

Cholera in Papua New Guinea: observations to date and future considerations

PAUL F. HORWOOD^{1,2} AND ANDREW R. GREENHILL^{1,3}

Papua New Guinea Institute of Medical Research, Goroka

SUMMARY

Cholera is a severe diarrhoeal illness caused by infection with the bacterium *Vibrio cholerae*. From July 2009 to late 2011 Papua New Guinea (PNG) experienced the first outbreak of cholera ever reported in this country. During this time >15,000 cases of cholera were reported, resulting in approximately 500 deaths. The origin of this outbreak is unknown, but considering the remote location of the initial outbreak an infected international traveller is unlikely to be the source. In this paper we review the characteristics of the PNG cholera outbreak and discuss the ongoing threat of cholera to the country and the region.

Cholera has been a global health problem for centuries. The disease originated in the Indian subcontinent and spread throughout the world in recent centuries via trade routes. Although >200 serogroups of *Vibrio cholerae* exist only two, O1 and O139, are responsible for epidemic cholera. The epidemic strains of *V. cholerae* produce a toxin, which is largely not present in environmental strains and is responsible for the profuse watery diarrhoea that is the main clinical characteristic of cholera. Cholera had a global distribution during the 19th century, but improved sanitation and hygiene has eliminated the disease from developed countries. The disease remains an important cause of morbidity and mortality in many low-income countries, but until recently it had not been reported in Papua New Guinea (PNG).

The cholera outbreak in PNG began in July 2009 in two villages on the north coast of Morobe Province, Nambariwa and Lambutina. The outbreak was reported by a physician visiting his father's village (1). Cholera cases rapidly spread throughout Morobe Province and subsequently to many of the coastal regions of the country. By mid-2011 more than 15,500 cholera cases had been reported throughout the country, with approximately

500 deaths (2). These figures are likely to be an underestimate of the true extent of the outbreak as reports from remote regions were scarce.

It is perhaps surprising that there were no reported cases of cholera in PNG until the commencement of the recent outbreak in mid-2009. PNG's neighbours to the north – Indonesia, Malaysia, the Philippines – and many other countries in South-East Asia are cholera-endemic countries or commonly have epidemic outbreaks. Cholera outbreaks have also been reported in many Pacific communities in close proximity to PNG, including West Papua (3), Papua (formerly Irian Jaya) (4,5), Micronesia (6), Fiji (7), Marshall Islands (8), Gilbert Islands (9), Guam (10) and Nauru (11). Isolated cases have also been imported into developed countries in the region such as Australia (12,13) and New Zealand (14). Multiple factors are likely to have contributed to cholera remaining undetected in PNG despite outbreaks in nearby countries, but may in part be due to the low rate of international travel between PNG and cholera-endemic countries. However, with the rapid economic development of PNG this situation is quickly changing. We have recently witnessed the importation of

1 Papua New Guinea Institute of Medical Research, PO Box 60, Goroka, Eastern Highlands Province, Papua New Guinea

2 Present address: Institut Pasteur du Cambodge, 5 Blvd Monivong, Phnom Penh, Cambodia
paul.horwood@hotmail.com

3 Present address: School of Applied and Biomedical Sciences, Federation University, Churchill Campus, Churchill, Victoria 3842, Australia

exotic diseases such as chikungunya (15) and Newcastle disease in chickens (16), which were both probably introduced through increased movement of people across international borders.

Many people have questioned how cholera entered PNG. Various mechanisms have been associated with the spread of *V. cholerae* to non-endemic regions of the world, including seafood (17), ship ballast water (18), ocean currents (19) and infected travellers (20). In PNG all of these factors are possibilities; however, considering the remote location of the initial outbreak it is unlikely that the outbreak originated from an infected international traveller or imported seafood. Therefore, the most likely mechanisms behind the introduction of cholera include ship ballast water and ocean currents. Considering the large amount of regular shipping traffic that passes through the strait between mainland PNG and New Britain, we could conceive of a scenario where a ship dumped ballast water and currents pushed the cholera-contaminated water on to the coast. This hypothesis is further supported by the close relationship of the PNG outbreak strains with

strains previously reported from South-East Asia (2) and the presence of a high-density shipping route that runs along the north coast of PNG from Asia to Australia (Figure 1). Unfortunately, the exact mechanism for the introduction of cholera into PNG is unlikely to be determined.

There are some notable features about the spread and distribution of the cholera epidemic in PNG. First, the outbreak was slow to spread around the country (relative to how quickly cholera epidemics have spread in many other countries). The lack of a road network and inaccessibility of air travel to many Papua New Guineans may have prevented the rapid spread of cholera, but this lack of a travel network should not be seen as a public health benefit given the difficulties it presents in service delivery. The compromised capacity of services in regional PNG costs lives, as witnessed by the high case fatality rate in Western Province (2). It is fortuitous that in PNG we did not witness an explosive outbreak of cholera that rapidly disseminated around the country, simultaneously impacting on a large number of provinces. This situation was very different to the recent outbreaks in

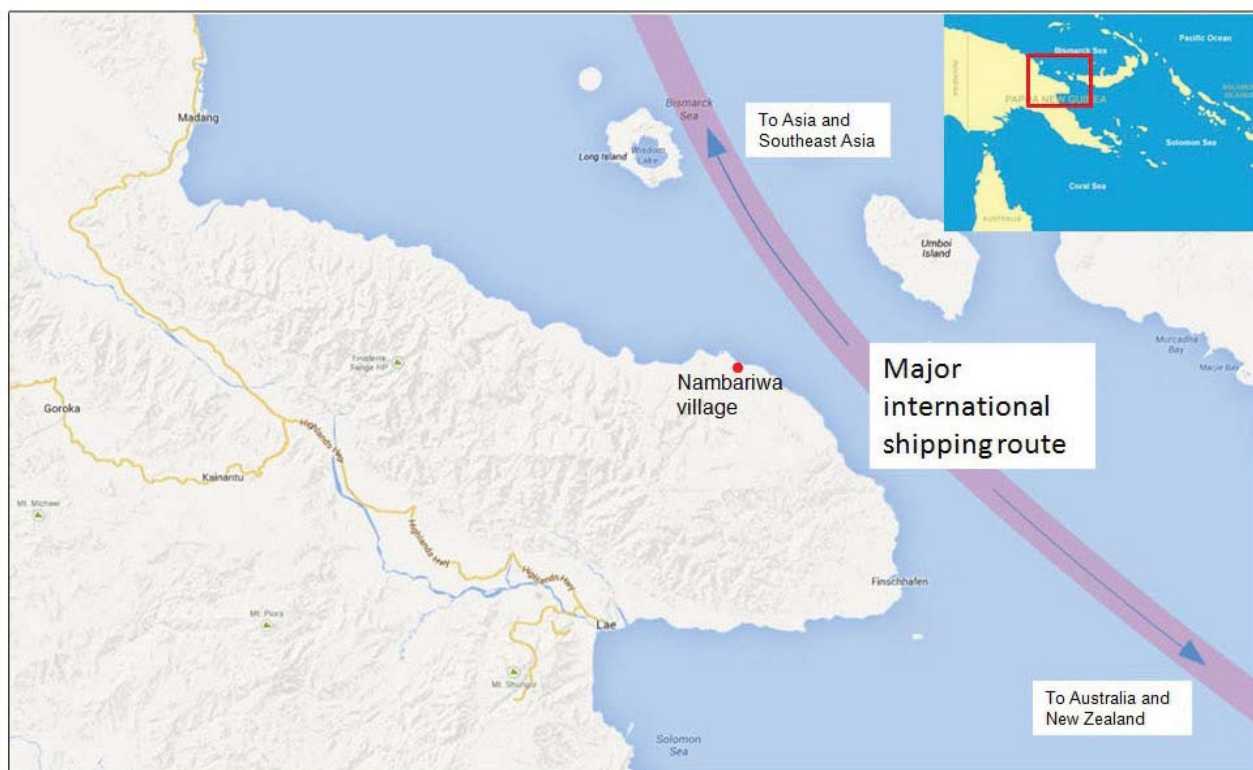


Figure 1. Papua New Guinea map showing the close proximity of the initial site of the cholera outbreak (Nambariwa village) with a major international shipping route as a possible source of cholera introduction into the country.

Haiti and Zimbabwe (21,22), although direct comparisons of these outbreaks with the outbreak in PNG are probably not indicative, considering the respective natural and social disasters that were involved in the outbreaks in these countries.

The second notable feature of the PNG cholera outbreak was the lack of transmission in the highlands region: all outbreaks occurred in coastal communities. No local transmission of cholera occurred in the highlands region, although imported cases were reported at Goroka Provincial Hospital (n = 5) and Mt Hagen Provincial Hospital (n = 1). The geographical characteristics of the highlands region (eg, fast-flowing non-saline rivers and steep topography which favours rapid movement of water) do not favour the persistence of *V. cholerae*. During the recent outbreak of cholera in Haiti it was reported that cases were significantly more likely to occur on coastal plain regions than in highland regions (23). Lower elevation was also highlighted as a significant risk factor for cholera outbreaks in the suburbs of Harare (Zimbabwe) during a large outbreak in 2008-2009 (24). Nonetheless, cholera outbreaks have been recorded from highland regions, such as an outbreak in West Papua associated with the sale of market products (3). As such, the highly populated highlands region of PNG should not be complacent, and could be at risk of future outbreaks.

Although cholera cases have not been reported in PNG since late 2011, there is a concern that an environmental reservoir for toxigenic cholera has been established in the large saline rivers of PNG and the country may become a cholera-endemic country with periodic outbreaks of varying severity. Despite being autochthonous in the aquatic environment, toxigenic strains of *V. cholerae* are rarely detected in coastal and river waters during interepidemic periods (25). However, environmental triggers such as salinity, rainfall, plankton blooms and sea surface temperature can result in the proliferation of toxigenic *V. cholerae* in the aquatic environment, thus leading to cholera outbreaks (26). For countries such as PNG, where only 40% of people have access to a safe water source (27,28), there is a constant risk of a resurgence in cholera cases (29). The repercussions of PNG being recognized as a cholera-endemic country may be greater than merely the increased burden on the health

care systems. Indeed, the economic cost to the local economy of a cholera outbreak in Peru in the early 1990s was at least US\$220 million over the first 15 months of the outbreak (approximately US\$308 million in today's currency), with some estimates being considerably higher (30). It is interesting to note that these figures are much higher than the money spent on improving water supply and sanitation in the country during the preceding decade (31).

Cholera has had a large impact on PNG in terms of morbidity, mortality and economic costs associated with the outbreak response. The outbreak peak in mid-late 2010 saw at least eight provinces affected by cholera outbreaks. It is imperative that syndromic surveillance systems are strengthened in PNG to ensure that there is a rapid response to further outbreaks of cholera to mitigate the spread and impact of the disease. An important aspect of this is improved laboratory capacity at national and provincial level (32) so that rapid confirmation of outbreaks can facilitate a rapid emergency response.

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