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The feasibility of eliminating podoconiosis

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Abstract

Podoconiosis is an inflammatory disease caused by prolonged contact with irritant minerals in soil. Major symptoms include swelling of the lower limb (lymphoedema) and acute pain. The disease has major social and economic consequences through stigma and loss of productivity. In the last five years there has been good progress in podoconiosis research and control. Addressing poverty at household level and infrastructure development such as roads, water and urbanization can all help to reduce podoconiosis incidence. Specific control methods include the use of footwear, regular foot hygiene and floor coverings. Secondary and tertiary prevention are based on the management of the lymphoedema-related morbidity and include foot hygiene, foot care, wound care, compression, exercises, elevation of the legs and treatment of acute infections. Certain endemic countries are taking the initiative to include podoconiosis in their national plans for the control of neglected tropical diseases and to scale up interventions against the disease. Advocacy is needed for provision of shoes as a health intervention. We suggest case definitions and elimination targets as a starting point for elimination of the disease.

Introduction

In 2012, the World Health Organization (WHO) published targets for the elimination of neglected tropical diseases or reductions in their impact to levels at which they are no longer considered public-health problems (Table 1). 2 Elimination is an attractive, motivating and powerful concept that attracts bold thinkers, increases political commitment, mobilizes donors
and resources, encourages innovations and motivates health workers. It also encourages service expansion and provides access to hard-to-reach communities. Some researchers and policy-makers argue that elimination programmes may not be cost-effective, may divert resources from other priorities and weaken or even destroy other disease control programmes. However, elimination is an attractive investment because – if the elimination effort is successful – any time-limited surge in spending should lead to long-term savings. Some definitions of important terms used by WHO in this context are listed in Box 1.

Podoconiosis (non-filarial elephantiasis) – an inflammatory disease caused by prolonged contact with irritant minerals in soil – was identified by WHO as a neglected tropical disease in 2011, but no global target has been set for its elimination. In recent years, there has been remarkable progress on podoconiosis research; the commitment of endemic countries to podoconiosis control has increased and elimination is now on the global health agenda. In this paper, we describe the symptoms of the disease, its socioeconomic impact, strategies for control and the feasibility of elimination.

**Symptoms and diagnosis**

At present, podoconiosis can only be diagnosed clinically from characteristic signs of the disease and the exclusion of infectious and hereditary causes of lymphoedema. The key early signs of podoconiosis are splaying of the forefoot, swelling of the foot and lower leg that disappears after overnight rest, thickening of the skin over the dorsum of the foot, and moss-like rough, warty growths on the feet. With time, the swelling of affected legs (lymphoedema) becomes either soft and pitting or nodular and fibrotic. Late-stage disease is characterized by fusion of the toes and joint stiffness. The patient’s history and the results of a physical examination and certain disease-specific tests may allow filarial elephantiasis, lymphoedema of systemic disease or leprosy to be excluded.

Although there are point-of-care diagnostic tests for lymphatic filariasis, such tests are not very sensitive in detecting filarial infection among advanced cases. The absence of any point-of-care tests for the diagnosis of podoconiosis is a continued challenge, especially when considering the disease’s elimination. Until such diagnostic tests are designed, the standardization of the disease’s clinical diagnosis will remain important and will involve establishing the predictive value of each of the various signs and symptoms. Previous studies
have indicated that clinical diagnosis is an accurate and workable approach in settings where podoconiosis is endemic.\textsuperscript{18} Similar studies now need to be conducted in settings in which lymphatic filariasis and podoconiosis may overlap. The effectiveness of clinical diagnosis in excluding other causes of lymphoedema needs to be formally evaluated.

**Socioeconomic impact**

Podoconiosis has severe health, social and economic consequences.\textsuperscript{19} According to a study in Ethiopia, the annual economic cost of podoconiosis in an area with 1.7 million residents was more than 16 million United States dollars (US$).\textsuperscript{19} When extrapolated to the national population, this result indicates a corresponding cost of more than US$ 200 million. People with podoconiosis were found to lose 45\% of their economically productive time because of morbidity associated with the disease.\textsuperscript{19} Most people with podoconiosis in Ethiopia experience an episode of acute inflammation that may be triggered by bacterial, viral or fungal infection, at least once per year.\textsuperscript{20–22} Such acute attacks are characterized by hot, painful and reddened swelling. Since podoconiosis patients become bedridden during such attacks, it leads to loss of productivity.

The social impact of podoconiosis is also substantial. In endemic areas of southern Ethiopia, the disease is considered to be the most stigmatizing health problem\textsuperscript{23,24} and affected people may be excluded from school, denied participation in local meetings, churches and mosques and excluded from marriage with unaffected individuals.\textsuperscript{23–27} In the same areas, most community members investigated were found to have negative, stigmatizing attitudes towards social interactions with people affected by podoconiosis.\textsuperscript{25} In northern Ethiopia, people with podoconiosis were found to have much lower quality of life scores, in all domains of quality of life, than healthy people from the same neighbourhoods.\textsuperscript{28}

The burden of podoconiosis will be estimated for the first time in the 2015 round of the global burden of disease study.\textsuperscript{29} Clearly generated disability-weight measurements and the inclusion in any assessment of the multiple impacts of podoconiosis – including acute attacks – should enable reasonably accurate estimates of the numbers of disability-adjusted life-years lost because of the disease.
Control strategies
Strategies aimed at addressing poverty at household level and infrastructure development such as roads, water and urbanization can all help to reduce podoconiosis incidence. Although the disease was probably once common in Algeria, Morocco, the Canary Islands and Tunisia, it has disappeared from these areas as the result of urbanization and socioeconomic development and the consequent, almost universal, use of shoes. Specific strategies for podoconiosis control may be divided into primary, secondary and tertiary prevention. Primary prevention – i.e. the prevention of contact between feet and the minerals in the irritant soil that trigger the inflammatory process – includes the use of shoes, regular foot hygiene and floor coverings. Secondary and tertiary prevention are based on the management of the lymphoedema-related morbidity and include foot hygiene, foot care, wound care, compression, exercises, elevation of the legs and treatment of acute attacks.

The objectives of secondary and tertiary prevention are to arrest progress of early disease, reduce the frequency of acute attacks and reduce the swelling of the limbs. Surgical removal of nodules may be indicated. Management of lymphoedema can lead to modest clinical improvement and substantial improvements in quality of life. The effectiveness and cost-effectiveness of these interventions are being evaluated.

Much of the available information on podoconiosis treatment and prevention comes from Ethiopia. Local strategies include the distribution of shoes in schools and integration with the national community-based health extension programme. In a small study in northern Ethiopia, over a third of people were willing to pay at least half of the cost of care and over 30% were willing to pay the full costs of shoes.

Use of shoes also has benefits in the fight against several neglected tropical diseases. There is likely to be synergy between the elimination of podoconiosis and the elimination of lymphatic filariasis. The latter has two pillars: (i) transmission interruption via mass drug administrations and (ii) clinical care and disability prevention. It should be relatively easy to the second pillar for both diseases.
Societal and political considerations

There is a growing political commitment for interventions against podoconiosis. In the absence of any relevant global strategies, several endemic countries have taken independent initiatives to address the challenges of control. For example, the Ethiopian government identified podoconiosis as one of its eight priority neglected tropical diseases and included the disease in its 2013–2015 integrated master plan for the control of such diseases. Ethiopia and Rwanda have each mapped the geographical distribution of podoconiosis nationwide. The only potentially endemic country that is currently experiencing severe political unrest is Democratic Republic of Congo, where the burden of podoconiosis – and the feasibility of its elimination – have yet to be studied. Risk maps can be developed based on the available evidence of environmental factors that are predictive of podoconiosis.

Since WHO included podoconiosis in its list of neglected tropical diseases, the international community has responded. The Wellcome Trust and the United States National Institutes of Health continue to be strong funders of podoconiosis research. The Big Lottery Fund (Manchester, United Kingdom) supports podoconiosis interventions financially and the TOMS® shoe company (Playa Del Rey, USA) is also an important funder of podoconiosis prevention and care – both through donation of children’s shoes and via direct financial support.

Feasibility of elimination

The elimination of podoconiosis is likely to be feasible. The fact that the disease is not infectious makes elimination easier. As discussed above, use of shoes is a practical intervention for prevention of podoconiosis. Consistent use of shoes, regular foot hygiene and covering floors are the key preventive strategies against podoconiosis. Although these measures appear simple, there are social, practical and logistical challenges that hinder their acceptance by people living in endemic areas. Financial constraints, lack of appropriate shoes for wet and dry seasons and sociocultural factors all affect the availability and use of shoes. If shoes are to be used as a health intervention, innovative approaches are needed to make them affordable. Shoes also need to be appropriate to local activities and seasonal patterns.
Conclusion

We have developed case definitions (Box 2) and elimination targets (Box 3) as a starting point for future efforts towards the elimination of podoconiosis. A global strategy for the elimination of this disabling disease is now needed, based on the evidence for both diagnosis and care. A clearer case for investment must be provided for funding agencies and endemic-country governments. The interventions for podoconiosis prevention and treatment are relatively simple. Restored function and improved quality of life – can be achieved for people with lymphoedema after just three months of treatment.\textsuperscript{30,32} Promotion of shoes for podoconiosis prevention is likely to have multiple health benefits.\textsuperscript{37}

By integrating podoconiosis care into the wider context of general foot care – including for leprosy and lymphatic filariasis – it should be possible to avoid duplication of efforts and enable the available resources to be used efficiently.\textsuperscript{38} The continued challenge in providing clinical services at scale is a shortage of skilled health workers. In those countries where podoconiosis is endemic, most health workers lack the knowledge and practical skills needed to address the symptoms of lymphoedema.\textsuperscript{44} Clinical management needs to be included in these countries’ curricula for the pre- and in-service training of health-care providers. National accreditation bodies for health-care providers need to be engaged in efforts to eliminate podoconiosis, and the disease needs to be included in any continued professional development for health workers.

Access to treatment services for those in need is an important aspect of podoconiosis elimination. Clinical services are currently provided by just a few faith-based and nongovernmental organizations.\textsuperscript{30,32} Provision of free-of-charge or low-cost prevention and treatment, through government-led programmes, will probably be critical to any elimination effort.

We need advocacy for shoes as a health intervention. For those individuals who cannot afford to buy shoes, subsidized distribution – perhaps via collaboration with shoe companies – should be considered. The TOMS® shoe company currently provides a pair of shoes to a child at risk of podoconiosis for each pair of shoes it sells elsewhere.\textsuperscript{45} Extending similar collaborations to other shoe companies would be beneficial.
Finally, continued research should focus on the development of good point-of-care diagnostic tests for podoconiosis, which are needed both to detect new cases and, ultimately, to verify elimination. Although definitive diagnosis may not be a priority as elimination programmes are launched, robust, sensitive and specific diagnostic tests will certainly be needed as podoconiosis becomes rare.

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**Competing interests:**
None declared.

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aims-stomp-out [cited 2014 Sep 11].
Table 1. Neglected tropical diseases and targets for their elimination set by the World Health Organization

<table>
<thead>
<tr>
<th>Target year, disease</th>
<th>Target</th>
<th>Target source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2015</strong></td>
<td></td>
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<tr>
<td>Chagas disease</td>
<td>Interruption of serological – i.e. transfusion-related – transmission in all endemic countries in Latin America</td>
<td>WHA resolution WHA63.20 (2010)</td>
</tr>
<tr>
<td>Dracunculiasis</td>
<td>Eradication, with country-by-country certification – of the elimination of transmission – by the International Commission for the Certification of Dracunculiasis</td>
<td>WHA resolutions WHA44.5 (1991) and WHA57.9 (2004)</td>
</tr>
<tr>
<td>Human African trypanosomiasis in Africa</td>
<td>Elimination from 80% of foci in selected countries</td>
<td>WHA resolutions WHA44.5 (1991) and WHA57.9 (2004)</td>
</tr>
<tr>
<td>Onchocerciasis in Latin America</td>
<td>Elimination as a public health and socioeconomic problem</td>
<td>WHA resolution WHA47.32 (1994)</td>
</tr>
<tr>
<td>Rabies</td>
<td>Elimination as a public health problem – i.e. elimination of morbidity – and, where feasible, the elimination of <em>Onchocerca volvulus</em> transmission</td>
<td>PAHO resolution 14.35 (1991)</td>
</tr>
<tr>
<td>Schistosomiasis</td>
<td>Elimination, as a public health problem, from the Caribbean, Indonesia, WHO Eastern Mediterranean Region and areas close to the Mekong river</td>
<td>WHO NTD road map (2012)</td>
</tr>
<tr>
<td>Yaws</td>
<td>Elimination, with zero reporting of cases following high-quality case searches validated by independent appraisals</td>
<td>WHA resolution WHA31.58 (1978)</td>
</tr>
<tr>
<td><strong>2020</strong></td>
<td></td>
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<tr>
<td>Blinding trachoma</td>
<td>Elimination as a blinding disease</td>
<td>WHA resolution WHA51.11 (1998)</td>
</tr>
<tr>
<td>Chagas disease</td>
<td>Interruption of vector- and transfusion-related transmission in all endemic countries in Latin America</td>
<td>WHA resolution WHA51.14 (1998)</td>
</tr>
<tr>
<td>Human African trypanosomiasis in Africa</td>
<td>Elimination as a public health problem – i.e. the detection of less than one case per 10 000 inhabitants in at least 90% of endemic foci and the total number of African cases reported annually reduced below 2000</td>
<td>WHO meeting (2012)</td>
</tr>
<tr>
<td>Leprosy</td>
<td>Elimination as a public health problem – i.e. reduction in incidence in every country to less than one case per 10 000 population</td>
<td>WHA resolution WHA44.9 (1991)</td>
</tr>
<tr>
<td>Lymphatic filariasis</td>
<td>Elimination of the disease as a public health problem and the interruption of transmission of the causative parasites</td>
<td>WHA resolution WHA50.29 (1997) and WHO RCEM resolution EM/RC47/R.11 (2002)</td>
</tr>
<tr>
<td>Rabies</td>
<td>Elimination from WHO South-East Asia and Western Pacific Regions of human rabies transmitted by dogs – defined as the absence of any human rabies case following a bite or other exposure to an indigenous dog for a period of 2 years in an area where (i) circulation of dog rabies virus between dogs has been stopped by immunization and other means and (ii) an effective system for human and dog rabies surveillance and diagnosis is in place</td>
<td>WHO ROSEA (2012)</td>
</tr>
<tr>
<td>Disease</td>
<td>Goal</td>
<td>Source</td>
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<tr>
<td>Schistosomiasis</td>
<td>Elimination, as a public health problem, from WHO American and Western Pacific Regions and from selected countries in Africa</td>
<td>WHO NTD road map (2012)²</td>
</tr>
<tr>
<td>Visceral leishmaniasis</td>
<td>Reduction of annual incidence in every sub-district of India to less than one case per 10 000 population</td>
<td>WHO NTD road map (2012)² and WHO ROSEA (2012)</td>
</tr>
<tr>
<td>Yaws</td>
<td>Eradication – defined as the absence of new cases for a continuous period of 3 years, supported by the absence of evidence of transmission in serosurveys among children aged &lt; 5 years</td>
<td>WHA resolution WHA31.58 (1978)</td>
</tr>
</tbody>
</table>

NTD: neglected tropical diseases; PAHO: Pan American Health Organization; RCEM: Regional Committee for the Eastern Mediterranean; ROSEA: Regional Office for South-East Asia; WHA: World Health Assembly; WHO: World Health Organization.

a Updating of target dates means that the target years given in several World Health Assembly resolutions do not match those shown here.

b Endemic treponematoses.

c In 2015, the working goal is a 5-year cumulative incidence of less than one case per 1000 among children who are aged 6–10 years, were born after the initiation of mass drug administrations and lived in areas covered by such administrations for at least 5 years.
Box 1. **World Health Organization’s definition of terms used in elimination and eradication efforts**\(^9,10\)

**Control**
Reduction of disease incidence, prevalence, morbidity or mortality to a locally acceptable level as a result of deliberate efforts – with continued intervention measures required to maintain the reduction.

**Elimination of disease**
Reduction to zero of the incidence of a specified disease in a defined geographical area as a result of deliberate efforts – with continued intervention measures required to maintain the elimination.

**Elimination of infection**
Reduction to zero of the incidence of infection caused by a specified agent in a defined geographical area as a result of deliberate efforts – with continued measures required to prevent the re-establishment of transmission.

**Elimination as a public health problem**
Control of the manifestations of a disease – at an arbitrarily defined qualitative or quantitative level – so that the disease is no longer considered a public health problem.

**Eradication**
Permanent reduction to zero of the worldwide incidence of infection caused by a specific agent as a result of deliberate efforts – with intervention measures no longer needed.

**Extinction**
Complete removal of the specific infectious agent so that it no longer exists in nature or the laboratory.
**Box 2. Case definitions of podoconiosis**

*Suspected case*

Any lymphoedema of the lower limb of any duration.

*Probable case*

Any lymphoedema of the lower limb present for more than one year in a resident of an endemic area.

*Confirmed case*

Lymphoedema of the lower limb present for more than one year in a resident of an endemic area, for which other causes – e.g. onchocerciasis, lymphatic filariasis, leprosy Milroy syndrome, heart failure and liver failure – have been excluded.
Box 3. Podoconiosis elimination targets

Elimination from an endemic district or implementation unit

Podoconiosis considered to be eliminated if the prevalence of untreated podoconiosis among individuals aged ≥15 years is <1% and >95% of lymphoedema cases are treated adequately after 10 years of programme implementation.

Elimination from country

Podoconiosis is considered to be eliminated when:

- prevalence of untreated podoconiosis among individuals aged ≥15 years, in every village sampled over a 10-year period, is <1%;
- after 10 years of control programme implementation, the prevalence of early signs of podoconiosis among children aged 10–15 years is <0.001%;
- protective shoes are worn by >95% of the population in endemic districts; and
- almost all (>95%) of the lymphoedema cases are treated adequately.