THE
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Summary of the Twenty-First Meeting of the International Task Force for Disease Eradication (II) July 10, 2013

The Twenty-First Meeting of the International Task Force for Disease Eradication (ITFDE) was convened at The Carter Center from 9:00 am to 3:30 pm on July 10, 2013 to discuss the current status of progress towards elimination of cysticercosis/taeniasis and towards control of meningococcal meningitis. The Task Force members are Sir George Alleyne, Johns Hopkins University; Dr. Stephen Blount, The Carter Center; Dr. Mickey Chopra, UNICEF; Dr. Donald Hopkins, The Carter Center (Chair); Dr. Adetokunbo Lucas, Harvard University; Dr. Montserrat Meiro-Lorenzo, The World Bank; Professor David Molyneux, Liverpool School of Tropical Medicine (retired); Dr. Mark Rosenberg, Task Force for Global Health; Dr. Lorenzo Savioli, World Health Organization (WHO); Dr. Laurence Slutsker, Centers for Disease Control and Prevention (CDC); Dr. Harrison Spencer, Association of Schools of Public Health; Dr. Dyann Wirth, Harvard School of Public Health; and Dr. Yoichi Yamagata, Japan International Cooperation Agency (JICA) (retired). Five Task Force members (Blount, Hopkins, Lucas, Rosenberg, Wirth) attended this meeting, and two others were represented by alternates (Dr. John Paul Clark for Meiro-Lorenzo and Dr. Mark Eberhard for Slutsker).

Presenters at this meeting were Dr. Amanda Cohn and Dr. Patricia Wilkins of the Centers for Disease Control and Prevention (CDC), and Dr. Arve Lee Willingham III of the University of Copenhagen.

Control of Meningococcal Meningitis

Meningococcal meningitis is an often fatal infection by the bacterium *Neisseria meningitides* that mainly affects tissues of the brain and spinal cord. It is spread from person to person by the respiratory route from carriers, and only infects humans. There is no animal reservoir. There are twelve serotypes, of which serotypes A, B, C, W135, X and Y may cause epidemics.[1] In the "meningitis belt" of sub-Saharan Africa, a region of 300 million persons extending from Senegal to Ethiopia, about 80% of all meningitis cases are caused by serotype A, in highly disruptive and lethal epidemics occurring at 7-14 year intervals and infecting tens or hundreds of thousands of persons, with case fatality rates of 10-15%. The incidence of meningococcal infections in Africa is much higher than in all other geographic areas. These epidemics typically occur during the dry season, and may be abetted by poverty and crowding. Since 2002, serotype W135 has been

[1] World Health Organization, Meningococcal meningitis, Fact Sheet No.141 (November 2012) accessed on 6/12/2013 at http://www.who.int/mediacentre/factsheets/fs141/en/index.html.

associated with smaller epidemics in Africa and South America. Serotypes B and C are the most common varieties found in North America and Europe. Most of the discussion at this meeting focused on serotype A infections in Africa's "meningitis belt". Meningococcal meningitis is not one of the 17 official Neglected Tropical Diseases of the World Health Organization.

Appropriate antibiotic therapy can be used to treat infected persons, once diagnosed, but the most effective intervention is mass immunization. Newer conjugate vaccines developed over the past ten years and administered by intramuscular injection, are much more effective than earlier polysaccharide vaccines. Task Force members were informed of a unique partnership of the Bill & Melinda Gates Foundation, PATH, the World Health Organization, GAVI, and the Serum Institute of India, under the "Meningitis Vaccine Project", which produced a conjugate vaccine (MenAfrVac) against serotype A meningitis that is more immunogenic, heat stable, and much less expensive (~US$0.44/dose vs. $4-$50/dose) than older vaccines. Unlike the older vaccines, the conjugate vaccine also prevents the carrier state, not just active infections, and so helps provide indirect "herd immunity" for the benefit of unimmunized persons as well. Polyvalent conjugate meningitis vaccines have been developed also, but are less immunogenic than monovalent vaccine and there is no vaccine for serotype B.

The new MenAfrVac conjugate vaccine was introduced in a mass campaign in Burkina Faso in December 2010, followed by Mali and Niger. By the end of 2012, the vaccine had been administered to more than 100 million persons (of 300 million at risk) in 10 African countries (of 22 countries at risk).[2] Immunization campaigns are tailored to the circumstances of individual countries. So far, the vaccine has proven to be very effective and safe. Burkina Faso, Mali and Niger had zero confirmed cases of serotype A meningococcal infections in 2012.[3] There is, however, some concern that infection with serotype W may replace serotype A infections, even if the extent of infection and mortality is lower. The plan is to complete coverage of the at risk population in the "meningitis belt" by the end of 2016.

Task Force members discussed the potential roles of risk factors such as antecedent viral infections and cigarette smoking. The possible impact of mass administration of azithromycin for trachoma was also mentioned, as well as the potential role of better hygiene such as hand washing, to prevent spread of the infection.

Conclusions and Recommendations

1. The development, production and roll out of the MenAfrVac conjugate vaccine against serotype A meningococcal meningitis in Africa is a major success story, and an exemplary model for future efforts. Development of such a vaccine was a featured recommendation when the ITFDE considered this topic in 2003 and its achievement is an indication of the significant progress made against meningococcal meningitis since then.
2. The apparent safety and impact on serotype A infections of the new MenAfrVac vaccine are impressive, and engenders hope that serotype A infections may be eliminated altogether eventually, but the vaccine and its effects need to be observed for several more years in order

[2] World Health Organization, 2013. Meningococcal disease in countries of the African meningitis belt, 2012—emerging needs and future perspectives. *Wkly Epidemiol Rec* 88:129—136.
[3] Conference Report, 2013. Priorities for research on meningococcal disease and the impact of serogroup A vaccination in the African meningitis belt. *Vaccine* 31:1453—1457.

to fully assess these features. A major research need now is for enhanced surveillance and good diagnostic facilities to monitor the occurrence of meningitis of various serotypes as well as any adverse events following mass immunization efforts.

3. Additional research is also recommended to assess costs associated with meningococcal epidemics and cost savings associated with prevention of such epidemics, as well as studies to confirm the safety and effectiveness of including this new vaccine in routine childhood immunization programs and to assess the possible role of associated viral infections.
4. An effective vaccine is also needed to prevent serotype B infections.

Elimination of Taeniasis/Cysticercosis

Taeniasis/cysticercosis (T/C) is one of the 17 Neglected Tropical Diseases officially recognized by the World Health Organization, and it is one of the original six diseases declared to be eradicable by the ITFDE in 1993. This disease occurs sporadically in urban and rural pig-raising and pork-consuming parts of the world, and it is closely associated with poverty. Not everyone agrees that T/C is a zoonosis, since people, not pigs, are the definitive host of the parasite. People may become infected in either of two ways. Humans who eat inadequately cooked pork may have the adult tapeworm develop in their intestine and subsequently excrete infective eggs and proglottids of the parasite in their feces. People or pigs that ingest feces or feces-contaminated food or water containing infective eggs or proglottids may develop cysts containing larval stages of *Taenia solium*. In humans, cysts that develop in the central nervous system can cause neurocysticercosis, a serious disease that may include epilepsy and other neurological abnormalities, which is the main reason why this parasite is so important. Neurocysticercosis is the leading cause of preventable epilepsy in the world. But cysticercosis in humans is a dead end for the parasite. Humans with neurocysticercosis do not contribute to the transmission of the disease. In pigs that ingest eggs of this parasite in human feces, the cysts develop in the muscles and other tissues, and it is by consuming inadequately cooked cyst-bearing pork that human beings are infected and allow the parasites to mature in their intestines and complete the transmission cycle. An adult tapeworm may live in a person for several years. There is no reservoir of this infection in wildlife, however dogs may be infected with *T. solium* cysts and may play a role in transmission in areas where dog meat is consumed.

The main intervention to stop *transmission* of this parasite is improved sanitary practices among human beings, to prevent the contamination of the environment by human feces containing *Taenia* eggs, since it is by ingesting such egg-containing human feces that pigs become infected and that humans acquire cysticercosis. Secondary lines of defense are to deny pigs access to human feces by not allowing them to range freely, to vaccinate pigs, and mass treatment of pigs with anthelminthic drugs. Taeniasis in humans may be diagnosed by microscopic examination of feces, by detection of tapeworm antigens (coproantigen) in the feces, or by detection of antibodies or antigens in serum. Human infections may be treated by albendazole or praziquantel administered orally in appropriate doses, and mass administration of these drugs for treating intestinal helminthes or schistosomiasis, respectively, may limit infections with pork

tapeworm in some areas.[4] Distinguishing *T. solium* (the pork tapeworm, which causes cysticercosis) from *T. saginata* (the beef tapeworm) and *T. asiatica*, which do not cause cysticercosis, is difficult, and two of these infections may co-exist in an area. Cysticercosis in humans may be diagnosed by characteristic radiologic pattern, biopsy of subcutaneous nodules, or detection of antigens and antibodies in the serum. Not all of the available serological tests are suitable for program use or commercially available. Infected pigs may be diagnosed by finding characteristic cysts on the underside of their tongue, or in the muscles of slaughtered animals. Infected pigs are of reduced commercial value, which provides a potential financial incentive to farmers to raise healthy cyst-free animals, but production of free-ranging pigs is less expensive, and inadequate inspection of slaughtered pigs allows cyst-containing pork to be sold and consumed.

Taeniasis is widespread in parts of Asia, Africa and Latin America, and it occurs in clusters of infected pigs and humans, but surveillance for this infection is still poor. Available data suggest that T/C may be spreading due to increasing consumption of pork, increased raising of pigs to meet the increased demand for protein, and the financial attractiveness of raising pigs by allowing them to range freely and scavenge, rather than having to secure feed stuff to provide pigs kept in a restricted enclosure.[5] Some surveys of humans and pigs over the past decade suggest that the risk of taeniasis and of cysticercosis is greatest in parts of sub-Saharan Africa, but others do not support this. The disease is also believed to also be highly endemic in parts of Latin America.

Discussion at this meeting confirmed that the main tools available to combat this infection are surveillance and diagnosis to detect infected people and pigs, mass treatment of people who are infected with taeniasis or at-risk; mobilization of communities for improved sanitation ("Community Led Total Sanitation"); treatment and vaccination of pigs; inspection and elimination of infected pigs; and education of people to cook pork thoroughly. Over the past decade, pilot studies to elucidate the effectiveness and practicality of various combinations of interventions to reduce taeniasis have been conducted in Honduras, Mexico, Peru, Tanzania and Zambia, with mixed results.[5] A project funded by the Bill & Melinda Gates Foundation in northern Peru between 2003 and 2010 showed that simultaneous mass treatment of humans and pigs and vaccination of pigs could interrupt transmission successfully, but the intensity of interventions required was deemed "difficult to transfer to routine settings elsewhere".[6] Sustained interruption of transmission of this parasite on a national scale has not yet been achieved in any resource poor country.

Task Force members noted increased surveys for this disease and development of the porcine vaccine since this subject was reviewed in 2003. However routine surveillance and reporting are still very poor in most affected countries. The highly successful mobilization of poor villagers in Amhara Region of Ethiopia to build and use hundreds of thousands of latrines in a few years as a part of efforts to combat trachoma was described as an example of the potential utility of

[4] Winkler AS, 2012. Neurocysticercosis in sub-SaharanAfrica: a review of prevalence, clinical characteristics, diagnosis, and management. *Pathog Glob Health* 106:261—274.
[5] Assana E, Lightowlers MW, Zoli AP, Geerts S, 2013. *Taenia solium* taeniosis/cysticercosis in Africa: Risk factors, epidemiology and prospects for control using vaccination *Vet Parasitol* 195:14—23.
[6] World Health Organization, 2011. Report of the WHO Expert Consultation on Foodborne Trematode Infections and Taeniasis/Cysticercosis. WHO/HTM/NTD/PCT/2011.3.

Community Led Total Sanitation to combat taeniasis.[7] Task Force members suggested that greater attention should be given to reducing transmission by improving human hygiene and sanitation. Inspection of the tongues of pigs in slaughterhouses could be an inexpensive strategy to rapidly detect foci of infected pigs and humans, and thus determine where interventions need to be implemented. Farmers must be convinced why it would be in their financial interest to raise pigs more hygienically, and evidence is needed to support that assertion.

Conclusions and Recommendations

1. The Task Force noted some progress to combat T/C over the past decade, notably increased surveys of infection in humans and pigs, and development of an effective vaccine for immunizing pigs.
2. The Task Force reaffirmed its conclusion that transmission of *T. solium* infections can be interrupted completely, and the disease eradicated, but more extensive surveillance and interventions are required.
3. As the Task Force recommended ten years ago, it seems advisable to identify one or two countries with strong political will to attack this problem and help them implement a nationwide effort, tailored to their circumstances and using existing tools, while stressing the importance of educating and mobilizing people in at-risk communities to cease open defecation and to cook pork thoroughly.
4. Studies are needed to document the costs of interventions, whether all available interventions need to be implemented together and at the same time, which of the interventions is the most effective, whether there is a core set of interventions that must be used, and the benefits to farmers of better pig husbandry practices.
5. Countries should be helped to improve surveillance for *T. solium* infections in people and pigs, and to report such data to WHO.
6. Other research priorities include the need for rapid, affordable, sensitive and specific tests to detect *T. solium* infections in humans and in pigs, and to ascertain the effects of mass drug administration of praziquantel and albendazole on prevalence of taeniasis in those populations.

[7] Ngondi J, Teferi T, Gebre T, Shargie EB, Zerihun M, Ayele B, Adamu L, King JD, Cromwell EA, Emerson PM, 2010. Effect of a community intervention with pit latrines in five districts of Amhara, Ethiopia. *Trop Med Int Health* 15: 592—599.