Fatal injury epidemiology among the New Zealand military forces in the First World War

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Abstract

**Background** Despite the large mortality burden of First World War (WW1) on New Zealand (NZ) military forces, no analysis using modern epidemiological methods has ever been conducted. We therefore aimed to study injury-related mortality amongst NZ military forces in WW1.

**Methods** An electronic version of the Roll-of-Honour for NZ Expeditionary Force (NZEF) personnel was supplemented with further coding and analysed statistically. We also performed literature searches to provide context.

**Results** Out of a total of 16,703 deaths occurring during the war (28 July 1914 to 11 November 1918), injury deaths predominated: 65.1% were “killed in action” (KIA), 23.4% “died of wounds” (DOW), 1.0% were other injuries (e.g. “accidents”, drownings, suicides and executions), and 10.5% were other causes (mainly disease). During the course of the war, the annual mortality rate from injury (for KIA + DOW) per 10,000 NZEF personnel in the North Hemisphere peaked at 1335 in 1915 (Gallipoli campaign) and then peaked again in 1917 at 937 (largely the Battle of Passchendaele). Some of the offensive campaigns involved very high mortality peaks (e.g. 2 days with over 450 deaths per day in October 1917).

**Conclusions** Participation in First World War was by far the worst fatal injury event in New Zealand’s history. Many of these injury deaths could be considered to have been preventable through: better diplomacy (to prevent the war), improved military planning to reduce failed campaigns (e.g. Gallipoli, Passchendaele), earlier use of protective equipment such as helmets, and improved healthcare services.

The literature on injury epidemiology associated with warfare is largely focused on particular injury types, and on wars since Vietnam (e.g.\(^1,2\)). Indeed, there is relatively little modern literature on injury epidemiology for the First World War, and even that is largely about specific injuries (e.g.\(^3,4\)). In particular, we could not identify any analytical epidemiological studies of the fatal injury burden for a nation from WW1. This gap also applies to New Zealand military forces, even though this nation had a proportionately high mortality burden from this war.

Interest in this war is likely to grow in New Zealand and in other countries involved with the forthcoming centenary, and so it is of relevance to critically consider the injury epidemiology of this event. Therefore, we aimed to briefly study injury-related mortality amongst New Zealand military forces in WW1 and consider some issues around potential preventability. Mortality was chosen as the most important and measurable indicator of the wider injury burden associated with WW1.
Methods

An electronic version of the Roll-of-Honour for New Zealand Expeditionary Force (NZEF) personnel in WW1 was obtained courtesy of the compiler, Professor Peter Dennis (University of New South Wales at the Australian Defence Force Academy).

Further work on this dataset included duplicate removal and coding for ethnicity. For the latter, personnel were classified as having Māori ethnicity if any of the following applied: having a Māori language name (first, second or surname); likewise for having a parent with a Māori language name; being buried in a Māori cemetery or having a memorial in such a cemetery; or having a iwi (tribal) affiliation listed in a biographical database (“Cenotaph database”) covering NZEF personnel and held by the Auckland War Memorial Museum7 (from whom we purchased a dataset).

Personnel were classified as having Pacific peoples ethnicity if they came from a South Pacific island providing military personnel for the NZEF (i.e. Fiji, Gilbert and Ellis Islands, Niue, Samoa, Tonga and the Cook Islands) and had any of the following: a Pacific name; a parent with a Pacific name; or they came from a named village. The approach of using the language of a name for considering ethnicity has been used elsewhere in historical work in New Zealand.6 It is also used for identifying from the electoral roll potential Pacific people respondents to public health surveys in New Zealand (the LEXICON method used by Massey University)7 and we used it in a previous study on pandemic influenza.8

For the denominator data we extracted a random sample of 1000 individuals (about 1%) of personnel who served in the NZEF as detailed in the Cenotaph database. This denominator sample was then adjusted further to replace (with additional random selection).

Ethnicity coding was then performed as for the numerator data. A validation study was performed for the method of ethnicity coding for Māori. It involved one of us (GT) with local history expertise who independently classified the ethnicity of WW1 participants in a rural area in which he had performed historical research.

The results indicated that the coding system we have used was under-ascertaining Māori ethnicity (a sensitivity of 73% (i.e. n=11/15). Of note however, is that the rural locality used in this validation study had a relatively high Māori population in the pre-WW1 era and intermarriage between Māori and New Zealand European was relatively common. As such the under-ascertainment found would be a worse case assessment if applied to New Zealand in general. In contrast all of those classified as Māori via our coding system were also classified as Māori in this validity study (specificity of 100%, n=17/17).

We also updated the Roll-of-Honour dataset with cause of death information including deaths relating to executions and suicides. The latter was via a search in March 2013 of the online Cenotaph database given new information added to this from on-going archival research by others on this topic.

From the final dataset we extracted information on the date, cause and place of death, and the unit, rank and ethnicity of the personnel. To add to the spatial dimension of the mortality, we also extracted the site of the cemetery or memorial, since for some NZEF personnel the site of actual death was different (e.g. they died from wounds when being transported from the battlefield to hospital facilities in another country e.g. the United Kingdom or Egypt).

We also performed literature searches to provide context, especially around aspects of the injury burden that could have been prevented at the time. In particular, we searched the literature for the contemporary diplomatic, military planning, equipment, shelter and health service means that could have reduced the fatal injury burden at the time.

Results

Out of a total of 16,703 deaths among NZEF personnel during the war (28 July 1914 to 11 November 1918), injury deaths predominated (Table 1). Being killed in action (65.1% of all deaths) exceeded dying of wounds (23.4% of all deaths) (Table 1). Injury deaths occurred in 14.9% of the military personnel who had embarked for overseas service (14,946/100,444).
Table 1. Causes of death among NZEF personnel during the First World War (both Northern and Southern Hemispheres 1914–1918)

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Year of First World War</th>
<th>1914*</th>
<th>1915</th>
<th>1916</th>
<th>1917</th>
<th>1918*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injuries</td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Killed in action (KIA)</td>
<td>0</td>
<td>1920</td>
<td>2203</td>
<td>3831</td>
<td>2916</td>
<td>10,870</td>
<td>65.1</td>
</tr>
<tr>
<td>Died of wounds (DOW)</td>
<td>0</td>
<td>594</td>
<td>814</td>
<td>1316</td>
<td>1179</td>
<td>3903</td>
<td>23.4</td>
</tr>
<tr>
<td>“Accident”</td>
<td>1</td>
<td>4</td>
<td>28</td>
<td>41</td>
<td>35</td>
<td>109</td>
<td>0.7</td>
</tr>
<tr>
<td>Drowned</td>
<td>0</td>
<td>36</td>
<td>6</td>
<td>5</td>
<td>10</td>
<td>57</td>
<td>0.3</td>
</tr>
<tr>
<td>Suicide**</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Executed</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Subtotal (injuries)</td>
<td>1</td>
<td>2555</td>
<td>3055</td>
<td>5196</td>
<td>4141</td>
<td>14,948</td>
<td>89.5</td>
</tr>
<tr>
<td>Other causes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died of disease (DOD)</td>
<td>9</td>
<td>283</td>
<td>171</td>
<td>250</td>
<td>584</td>
<td>1297</td>
<td>7.8</td>
</tr>
<tr>
<td>Other**</td>
<td>2</td>
<td>48</td>
<td>133</td>
<td>101</td>
<td>174</td>
<td>458</td>
<td>2.7</td>
</tr>
<tr>
<td>Total deaths</td>
<td>12</td>
<td>2886</td>
<td>3359</td>
<td>5547</td>
<td>4899</td>
<td>16,703</td>
<td>100</td>
</tr>
<tr>
<td>%</td>
<td>0.1%</td>
<td>17.3%</td>
<td>20.1%</td>
<td>33.2%</td>
<td>29.3%</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

* For 1914, starting from 28 July; for 1918 ending on Armistice day (11 November). Only 4 of the injury deaths occurred in NZ; 2 amongst those who had never embarked for service overseas.

** A genealogical website suggests an additional 3 suicides among the NZEF for this 1914–1918 period (“Miscellaneous New Zealand War Deaths 1914–1923”). But such details were not available on the primary databases we used for this study (2 of these were listed as “Section 2” in the Roll-of-Honour and one name was not included).

*** “Other” mainly includes “Section 3” (n=266); “Section 2” (n=151) and unknown causes. “Section 2” was those “who died after discharge from the NZEF from wounds inflicted or disease contracted while on active service.” “Section 3” were “those who died from accident occurring or disease contracted, while training or attached to the NZEF in NZ.” While many of the Section 2 and 3 deaths appear to have been from disease, it is possible that some of these were also injury deaths (e.g. from the long-term effects of wounds).

Demographic characteristics—There were 179 injury deaths among those classified as being Māori (1.2% of the total) and seven such deaths among Pacific soldiers. The cumulative injury mortality risk was highest for European/Other (1514 per 10,000 population); then Māori (1103 per 10,000); and then Pacific soldiers (101 per 10,000). Ten of the injury deaths (0.1% of the total) were women. These were all nurses who drowned when the ship they were travelling in was torpedoed (HM Transport SS Marquette, on 23 October 1915; and see also details in this NZMJ piece on the memorial chapel in Christchurch: http://journal.nzma.org.nz/journal/119-1244/2292/).

The date of birth, or age at death, have not been routinely recorded in the Roll-of-Honour or Cenotaph database we examined. Nevertheless, as part of other work (a study of an outbreak of pandemic influenza on a troopship in 1918) we found that the mean age of the NZEF personnel on-board was 26.7 years.

In terms of military rank and role, injury deaths were distributed as follows: officers (n=686, 4.6% of the deaths), non-commissioned officers (n=2686, 18.0%), health care workers in the New Zealand Medical Corps and the New Zealand Army Nursing
Service (n=146, 1.0%), and all other ranks (n=11,428, 76.5%). Denominator data are not available to calculate mortality risk by these ranks.

**Temporal patterns**—During the course of the war the annual risk of injury death (for KIA + DOW in the Northern Hemisphere) declined after peaking at 1335 per 10,000 in 1915 (Gallipoli campaign) and then peaked again in 1917 at 937 (largely the Battle of Passchendaele) [see Figure 1]. However, the proportion of DOW deaths out of all injury deaths did not decline over time and peaked in 1918 at 28.8%.

**Figure 1. Annual risk of injury mortality for New Zealand military personnel in the First World War in the Northern Hemisphere (with only 1 death in 1914)**

The injury deaths varied by season with a relatively small proportion of deaths in the Northern Hemisphere winter (range: 0.0% to 5.4% of all the deaths). The peaks in numbers of deaths by season were autumn 1916 (n=2313, 15.5%, Somme offensive) and autumn 1917 (n=2317, 15.5%, Battle of Passchendaele).

The seasonal variation is also apparent in Figure 2 which shows the injury deaths by month and year. Also apparent are that the peaks in numbers of deaths generally related to Allied offensives (an exception being the March 1918 offensive by Germany).
Figure 2. Monthly pattern of injury mortality for New Zealand military personnel in the First World War in the Northern Hemisphere (1915 to 1918)*

* Peaks in 1915 reflect the Gallipoli campaign (Allied offensive). The large peak in 1916 reflects the Somme offensive in France. The first peak in 1917 reflects the Battle of Messines, Belgium (an Allied offensive); the second, the Battle of Passchendaele (Third Battle of Ypres), Belgium (another Allied offensive, see Figure 3). In March/April 1918 there was a response to a major German offensive in Western France and from July onwards there were multiple Allied advances on the Western Front.

Some of the offensive campaigns involved very high mortality peaks over just a matter of days. Indeed, for the worst month of the war for the NZEF (October 1917), two extreme mortality peaks are shown in Figure 3. In this month the New Zealand forces took part in two major actions at Passchendaele, in Belgium.

Figure 3. Daily pattern of injury mortality for New Zealand military personnel in the month of the First World War with the highest number of NZEF deaths (October 1917, Battle of Passchendaele, Belgium)*

* For injury deaths in France, Belgium, and the United Kingdom (and excluding 5 deaths from accidents and 9 deaths in Palestine that month).
The first peak in Figure 3 (for 4 October) reflects a relatively successful military action—but still with major loss of life. The second peak (12 October) reflected a failed offensive due to heavy rain and the inability of the artillery to destroy barbed wire and German defensive bunkers (pillboxes) that housed machine guns.\(^{12}\) (p51,90) Figure 3 also shows that in subsequent days the proportion of deaths that were from wounds (relative to KIA), were relatively high compared to on the two days of the offensives.

Table 2. Spatial distribution of injury mortality for NZEF personnel in the First World War as reflected by the locations of cemeteries and memorials*

<table>
<thead>
<tr>
<th>Region/Country**</th>
<th>Cemeteries/ memorials (N)</th>
<th>Individuals named (N)</th>
<th>Proportion of all names (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>242</td>
<td>7207</td>
<td>48.2</td>
</tr>
<tr>
<td>Belgium</td>
<td>111</td>
<td>4588</td>
<td>30.7</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>56</td>
<td>193</td>
<td>1.3</td>
</tr>
<tr>
<td>Greece</td>
<td>8</td>
<td>52</td>
<td>0.3</td>
</tr>
<tr>
<td>Malta</td>
<td>7</td>
<td>28</td>
<td>0.2</td>
</tr>
<tr>
<td>Gibraltar</td>
<td>2</td>
<td>6</td>
<td>0.0</td>
</tr>
<tr>
<td>Ireland</td>
<td>4</td>
<td>5</td>
<td>0.0</td>
</tr>
<tr>
<td>Germany</td>
<td>2</td>
<td>3</td>
<td>0.0</td>
</tr>
<tr>
<td>Subtotal</td>
<td>432</td>
<td>12,082</td>
<td>80.8</td>
</tr>
<tr>
<td>Middle East</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>84</td>
<td>2303</td>
<td>15.4</td>
</tr>
<tr>
<td>Egypt</td>
<td>15</td>
<td>278</td>
<td>1.9</td>
</tr>
<tr>
<td>Palestine/Israel</td>
<td>7</td>
<td>192</td>
<td>1.3</td>
</tr>
<tr>
<td>Syria</td>
<td>1</td>
<td>46</td>
<td>0.3</td>
</tr>
<tr>
<td>Iran</td>
<td>1</td>
<td>1</td>
<td>0.0</td>
</tr>
<tr>
<td>Iraq</td>
<td>1</td>
<td>1</td>
<td>0.0</td>
</tr>
<tr>
<td>Subtotal</td>
<td>109</td>
<td>2821</td>
<td>18.9</td>
</tr>
<tr>
<td>South Pacific/Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NZ – memorials***</td>
<td>5</td>
<td>20</td>
<td>0.1</td>
</tr>
<tr>
<td>NZ – cemeteries***</td>
<td>12</td>
<td>20</td>
<td>0.1</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>2</td>
<td>2</td>
<td>0.0</td>
</tr>
<tr>
<td>Samoa</td>
<td>1</td>
<td>1</td>
<td>0.0</td>
</tr>
<tr>
<td>Tahiti</td>
<td>1</td>
<td>1</td>
<td>0.0</td>
</tr>
<tr>
<td>Not known</td>
<td>1</td>
<td>1</td>
<td>0.0</td>
</tr>
<tr>
<td>Subtotal</td>
<td>22</td>
<td>45</td>
<td>0.3</td>
</tr>
<tr>
<td>Total</td>
<td>563</td>
<td>14,948</td>
<td>100.0</td>
</tr>
</tbody>
</table>

* Some of these cemeteries and memorials include names of those whose bodies were never found, or who died at sea or in transit (e.g. on a hospital ship taking the wounded away from a conflict zone); ** As per country boundaries in 2013 and not distinguishing between contested boundaries in Palestine/Israel; *** Only 4 of these injury deaths recorded at New Zealand (NZ) memorials and cemeteries actually occurred in New Zealand (3 suicides and 1 drowning). Most (n=18) died of wounds while at sea (mainly on route to New Zealand).
Spatial patterns—The location of injury deaths is shown in Table 2, based on the location of cemeteries and memorials.

At the regional level, most of these deaths were in Europe (80.8%) and particularly France (48.2% of the total) and Belgium (30.7%). The next major region was the Middle East (18.9%), particularly Turkey (15.4%). Some of these cemeteries and memorials include names of those whose bodies were never found, or who died at sea or in transit (e.g. on a hospital ship taking the wounded away from a conflict zone).

Discussion

Main findings and interpretation—The fatal injury burden from WW1 for New Zealand was extremely high and clearly exceeded that for New Zealand from World War II (which was 11,625 deaths from all causes\textsuperscript{13}). These WW1-related deaths need to be put in the context of the population of 1,149,225 of New Zealand in the 1916 census,\textsuperscript{14} (i.e. 1.5% of the total population). The burden was also much greater than that from the largest natural disaster in New Zealand’s history, the 1918 influenza pandemic (estimated at 8573 deaths\textsuperscript{15}). Similarly, for the earthquake causing the highest mortality burden, the 1931 Hawke’s Bay earthquake with 258 deaths.\textsuperscript{16}

Another striking aspect of the injury burden was how far it exceeded deaths from disease in this “industrial war” (Table 1). In preceding wars such as the American Civil War and the South African War (Second Boer War), most deaths among soldiers were from disease (e.g. two-thirds for British troops in the South African War, particularly from typhoid).\textsuperscript{17}

As shown in Figure 1, the proportion of “died of wounds” (DOW) deaths out of all injury deaths did not decline as the war progressed. This finding suggests that the improvements in medical services for the wounded were probably outweighed by other factors. These could have included the ongoing changes in weaponry such as the greater number and more effective use of artillery as the war progressed, but also changes in military tactics, both defensive and offensive.

The effective use of artillery is particularly relevant as it has been calculated that artillery caused 58% of the war’s military fatalities.\textsuperscript{18} (p184) It is also plausible that improvements in evacuation also contributed to this pattern. That is rather than the wounded dying in the field and being classified as “KIA”, better evacuation processes later in the war\textsuperscript{19} may have resulted in more wounded getting carried to a field station, where they subsequently still died and were classified as “DOW” instead of “KIA”.

The other temporal pattern of note is how the largest peaks in injury mortality corresponded to Allied offensive actions (versus the defensive response to the March 1918 German offensive—see Figure 2). Offensive action in settings where artillery had not effectively removed German machine gun posts was particularly devastating (e.g. 12 October 1917, Battle of Passchendaele, Figure 3).

The New Zealand Division’s role on the Western Front, as with the British Expeditionary Force in general, was primarily an offensive one. The New Zealand Division experienced just one defensive battle on the Western Front: the German offensive of 21 March to 5 April 1918.
The cumulative injury mortality proportions for WW1 were highest in the European/Other ethnic group. This probably reflects the differing roles of Māori and Pacific soldiers in the NZEF, with these personnel generally having more involvement working in non-combat units such as a Pioneer Battalion. Most casualties occurred in infantry units, followed by artillery. But the injury mortality contrasts with the pattern for disease deaths where Māori and Pacific soldiers had higher cumulative mortality burdens, and indeed a higher all-cause mortality burden for Māori than for the European/Other ethnic group.

Study limitations—We found (and corrected) minor errors with the Roll-of-Honour dataset and indeed it is likely that various other minor errors still exist. For example, an online dataset which is regularly updated by a New Zealand genealogist has an additional four deaths included (i.e. n=18,311 vs n=18,307 in the dataset we used, for the 1914–1923 period). Furthermore, some injury deaths might still be misclassified as “killed in action” or “accident” when these were actually suicides.

Indeed, by restricting our analysis to the date of the end of the war (11 November 1918), we have excluded some unknown proportion of the 1604 deaths in the subsequent period (to the end of 1923 in the Roll-of-Honour), that could have been due to injuries.

The deaths in this period are generally not well classified as to the cause, given that many occurred in personnel discharged from the military. Many are likely to have died from one or more waves of the 1918/19 influenza pandemic, and other diseases and “accidents”. Long-term mental health burdens associated with the war, may also have increased intentional injury risk via suicide in subsequent decades, given the evidence for mental health sequelae amongst veterans, including New Zealand veterans.

The lack of collated denominator data for the entire NZEF has limited our ability (in this unfunded study), to determine the risk of injury death by age-group and by other variables of interest such as occupational class and military rank. But such data could be extracted from the archival records in future analyses. Consideration could also be given to estimating the injury impact on New Zealand citizens who enlisted in other armies (especially that of the United Kingdom and Australia).

Aspects of preventability—While we acknowledge it is somewhat speculative to retrospectively consider issues around preventability for historical events, the available literature does suggest these to varying extents. Primarily, it appears very plausible that better diplomacy and communication could have prevented the war entirely. Also, once the war was underway, it also appears that diplomatic action failed to prevent or constrain the further use of chemical weapons, once the existing international law on chemical weapons use (the Hague Convention of 1899) had been initially violated by Germany.

Improved military planning might have also helped to reduce the fatal injury burden, by for example avoiding the failed Gallipoli Campaign, in which the NZEF suffered severely (most of the deaths in 1915 and specifically estimated at 2779 deaths, which is slightly more than an official figure of 2721).

Similarly, more thoughtful military decisions by the high command on the Western Front could have avoided the Battle of Passchendaele or at least halted military
operations when weather and terrain conditions meant there was little prospect of success. If Field Marshal Sir Douglas Haig had called off this battle on the afternoon of 4 October 1917 when the spell of reasonable weather ended, many lives, including New Zealanders, would have been spared.

Haig’s decision to continue the offensive after this point, against the advice of his army commanders, was the most controversial of his career. The influential military theorist and historian Major General JFC Fuller believed that Haig’s decision to continue with a “tactically impossible battle … was an inexcusable piece of pig-headedness on the part of Haig”. Unfortunately too many soldiers paid the price for this “pig-headedness”.12 (p115) 31

Poor planning was also associated with more specific events. For example, the sinking of the Marquette was potentially avoidable since “a marked hospital ship, by definition safe from attack, had left the same port on the same day as the Marquette, completely empty. By putting the medical staff in an unmarked transport in a convoy carrying troops and ammunition, the authorities unnecessarily risked their lives.”10

The deaths of 10 NZEF personnel in a railway accident in the UK,32 also had preventable elements.

Improved protective equipment such as the use of steel helmets by New Zealand troops earlier in the war would probably have helped reduce head wounds and associated fatalities. Photographs of soldiers in Gallipoli in 1915 show a variety of soft hats in use and steel helmets did not appear in use until 1916 (frontline NZ troops in Western Europe—using the British-designed “Brodie helmet”, see Figure 4). In contrast, the steel “Adrian helmet” started to be used by the French army at an earlier stage, in the summer of 1915.33

Helmet design could also have been better since the German helmet (the “stahlhelm”) was stronger than the Brodie helmet and gave better protection to the back of the head and neck (though it was also more expensive and heavier). The American version of the Brodie helmet was also stronger than the British version.33

Tighter restrictions on the provision of alcohol in military rations may also have reduced a range of fatal injuries. Views on the benefits and hazards of alcohol rations for allied soldiers varied34 and the amounts provided were often small. Nevertheless, for the NZEF at Gallipoli the daily alcohol ration was “½ gill rum at discretion of G.O.C. on recommendation of S.M.O”.35 This is equivalent to 71 ml of rum or around 2.2 standard drinks (assuming rum at 40% alcohol by volume and using the official NZ formula [http://www.alac.org.nz/alcohol-you/whats-standard-drink]). This level of alcohol consumption would give a blood alcohol level of around 0.05 g/100 ml in a 70 kg man which is over double the level known to impede task performance (<0.02 g/100 ml).36

Improved nutrition of NZEF personnel may also have reduced injury deaths. For example, nutrient deficiency diseases such as scurvy (e.g. at Gallipoli37) may have increased the risk of death once wounded. It is also plausible that some personnel at Gallipoli may have had night blindness from low vitamin A intake37 (which may have increased the risk of injury when fighting at night).
Better disease prevention (to prevent dysentery, typhoid, and malaria among NZEF personnel) may also have helped avoid the situation of weaken troops who might have succumbed more readily to death from wounds.

Finally, improved design and resourcing of military medical services is likely to have helped reduce deaths from injury. Examples of deficits included the lack of enough medical supplies, health workers and hospital ships in the Gallipoli Campaign. The lack of adequate medical facilities was one of a number of deficiencies outlined in the final report of the Dardenelles Commission although its censures were "polite and vague, rather like the orders for the Suvla landing".

New Zealand conducted its own investigation into “various matters” concerning the NZEF in September-October 1915. The investigating officer, Lieutenant Colonel the Hon R Heaton Rhodes, reported that during the April landing and the August offensive “congestion and consequent delays in getting the sick and wounded away” had been a serious problem. He sought assurances that such delays would not occur again. The use of hospital facilities in Egypt for the wounded in this campaign were also criticised as being a poor choice (e.g. due to fly problems) relative to using hospitals in Malta or England.
There were sometimes shortages of stretcher-bearers and initially less fit men were selected for this work—until this was subsequently changed to the fitter and stronger men. The initial use of horse-drawn ambulances (rather than motorised ones) on the Western Front was also problematic. Indeed, use of motorised ambulances (Figure 4), well-trained stretcher bearers, and improvements in fracture/wound management by medical services have been described as factors reducing the case fatality level among the wounded in later stages of the war.

Paradoxically though, improvements in medical treatment may have helped prolonged the war. As David Stevenson has noted:

"Still more remarkable was medicine’s success in rehabilitating the wounded: and this more than anything else accounted for the armies’ ability to keep fighting despite seemingly prohibitive casualty rolls. Most lists compiled during the war lumped together dead and wounded without indicating that only a minority of the latter were unable to ever serve again." (p207-8)

Conclusions

The First World War was by far the worst fatal injury event in New Zealand’s history, exceeding all other wars and natural disasters by a large margin. Many of these injury deaths could be considered to have been preventable at the time through better diplomacy, improved military planning, use of protective equipment and better medical services.

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