List of slides and explanatory notes

Topic D: Disease transmission, with special reference to schistosomiasis

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Credit individual slides:

World Health Organization
D.1, D.2, D.3, D.8

Danish Bilharziasis Laboratory
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Disease and development are critically connected in many places where poverty, low environmental standards and lack of sufficient resources to ensure adequate environmental management and health care go hand in hand.

The two main pathways by which agricultural development will influence the human health status are the change in environmental receptivity and the change in community vulnerability.

**Environmental receptivity** covers vector ecology and biology: it may include changes in vector abundance, in the genetic composition of species complexes, in the longevity of vectors and in the resistance of vector (and the parasites they carry) to certain chemicals such as insecticides or drugs.

**Community vulnerability** may be affected by changes in economic activities, and in the settlement, re-settlement and migration of people with different levels of immune status or carrying different strains of parasites.

The health services will have to face the resulting new situation, and may or may not have the capacity to deal with it. Whatever the case may be, it is up to the sectors responsible for development to ensure that adverse health impacts are limited to a minimum and that health opportunities are used to a maximum benefit of local communities.

Agricultural development implies changes in the hydrology and the land use patterns in a large area. Thus, both terrestrial and aquatic breeding sites of disease vectors will be affected. The aquatic breeding sites produce vectors of malaria, arboviruses and the filariases (including onchocerciasis). Changes in man-vector contact are reflected in changed incidence rates. Snails and water fleas, also depending on aquatic habitats, will have an impact on the schistosomiasis and dracunculiasis (see below) situation. On the other hand, changes in the incidence of sleeping sickness and leishmaniasis are associated with modifications in terrestrial ecosystems. Vegetation cover is a crucial parameter for some malaria vectors, as it is a determinant of relative humidity.

Dracunculiasis or Guinea worm infection is a vector-borne disease transmitted by water fleas, aquatic copepods, which serve as intermediate hosts in the life cycle of the parasite *Dracunculus medinensis*. Some ten years ago, its distribution included most of tropical semi-arid Africa as well as parts of India and Pakistan. Thanks to the efforts coordinated by the World Health Organization, India and Pakistan will soon be certified as being free of the disease and its area of distribution in Africa has decreased considerably - global elimination of the disease as a public health problem is foreseen by the end of the century.
The transmission of Guinea worm infection exclusively depends on drinking contaminated water, i.e. water with infected water fleas. The disease is caused by a round worm about one meter in length which lives under the surface of the skin. Disability occurs when the female worm emerges, creating a painful blister usually on one of the lower limbs. Secondary infections may further aggravate the affliction. When a Guinea worm blister is immersed in water, the worm releases larvae, which infect the freshwater copepods. Water contact patterns may be related to routine household or agricultural use of water, but people often enter the water to relief the burning pain of the blister.

The disability prohibits walking, working and even routine household activities. The nature of the transmission allows inexpensive, community-based control methods, including health education, providing safe drinking water, applying filters when potentially infected water is used for drinking, and boiling water. The impact of the disease on economic productivity is estimated to be high: a World Bank study of the impact of dracunculiasis in the rice growing belt of Nigeria concluded that rice production may be doubled with the elimination of the disease.

**Slide D.3**

**Contact frequency related to disease transmission.** For some diseases only one infective mosquito bite is sufficient to result in clinical illness. This is notably so in the case of malaria: not only do a large number of so-called sporozoites get injected into the bloodstream, but the parasites undergo further multiplication in the liver before developing into merozoites that infect red blood cells. For other diseases, such as schistosomiasis, only prolonged exposure leads to clinical illness. Such parasites do not multiply in their definitive host, but as the parasite load builds up over the years, clinical symptoms will gradually become apparent.

**Slide D.4**

Small holder irrigation (in this slide in Mali) creates an increased risk for schistosomiasis transmission, particularly in connection with seepage, hydraulic structures that favour vector breeding and insufficient drainage.

Such increased risks depend on a number of factors:

- the creation of suitable habitats for snails (reservoirs, hydraulic structures, canals with slow-flowing water and with abundant aquatic weeds)

- the spatial distribution of human settlements in the irrigation scheme in relation to various water contact points

- human behaviour in terms of agricultural practices and domestic water use, and with respect to sanitation

The risks can be off-set by proper environmental management measures. Disease situations that have arisen as a result of the introduction of small-holder irrigation need
to be addressed by the health services with surveillance and drug distribution programmes.

Small-holder irrigation tends to be more prone to the creation of risk factors, mainly because it is usually less sophisticated than larger state or privately run schemes. This is, however, not necessarily true: in Zimbabwe small-holder farmers have been successfully set up to run a sprinkler irrigation system, which entails little or no health risks.

**Slide D.5**

Reservoirs, in particular night storage reservoirs, provide the perfect habitat for intermediate host snails of schistosomiasis. Irrigation and drainage canals also contribute importantly, especially those where me flow is slow and where there is an abundance of aquatic weeds. Aquatic weed growth is usually more prominent in drainage canals, due to the run off of fertilizer.

Some hydraulic structures in irrigation schemes also mm into snail habitats and may become major transmission sites if children use them for swimming. Duckbill weirs are notorious as transmission sites.

Studies of the Blair Research Laboratory and the Overseas Development Unit of Hydraulics Research/Wallingford have tested designs for self draining structures in the Mushandike Small-holder Irrigation Scheme. Together with general land-leveling, lined canals with an optimal gradient and the provision of latrines in the fields, the introduction of these structures led to a substantial decrease in transmission risks. An example of a free-draining off-take design is presented on the next page.

The most important crops in terms of schistosomiasis transmission risks are rice and sugar cane. Contrary to popular belief, little or no transmission takes place in the irrigated rice fields, where water temperature tends to be too elevated for the snails. Also, in rice production systems there are periods in the cropping cycle when fields are left to dry and canals are drained. Sugar cane production requires larger quantities of water on a permanent basis, which reflects in high risk levels. The social structure of populations working in commercially run sugar cane plantations, and the use of seasonal labour, possibly coming in from infected areas and settling in temporary living quarters with little or no sanitary facilities, further adds to these risk levels.

Aquaculture is often cited as another source of schistosomiasis infection, and it may be when pisciculture of freshwater fish is concerned. Risks are usually reduced if the choice of fish ensures little or no aquatic weeds (for this purpose, the fish culture may have a mixture of marketable fish and fish that consume aquatic weeds), or, even better, if the fish species selected eats snails. In fish ponds with steep walls, water contact of
fishermen may be negligible, but when the ponds have shallow shores fishermen may wade into the water to capture fish.

**Slide D.8**

In addition to agricultural practices, peoples’ movements in rural areas may pose risks, for instance at places where they have to cross streams or creeks and where water contact may be unavoidable.

**Slide D.9**

Many hydraulic structures designed for water management in the scheme become multipurpose structures when local communities start using them for bathing, washing laundry and dishes and watering cattle.

**Slide D.10**

Rural communities involved in large scale irrigated agriculture (such as the area shown in this slide, in the Sudan) depend for their water supply on the irrigation and drainage canals. In these areas ground water is often saline, because of the percolation of nutrients and fertilizer, so wells are not an option. If they can avoid it, members of such communities (usually the women) will not take water from drainage canals, which may be bitter because of fertilizer run-off and pesticide and herbicide residues. As a result, they may have to carry their water over a distance of several kilometers or, in more affluent rural communities, they can buy it from a water trader at a price several times higher than the price their urban counterparts pay for piped water. The lack of adequate sanitation in these communities ensures that the life cycle of the *Schistosoma* parasite is effectively maintained.