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Yaws (*T. pallidum pertenue*)
Rice University - BIOC 331

Abstract:
Yaws is a human disease found predominantly in tropical regions among children. The causative agent of yaws, Treponema pallidum pertenue, is a spirochete bacteria closely related to syphilis - in fact, it is classified as the same species. Notably, unlike syphilis (a STD) yaws is transmitted by skin-to-skin contact. The symptoms of yaws are different from syphilis and include: the appearance of papillomatous lesions, arthralgia, malaise, bone and cardiovascular degradation. Of particular note, yaws is easily treatable using a single dosage of antibiotic. As such, yaws is actually rather close to being eliminated, putting it on the short list which includes only smallpox. The WHO estimates that the pathogen will no longer trouble mankind after 2020.

Taxonomy:
- Domain: Bacteria
- Phylum: Spirochaetes
- Class: Spirochaetia
- Order: Spirochaetales
- Family: Spirochaetaceae
- Genus: Treponema
- Species: pallidum
- Sub-species: pertenue

Pathology:
Yaws disease progresses through three major stages. In the first, a mother yaw (or lesion) appears at site of exposure. This lesion grows with time, and is commonly found on the legs and ankles. The incubation period ranges from 10-90 days. After 3 weeks to 2 years, secondary lesions appear. Joint pain and malaise are common symptoms at this point. Palms and soles may fissure due to keratinization, making walking difficult. In the third stage, which develops after >5 years of untreated infection, chronic destruction of heart, skin and bone occurs (Mitjà et al. 2013).

Infection:
Yaws is spread by skin-to-skin contact, but only among humans (Mitjà et al. 2013). It's the most common of the three endemic treponematoses (yaws, bejel and pinta). Yaws is typically found in warm and humid climates (tropics) among poor children. Notably, 75% of infected are under age 15. Infection varies with changes in humidity (Kazadi et al. 2014). In 2013, a total of 58,915 yaws infections were reported by the WHO. From 2008-2012 >300,000 cases were reported to the WHO. Yaws poses a chronic/constant threat to endemic areas - it does not flare up nor disappear naturally (Kazadi et al. 2014). Yaws can be effectively treated with a single dose of penicillin or azithromycin (Mitjà et al. 2013).

Distribution (2012):

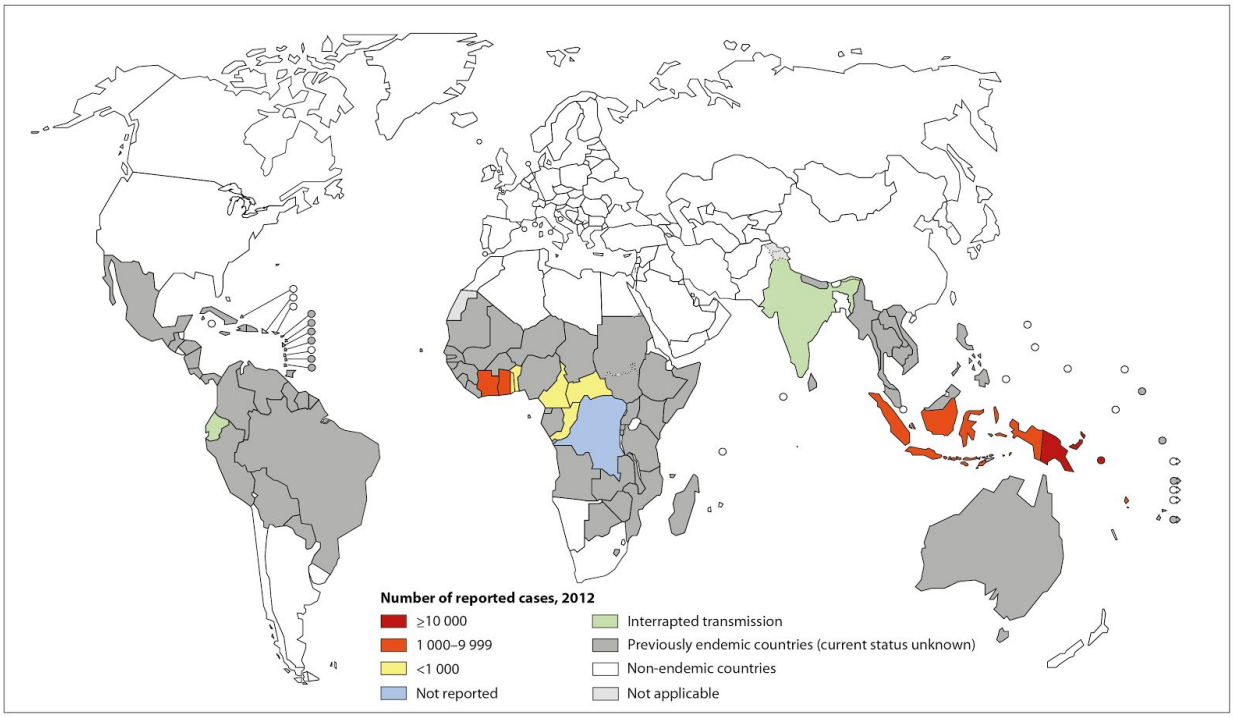

Fig 1: The following map displays the global distribution of yaws in 2012. The disease has been eliminated from much of its historical range and is now confined to tropics in Africa and Asia/Oceania. That said, current monitoring efforts may not detect sub-clinical or latent yaws, and reporting may be incomplete (Kazadi et al. 2014).

A History of Yaws:

Homo erectus skeletons dating back 1.6 million years show evidence of yaws infection. This indicates the disease is quite ancient (Harper et al. 2008; Rothschild et al. 1995;). Yaws symptoms were first described in 1648 by Willem Piso, a Dutch physician in South America. He recorded his observations in his book on the natural history of Brazil (Mitjà et al. 2013). The causative agent of yaws was elucidated in 1905 by Aldo Castellani, shorly after syphillis (Mitjà et al. 2013; Stamm 2015). Penicillin emerges after WWII; discovered to be very effective against Yaws. These two discoveries sparked a campaign to eliminate the disease from 1952 to 1964. As a result of the campaign, global yaws prevalence dropped by 95% however, the eradication effort failed. The disease re-emerged from those few places in which it had not been eliminated (Rinaldi 2012).

Trends in Research:

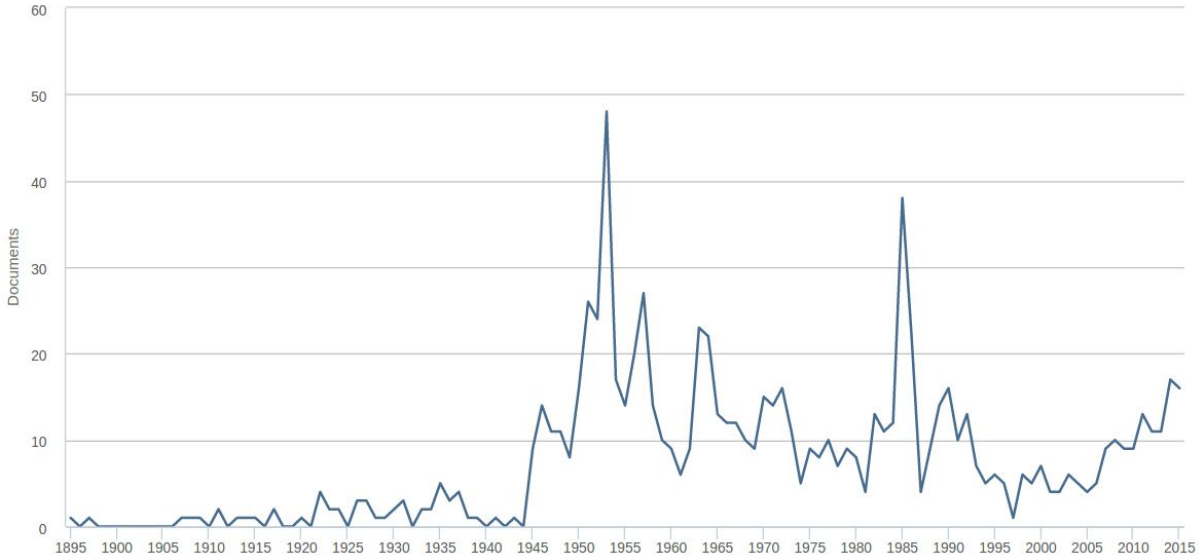

Fig 2: A plot of the number of scientific articles published on yaws from 1895 to 2015. Following the description of yaws in 1905, the scientific community began to engange in research on the pathogen. The largest spike in interest occured around the 1950s in response to the WHO elimination effort.
(Scopus Search, Retreived Nov. 2015)

Studying Yaws:

Yaws cannot be grown in culture; it only survives in mammalian tissues. The pathogen is easily killed by changes in environment (drying/heating) and replicates very slowly (30-33 hrs per division). Researchers typically grow the pathogen in rabbits and golden hamsters. Genetic analysis suggests that yaws is the oldest of the treponemal diseases. No known pathogens infect T. pallidum (Harper et al. 2008; Mitjà et al. 2013).

Origins of a Name:

Fig 3: Lesions typical of yaws. Image is in public domain (retrieved from Wikipedia).
The term yaws originates from either the Carib term for sore (yaya), or the African term for berry (yaw). Yaws may also be called framboesia tropica after the French word for raspberry (framboise).

Elimination Efforts:
Yaws was the first disease slated for eradication after the establishment of the WHO in 1948. This attempt failed, as yaws reemerged from pockets of disease which escaped detection. Yaws should be one of the easier diseases to eliminate(Rinaldi 2012). In 1996, India began a highly successful campaign to eliminate the disease. The government distributed educational materials and paid cash rewards for those who reported cases of the disease. Serological testing was employed to detect sub-clinical cases, and home-to-home monitoring allowed for treatment to be pervasive. As a result, India has had no new cases reported since 2004 (Narain et al. 2015). This success encouraged the renewal of elimination efforts in 2012. The advent of a new treatment strategy: oral azithromycin treatment may improve success. It is far more simple and painless (Rinaldi 2012).

Barriers to Elimination:
WHO hopes for elimination by 2020. There are several concern to keep in mind moving forward with this effort. Complete elimination of yaws will be necessary, otherwise it will reemerge as in the first campaign. Serological testing is needed in order to identify subclinical cases (Rinaldi 2012). Vaccination against yaws is not possible and reinfection with yaws after exposure is possible. Reservoirs of infection exist among young children, and they represent a key point for intervention. Animal reservoirs are present, however cross-species transmission is not evident at this time. There is a tremendous need for continued monitoring to detect outbreaks and evolution of antibiotic resistance (Kazadi et al. 2014; Mitjà et al. 2013; Rinaldi 2012). Overall, the cost of elimination estimated at $362 Million (Fitzpatrick et al. 2014). Despite all these concerns, elimination is quite feasible!

References:

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