 (4.2%), had possible signs of asymptomatic nutritional neurological damage. Twenty-four of the 49 patients had a peripheral neuropathy, of whom 11 (1.2%) had symptoms consistent with persisting BFS. Of the 24 patients, the neuropathy was mainly sensory in 8, motor in 6 and mixed in 10, with the lower rather than upper limbs usually affected. Tricyclic antidepressants were tried as a therapeutic intervention, and 'sometimes relieved the pain, at least partly'.<sup>1</sup> Table 1 shows two examples of cases which illustrate these presentations.<sup>14</sup>

## Nowell Peach

Several retrospective accounts of BFS were published in the immediate post-war period, and whilst detailing with remarkable consistency the clinical presentation of BFS, the conditions of captivity meant the authors were unable to support these accounts with contemporaneous documentation or medical record.<sup>9</sup> Even when records were made, the lack of cooperation from the Japanese Authorities meant it was unlikely that they would survive captivity. Glusman recorded detailed neurological examinations but his original case records were destroyed.<sup>3</sup>

However, there was one exception. Flight Lieutenant Nowell Peach was a medical officer serving with the Royal Air Force Volunteer Reserve who had been taken prisoner in Java at the end of February 1942.<sup>8</sup> He recorded detailed clinical notes on a form, including neurological examination, of 54 FEPOW

**Table 1.** Two cases of persistent symptomatic nutritional neurological neuropathies in FEPOW followed up in 1982 and published in the *Journal of Neurology, Neurosurgery, and Psychiatry* by Gill and Bell

Case One	This 62-year-old man was assessed 35 years after release, in 1980. He was interned in Java and the Celebes where he suffered malaria, dysentery, wet beriberi and paraesthesiae of the legs with loss of sensation of ground contact. His vision was also blurred. He regained good health on release, but paraesthesiae of his feet continued. When examined at Liverpool he had reduced pain and temperature sensation bilaterally, to mid-thigh level. Nerve conduction studies confirmed a 'patchy peripheral nerve lesion consistent with nutritional neuropathy'.
Case Two	A 57-year-old ex-FEPOW was seen in 1975. He had been interned in Rangoon during the war, had suffered chronic dysentery, and lost 32 kg in weight. He developed paraesthesiae peripherally, burning of the hands and legs, unsteadiness in the dark, deafness and poor vision. After the war his symptoms gradually improved, but paraesthesiae, unsteadiness and burning feet persisted. He was regularly kept awake at night by the pains in his feet, and he would walk around the house to gain relief. Examination revealed marked signs of a sensory neuropathy in the legs, as well as evidence of posterior column loss.

<u>Complaint:</u> Burning under metatarsal hands & heels, and shooting pains in feet. Pins & needles in fingers. Describes the pain in feet as being like that after freezing. Standing in cold floor makes worse. Eased by pouring on cold water.		
<u>Duration:</u> 14 months.	<u>Intensity:</u> Medium.	<u>Progress:</u> Improving.
<u>Other Deficiency Signs:</u>		
<u>IPS</u> -	<u>Scrotum</u> -	<u>Loss of Weight</u> -
<u>Onyria</u> -	<u>Nails</u> -	<u>Eyes</u> Vision lost. Now 5/10. No optic atrophy.
<u>MS</u> -	<u>Mucosal</u> -	<u>Aesthesia</u> +
<u>Orch</u> -	<u>Pigment</u> Forehead of face.	<u>Paresis</u> +
<u>Throat</u> -	<u>Anaemia</u> -	<u>Giddiness</u> -
	<u>Oedema</u> -	
	<u>Hand</u> slightly.	
<u>M.H. Malaria</u> + 3. (1 Type)	<u>V.D.</u> -	<u>Others</u> -
<u>Dysentery</u> Bacillary.	<u>Dysuria</u> +	<u>Smoking</u> Nil.
<u>Appetite:</u> Good.	<u>Indigestion:</u> Nil.	<u>Stools:</u> N.
<u>Diet:</u> Rice Full Ration.	<u>Extras</u> 5/2.	Milk. Meat. Yeast. Fruit.
<u>Feet (Condition)</u>		
<u>Deformity:</u> Nil.	<u>Skin:</u> - N.	
<u>Vascularity:</u> N.	<u>Sweating:</u> N.	
<u>Pulse, Ant. Tib. Pulp.</u>		
<u>Sensory System</u>		
<u>ANAESTHESIA</u> (Pin Prick: Hypaesthesia in sole like of sole. Otherwise N.)	<u>PARAESTHESIA</u> (Superficial: Nil.)	
(Stroke : N.)	(Deep: Nil.)	
(Pressure : N.)		
<u>Motor System:</u>		
<u>KJ:</u> -	<u>CNS</u>	
<u>AJ:</u> -	<u>Plantar:</u> N.	
<u>Wasting:</u> Nil now. Was + at	<u>Rhomberg:</u> N.	
<u>Paresis:</u> Gait normal now, was off legs.	<u>Pupil:</u> N.	
	<u>Hystagmus:</u> N.	
<u>Cardiovascular Pulse:</u> (Rate: 72.)	<u>Heart.</u> (Size: N.)	
(Rhythm: Reg.)	(Sounds: N.)	
(Tension: N.)	<u>Exercise Tolerance:</u> Good.	
<u>Femoral Artery:</u> No tones		

**Figure 1.** An example of a case record written by Nowell Peach as a FEPOW in 1942. The complaint reads, 'Constant ache in distal part of foot, with intermittent pain of a shooting nature. Any change of occupation gives temporary relief from the shooting pain, which came on again after about an hour in any one position. No superficial burning. Shooting pain is "like a dentist touching a nerve"'.

presenting with BFS at Tandjong Priok camp (Jakarta, Indonesia) between November 1942 and March 1943.

Figures 1-3 show three examples of these unique records, which he managed to secrete from the Japanese. Peach survived the war and became a General Practitioner Surgeon. He revealed

the existence of the original notes when interviewed by the FEPOW oral history project half a century later. The history and some medical aspects of these records have been reviewed before;<sup>12</sup> here we analyse the pain and related symptoms and signs which Peach reported.

<u>Complaint</u> Constant ache in distal part of foot, with intermittent pain of a shooting nature. Any change of occupation gives temporary relief from the shooting pain, which came on again after about an hour in any one position. No superficial burning. Shooting pain is "like dentist touching a nerve".		
<u>Duration:</u> 6 weeks.	<u>Intensity:</u> Severe at times.	<u>Progress:</u> Stationary.
<u>Other Deficiency Signs:</u>		
<u>Lips.</u> } N.	<u>Scrotum.</u> Eczema 6 months.	<u>Testes.</u> +.
<u>Tongue.</u> }	<u>Nails.</u> N.	<u>Eyes.</u> N.
<u>Gums.</u> }	<u>Mucolabial.</u> N.	<u>Asthenia.</u> N.
<u>Mouth.</u> }	<u>Pigment.</u> Nil	<u>Paresis.</u> N.
<u>Throat.</u> }	<u>Anaemia.</u> Nil	<u>Giddiness.</u> N.
	<u>Oedema.</u> Nil	
<u>P.H.</u> Malaria -	<u>V.D.</u> -	<u>Others.</u> Dyspepsia -
Dysentery -	<u>Dengue</u> "Woo" 15/day until 1/2 ago	probably because identical
<u>Appetite:</u> Poor.	<u>Indigestion:</u> +	<u>Stools:</u> N.
<u>Diet:</u> Rice 1/2 Ration.	<u>Extras</u> Extra Stews ration. Eggs 2/week until 2 months ago	
<u>Feet (Condition)</u>		
<u>Deformity</u> Nil	<u>Skin</u> N.	
<u>Vascularity</u> Nil	<u>Sweating</u> N.	
<u>PULSE (ANTI TIB.)</u> Nil. P.A.P.		
<u>Sensory System</u>		
<u>ANAESTHESIA</u> ( Pin Prick. Nil )	} Parasthesia.	<u>PARAESTHESIA</u> Superficial. Dorsal to Metatarsal heads.
( Stroke. Nil )		Deep. N.
( Pressure. Nil )		
<u>Motor System.</u>		
KJ N	<u>CNS</u> Plantar N.	
AJ N	Rhomberg N.	
Wasting N	Pupil N.	
Paresis N	Nystagmus N.	
<u>Cardiovascular.</u>		
( Rate. 112.	<u>Heart</u> Size. N.	
( Rhythm. R.	Sounds. N.	
( Tension. N.	<u>Exercise Tolerance.</u> N.	

Figure 2. An example of a case record written by Nowell Peach as a FEPOW in 1942. The complaint reads, 'Burning under metatarsal heads and heels, and shooting pains in feet. Pins and needles in fingers.'

Peach's records comprise cases seen between late 1942 and early 1943 which coincided with the period when 'clearest and least complicated picture' of BFS was seen.<sup>5</sup> BFS was first recognised in July 1942, the incidence increased over the summer and had become widespread by October 1942. However, from 1943 there was a generalised movement of FEPOW to provide slave labour for the large scale construction projects such as the railways. Simpson explained that during 'this hectic, hopeless period, it was impossible to follow up in detail the fate of these cases'. After the completion of these projects in 1944/45, the survivors were 'fed better and worked for shorter periods', and knowledge of the prophylactic value of diet prevented further cases of BFS.<sup>7</sup>

In order to elucidate BFS, we have analysed 53 of Peach's case files (one being omitted due to illegibility). The patients had a mean age of 29 years (range 20–41) and had experienced symptoms for a mean of 13 weeks (range 2–56). Forty-seven (89%) patients reported pain intensity categorized as 'moderate' or 'severe'. Peach later recorded that 26 (49%) of cases were 'improving' with only 5 (9%) progressing.

Appetite was recorded as 'normal' in 34 (64%) patients, with the same number being given a full ration; 25 (47%) were receiving extra food, including milk and fruit. The documentation of

appetite, ration and additional nutrition, alongside the clinical picture, demonstrate that Peach recognized the link between nutrition and BFS. He notes in three case files that the condition had improved after dietary supplementation with eggs and soya beans.

Thirty-one (58%) cases were recorded as having weight loss, and other features of nutritional deficiency were often recorded in many patients, the most frequent being those in the lips, scrotum, tongue and eyes, matching the reports from other camps. A history of tropical infection was frequently found in BFS cases with 13 (25%) recording malaria, 24 (45%) dengue fever and 23 (43%) dysentery. Peach noted that in six (11%) cases the presentation of BFS coincided with an infection.

## Symptoms and physical examination

Peach wrote a brief symptom descriptor summary for each case. These are 'free text', and thus do not constitute the current systematic approach of recording neuropathic pain descriptors.<sup>19–21</sup> Nevertheless, these descriptors do afford insight into the symptoms reported by FEPOW patients with BFS and are similar to those described in other reports (Table 2).

<u>Complaint:</u> <i>Burning of soles &amp; aching in toes. Continual. Worse at night. Not relieved by walking. Feels as though he has tight boots on.</i>		
<u>Duration:</u> <i>2 months.</i>	<u>Intensity:</u> <i>Severe.</i>	<u>Progress:</u> <i>Progressing.</i>
<u>Other Deficiency Signs:</u>		
<u>Lips:</u> <i>Perfèche.</i>	<u>Oedema:</u> -	<u>Eyes:</u> -
<u>Tongue:</u> <i>Marginal glossitis</i>	<u>Scrotum:</u> -	<u>Asthemia:</u> +.
<u>Mouth:</u> +	<u>Nails:</u> -	<u>Paresis:</u> -
<u>Gums:</u> <i>N. -</i>	<u>Nasolabial:</u> -	<u>Giddiness:</u> -
<u>Throat:</u> <i>N. -</i>	<u>Pigment:</u> -	<u>Loss of Weight:</u> <i>&gt;1 stone.</i>
<u>P.H.</u> <i>Malaria + 8 times.</i>	<u>V.D.</u> -	<u>Others.</u> -
<i>Dysentery. -</i>	<i>Dengue. 10/12 ago.</i>	<i>Smoking. V. mod.</i>
<u>Appetite:</u> <i>good.</i>	<u>Indigestion:</u> -	<u>Stools:</u> <i>N.</i>
<u>Diet.</u> <i>Rice. Full ration.</i>	<u>Extras.</u> <i>Egg 3 times a week.</i>	
<u>Feet (Condition)</u>		
<u>Deformity:</u> <i>? 1st flattening.</i>	<u>Skin:</u> <i>N.</i>	
<u>Vascularity:</u> <i>N.</i>	<u>Sweating:</u> <i>N.</i>	
<u>Pulse.</u> <i>Ant. Tib. N.</i>		
<u>Sensory System:</u>		
<u>ANESTHESIA</u> ( <u>Pin Prick:</u> <i>not felt in border base of legs, + wrist</i> )	<u>PARAESTHESIA</u> ( <u>Stroke:</u> <i>? sacral area.</i> )	<u>Superficial</u> <i>N.</i>
( <u>Pressure:</u> <i>N.</i> )		<u>Deep</u> <i>Calves.</i>
<u>Motor System</u>		
<u>KJ:</u> <i>N.</i>	<u>CNS</u>	
<u>AJ:</u> <i>N.</i>	<u>Plantar:</u> <i>N.</i>	
<u>Wasting:</u> <i>? calves.</i>	<u>Rhomberg:</u> <i>N.</i>	
<u>Paresis:</u> -	<u>Pupil:</u> <i>N.</i>	
	<u>Nystagmus:</u> <i>N.</i>	
<u>Cardiovascular, Pulse:</u> ( <u>Rate:</u> <i>84</i> )		
	( <u>Rhythm:</u> <i>R.</i> )	<u>Heart:</u> ( <u>Size:</u> <i>N.</i> )
	( <u>Tension:</u> <i>Low.</i> )	( <u>Sounds:</u> <i>N.</i> )
<u>Femoral Artery:</u> <i>N.</i>		<u>Exercise Tolerance:</u> <i>N.</i>

Figure 3. An example of a case record written by Nowell Peach as a FEPOW in 1942. The complaint reads, 'Burning of soles and aching in toes. Continual. Worse at night. Not relieved by walking. Feels as though he has tight boots on'.

Table 2. Table showing frequency of symptom descriptors in case records recorded by Nowell Peach in FEPOW

Location of pain	Feet	47 (89%)
	Metatarsals	20 (38%)
	Legs	19 (26%)
	Toes	13 (25%)
	Hands	7 (13%)
Character of pain	Shooting	38 (72%)
	Aching	37 (70%)
	Burning	30 (57%)
	During night	8 (15%)
Pain worsens	With stillness or prolonged standing	3 (6%)
	With walking	10 (19%)
Pain improves	Being preoccupied with work	3 (6%)
	Immersing feet in cold water	2 (4%)

Results are recorded in absolute number and in brackets as a percentage.

A unique aspect of Peach's files was a brief neurological examination, of which the frequency of neurological signs is recorded in Table 3. He assessed tendon reflexes using a tendon hammer made for him by Army engineers (Figure 4). The solitary example of hyperaesthesia recorded was found on the soles

and the tips of the fingers and toe, and presented alongside reduced sensation in the legs.

## Neuropathic pain

Although these FEPOW may have also suffered feet pain from another origin (e.g. osteoarthritis), this is unlikely to have been the case in most patients, and based on the description and location it might be thought intuitively that the pain reported in BFS was strongly suggestive of neuropathic pain. We scrutinised Peach's records to ascertain to what extent this would be the case when judged by current diagnostic criteria (Figure 5).<sup>22</sup> Neuropathic pain is defined by the International Association for the Study of Pain as 'pain caused by a lesion or disease of the somatosensory system'.<sup>23</sup> In practice, applying this definition essentially revolves around two questions: first, whether there is a lesion or disease of the somatosensory system? Second, is the pain neuropathic? The second question is often addressed by determining whether the pain is located in a neuroanatomically plausible location and by the presence of certain symptom descriptors known to be associated with neuropathic pain. To augment the clinical utility of the grading system it follows the

pattern of a conventional clinical consultation. Herein we have attempted, for the first time, to apply this grading system in a historical context.

For 'possible' neuropathic pain there is a requirement for: (i) A history of relevant neurological lesion or disease and (ii) The pain distribution is neuroanatomically plausible. The history of severe malnutrition clearly raises the possibility of a relevant neurological disease in the form of a peripheral polyneuropathy, particularly given the distal symmetrical pattern of symptoms implicit in Peach's files. The grading system also permits the use of symptom descriptors which, whilst not pathognomonic for neuropathic pain, are strongly associated with it. A range of questionnaires have been designed and validated for this purpose.<sup>20,21</sup> The Neuropathic Pain Symptom Inventory (NPSI) is a symptom inventory which evaluates the presence and severity of 10 different neuropathic pain descriptors.<sup>19</sup> Although it is not possible to fully utilise any of these instruments retrospectively because not all the required questions were asked or quantified by Peach, it is possible to ask to what extent the symptom descriptors recorded by Peach also feature in the NPSI or the DN4 pain questionnaire. 52/53 (98%) of Peach's files document either 'pain' or 'ache' and 49 (92%) had at least one of the DN4 descriptors of 'burning' or 'electric shock' recorded. Peach recorded most frequently the NPSI descriptors

**Table 3.** Table showing frequency of neurological signs in 53 case records recorded by Nowell Peach in FEPOW

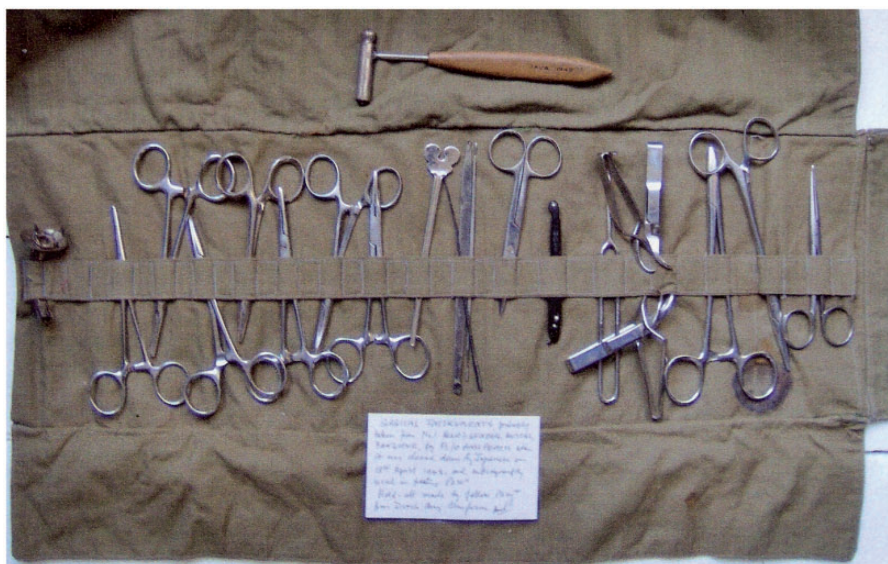
Sensation	Anaesthesia to pin prick	8 (15%)
	Anaesthesia to light touch	5 (9)
	Anaesthesia to pressure	3 (6%)
	Hyperaesthesia	1 (2%)
Motor	Weakness	6 (12%)
	Hyperreflexia knee reflex	4 (8%)
	Hyporeflexia knee reflex	9 (17%)
	Hyperreflexia ankle reflex	1 (2%)
	Hyporeflexia ankle reflex	14 (26%)

Results are recorded in absolute number and in brackets as a percentage.

of 'shooting' in 38 (72%) of patients, 'aching' in 37 (70%) and 'burning' in 30 (57%). According to the validation paper for the NPSI,<sup>19</sup> the symptom quality of 'burning' is reported by 70% of patients with neuropathic pain and symptoms similar to 'shooting' ('stabbing' or 'electric shocks') in ~60%; with 'aching' not included due to it being frequently described in other types of pain. 'Burning' or 'shooting' (or similar) also feature in all five of the major diagnostic symptom questionnaires for neuropathic pain.<sup>20</sup> Four reports of BFS in FEPOWs all described patients suffering 'burning' and 'shooting pain'; e.g. Cruickshank documented 58.6% of the 500 cases he assessed reported 'sharp', 'shooting' pain.<sup>3,4,6,7</sup> The pain symptom descriptors which feature in Peach's and other accounts are also prominent in modern day profiles of patients with painful neuropathies including HIV-associated sensory neuropathy<sup>24</sup> and diabetic neuropathy, which has been reported as 'distal, symmetrical, often associated with nocturnal exacerbations, and commonly described as pricking, deep aching, sharp like an electric shock, and burning'<sup>25</sup>; corresponding with the descriptions given of BFS.

For a grading of 'probable' neuropathic pain there is an additional requirement relating to sensory examination: 'sensory signs in the same neuroanatomically plausible distribution as pain'.<sup>22</sup> In Peach's report 37 (70%) patients had 'pain' recorded as a symptom descriptor of whom only 6 (16%) had sensory abnormalities revealed by his physical examination. A total of 16 (30%) patients had both pain and paraesthesiae recorded of whom 10 (62.5%) of those had sensory abnormalities recorded. It might be reasonably expected that a higher proportion of these patients might have had detectable abnormalities in sensation. However, Peach was not a trained neurologist and was conducting his examinations in adverse conditions with improvised instruments. For a grading of 'definite' neuropathic pain a diagnostic test confirming a lesion or disease of the somatosensory system is required- clearly beyond what was feasible in captivity.

The recent NeuPSIG criteria were developed to exclude cases without evidence of a neurological lesion from clinical examination or laboratory test, and this situation is found in many clinical conditions (i.e. small fiber neuropathies, radiculopathies),



**Figure 4.** Surgical instruments used by FEPOW in captivity, including Nowell Peach's homemade tendon hammer inscribed with 'Java 1942'. We are most grateful to Nowell peach's family for allowing us to use this image.

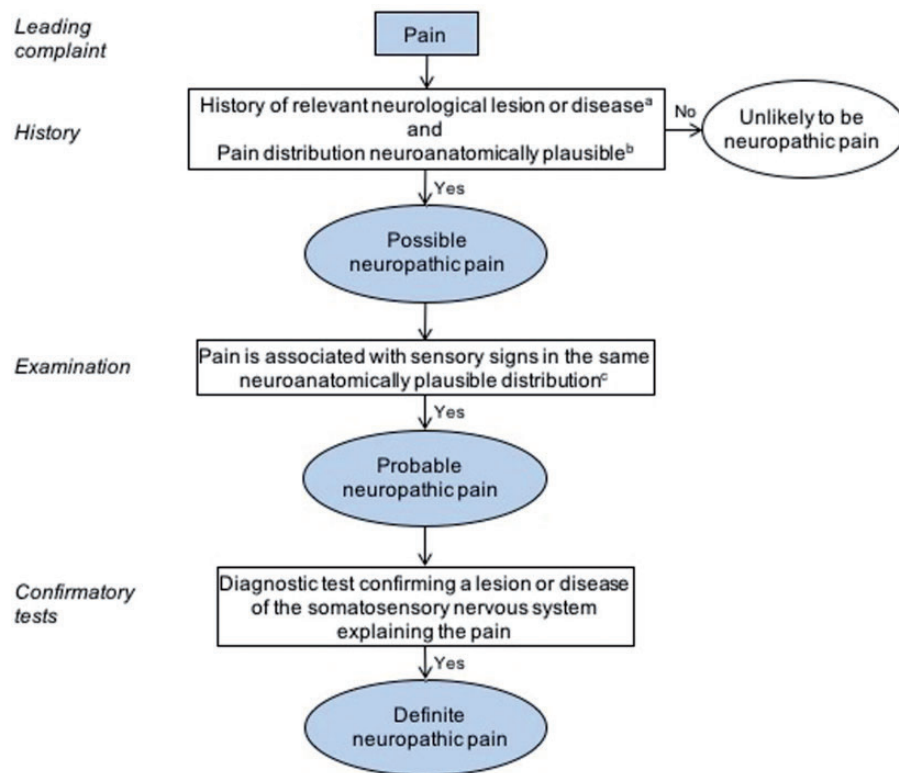


Figure 5. Diagram showing current criteria required for diagnosing neuropathic pain.

where it could be difficult to reach the level of ‘probable’ neuropathic pain without using sophisticated clinical or laboratory tests. Therefore, on the basis of the foregoing discussion the pain suffered by the majority of Peach’s patients with BFS was possibly neuropathic in origin, but it is not appropriate to ascribe a level of certainty of ‘probable’ in most cases.

## Conclusion

Flight Lieutenant Nowell Peach’s long hidden clinical records of individual BFS patients have permitted scrutiny of whether their pain was likely to be neuropathic in origin when analysed using 21st century standards and definitions. When analysed alongside other papers from the era, a number of conclusions can be drawn. The aetiology of BFS is almost certainly nutritional, but the exact dietary factor is less certain. FEPOW were grossly malnourished with multiple vitamin deficiencies. BFS is described as a unique presentation, seen both alongside, and independently from, other deficiencies of B-vitamins. The limited trials which were conducted in the POW camps did not draw any positive results about a specific vitamin deficiency. However, when treated with a general improvement in diet, or food sources rich in multiple B-vitamins, the condition improved. It is therefore most likely that BFS, a condition which can now be described as a ‘possible’ neuropathic pain syndrome, represented a deficiency of multiple B-vitamins. After seventy years, the data painstakingly gathered under the worst of circumstances, by a determined medic, have proved to be of

interest and value in the modern diagnostics of neuropathic pain.

Conflict of interest. None declared.

## References

1. Parkes M, Gill GV. *Captive Memories: Far East POWs & Liverpool School of Tropical Medicine*, 1st edn. UK, Palatine, 2015.
2. Tanaka Y. *Hidden Horrors: Japanese War Crimes in World War II*, 1st edn. New York, Westview Press, 1997.
3. Glusman M. The Syndrome of “Burning Feet” (Nutritional Melalgia) as a Manifestation of Nutritional Deficiency. 1947; 3:211–33.
4. Cruickshank E. Painful feet in prisoners of war in the Far East. *Lancet* 1946; 248:369–72.
5. Dunlop E. Medical experiences in Japanese captivity. *Br Med J* 1946; 2:481–6.
6. Page J. Painful-feet syndrome among prisoners of war in the Far East. *Br Med J* 1946; 2:260–2.
7. Simpson J. *A syndrome of painful feet and retrobulbar neuritis occurring amongst British prisoners of war in the Far East*. MD Thesis, University of Durham, UK, 1946.
8. Parkes M. Alfred Nowell Hamilton peach. *Br Med J* 2012; 344:e17649.
9. Dunlop E. *The War Diaries of Weary Dunlop*. 1st edn. Australia, Thomas Nelson, 1986.
10. Churchill M. Dietary deficiency diseases among prisoners of war. *J R Army Med Corp* 1945; 85:294–8.
11. Grierson J. On the burning in the feet of natives. *Trans Med Phys Soc (Calcutta)* 1826; 2:275–80.



12. Welch E, Peach N, Parkes M, Gill GV. Burning feet syndrome: an old tropical syndrome revisited. *Ann Trop Med Public Health* 2013; **6**:65–70.
13. Frankland A. Deficiency scrotal dermatitis in P.O.Ws in the Far East. *Br Med J* 1948; **1**:1023–6.
14. Gill GV, Bell DR. Persisting nutritional neuropathy amongst former war prisoners. *J Neurol Neurosurg Psychiatry* 1982; **45**:861–5.
15. Landor JV, Pallister RA. Avitaminosis B2. *Trans R Soc Med Hyg* 1935; **29**:121–34.
16. Gerris J. The legacy of Archibald Cochrane: from authority based towards evidence based medicine. *Facts Views Vis Obgyn* 2011; **3**:233–7.
17. Gopalan C. The burning feet syndrome. *Ind Med Gaz* 1946; **81**:22–6.
18. Bibile SW, Lionel NDW, Dunuwille R, Perera G. Pantothenol and the burning feet syndrome. *Br J Nutr* 1957; **11**:434–9.
19. Bouhassira D, Attal N, Fermanian J, Alchaar H, Gautron M, Masquelier E, et al. Development and validation of the Neuropathic Pain Symptom Inventory. *Pain* 2004; **108**:248–57.
20. Bennett MI, Attal N, Backonja MM, Baron R, Bouhassira D, Freynhagen R, et al. Using screening tools to identify neuropathic pain. *Pain* 2007; **127**:199–203.
21. Haanpää M, Attal N, Backonja M, Baron R, Bennett M, Bouhassira D, et al. NeuPSIG guidelines on neuropathic pain assessment. *Pain* 2011; **152**:14–27.
22. Finnerup NB, Haroutounian S, Kamerman P, Baron R, Bennett DL, Bouhassira D, et al. Neuropathic pain: An updated grading system for research and clinical practice. *Pain*. 2016; **157**:1599–606.
23. Jensen TS, Baron R, Haanpää M, Kalso E, Loeser JD, Rice AS, et al. A new definition of neuropathic pain. *Pain* 2011; **152**:2204–5.
24. Phillips TJ, Brown M, Ramirez JD, Perkins J, Woldeamanuel YW, Williams AC, et al. Sensory, psychological, and metabolic dysfunction in HIV-associated peripheral neuropathy: a cross-sectional deep profiling study. *Pain* 2014; **155**:1846–60.
25. Tesfaye S, Boulton AJ, Dyck PJ, Freeman R, Horowitz M, Kempler P, et al. Diabetic neuropathies: update on definitions, diagnostic criteria, estimation of severity, and treatments. *Diab Care* 2010; **33**:2285–93.