International Scientific Meeting on Nodding Syndrome

Kampala, Uganda

30 July – 1 August 2012

Meeting Report
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ACKNOWLEDGEMENTS

This document is a report of the first International Scientific Meeting on Nodding Syndrome that was generously hosted by the Government of Uganda. The meeting was organized jointly by the World Health Organization Regional Office for Africa, the Regional Office for the Eastern Mediterranean, country offices in Uganda and South Sudan, and WHO Headquarters, in collaboration with the Ministry of Health of Uganda, the Centers for Disease Control and Prevention and the United Kingdom Department for International Development.

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<thead>
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<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>ACDIPE</td>
<td>Action for Disadvantaged People</td>
</tr>
<tr>
<td>AED</td>
<td>Anti-epileptic drugs</td>
</tr>
<tr>
<td>APOC</td>
<td>African Programme for Onchocerciasis Control</td>
</tr>
<tr>
<td>ASF</td>
<td>African swine fever</td>
</tr>
<tr>
<td>BMGF</td>
<td>Bill and Melinda Gates Foundation</td>
</tr>
<tr>
<td>BNI</td>
<td>The Bernhard Nocht Institute for Tropical Medicine (BNI), Germany</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention, USA</td>
</tr>
<tr>
<td>CDTI</td>
<td>Community Directed Treatment with Ivermectin</td>
</tr>
<tr>
<td>CNS</td>
<td>Central nervous system</td>
</tr>
<tr>
<td>CSF</td>
<td>Cerebrospinal fluid</td>
</tr>
<tr>
<td>DFID</td>
<td>Department of International Development, UK</td>
</tr>
<tr>
<td>DFG</td>
<td>Deutsche Forschungsgemeinschaft</td>
</tr>
<tr>
<td>DGF</td>
<td>Democratic Governance Facility</td>
</tr>
<tr>
<td>DNA</td>
<td>Deoxyribonucleic acid</td>
</tr>
<tr>
<td>DRC</td>
<td>Democratic Republic of Congo</td>
</tr>
<tr>
<td>EBV</td>
<td>Epstein-Barr virus</td>
</tr>
<tr>
<td>EEG</td>
<td>Electroencephalogram</td>
</tr>
<tr>
<td>EDCTP</td>
<td>European and Developing Countries Clinical Trial Partnerships</td>
</tr>
<tr>
<td>EMG</td>
<td>Electromyography</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>HCW</td>
<td>Health-care workers</td>
</tr>
<tr>
<td>IDPs</td>
<td>Internally Displaced Persons</td>
</tr>
<tr>
<td>IDSR</td>
<td>Integrated Disease Surveillance and Response</td>
</tr>
<tr>
<td>IRD</td>
<td>Institut de Recherche pour le Développement, France</td>
</tr>
<tr>
<td>KAP</td>
<td>Knowledge, Attitudes and Practices</td>
</tr>
<tr>
<td>MDP</td>
<td>Mectizan Donation Program</td>
</tr>
<tr>
<td>M&amp;E</td>
<td>Monitoring and Evaluation</td>
</tr>
<tr>
<td>MMWR</td>
<td>Morbidity and Mortality Weekly Record</td>
</tr>
<tr>
<td>MOE</td>
<td>Ministry of Education</td>
</tr>
<tr>
<td>MOH-RSS</td>
<td>Ministry of Health, Republic of South Sudan</td>
</tr>
<tr>
<td>MOH-WES</td>
<td>Ministry of Health, Western Equatorial State</td>
</tr>
<tr>
<td>MRI</td>
<td>Magnetic resonance imaging</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-governmental organization</td>
</tr>
<tr>
<td>NIH/NIAID</td>
<td>National Institutes for Health /National Institute of Allergy and Infectious Diseases</td>
</tr>
<tr>
<td>NS</td>
<td>Nodding Syndrome</td>
</tr>
<tr>
<td>NTF</td>
<td>National Task Force</td>
</tr>
<tr>
<td>OPM</td>
<td>Office of the Prime Minister</td>
</tr>
<tr>
<td>PCR</td>
<td>Polymerase chain reaction</td>
</tr>
<tr>
<td>Rtd</td>
<td>Retired</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Name</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>UK:</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>UNHRO:</td>
<td>Uganda National Health Research Institute Organization</td>
</tr>
<tr>
<td>URT:</td>
<td>United Republic of Tanzania</td>
</tr>
<tr>
<td>USA:</td>
<td>United States of America</td>
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<tr>
<td>WHO:</td>
<td>World Health Organization</td>
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</table>
EXECUTIVE SUMMARY

Nodding syndrome (NS) is a neurological condition with unknown etiology. It was first documented in the United Republic of Tanzania (URT) in the 1960s, then later in the Republic of South Sudan in the 1990s and in northern Uganda in 2007. Typically, NS affects children between the ages of 5 and 15 years causing progressive cognitive dysfunction, neurological deterioration, stunted growth and a characteristic nodding of the head. Despite numerous and extensive investigations in all three countries, very little is known about the disease and its cause.

The World Health Organization (WHO), in collaboration with the Ministry of Health (MOH), Uganda and the Centers for Disease Control and Prevention (CDC), convened the first scientific meeting on Nodding Syndrome in Kampala, Uganda, from 30 July to 1 August 2012.

More than 100 participants were invited to the meeting, including technical staff from the ministries of health of South Sudan, URT and Uganda. Representatives from related Ugandan ministries, such as the Ministry of Agriculture, Ministry of Disaster Preparedness, and Ministry of Information and National Guidance, among others, were also invited. Attendees included staff from training and research institutions, local nongovernmental organizations (NGOs) supporting NS interventions, technical and bilateral partners (CDC, the Department for International Development –DFID, the United States Agency for International Development–USAID) and representatives from WHO.

The meeting served as a forum for sharing information on NS research and experiences from countries affected by the disease. Objectives for the meeting included:

- Outlining a critical research agenda for NS, based on knowledge gaps;
- Defining and/or recommending interventions for management and control, based on current information;
- Harmonizing surveillance case definitions; and
- Identifying a collaborative framework that would enable recommendations from the meeting to move forward.

The scientific meeting was organized around thematic areas and structured as summarized below.

**Session 1:** Disease epidemiology, designation of illness and case definitions used for research and interventions
**Session 2:** Etiology and risk factors
**Session 3:** Clinical presentations, laboratory and neurological investigations
**Session 4:** Response plan including case management
**Session 5:** Development of critical research agenda
**Session 6:** Surveillance standards and control interventions
**Session 7:** Development of research collaborative framework and next steps

In addition, poster presentations covering various thematic areas, including response and interventions, were displayed.

Conclusions from the meeting included the following:

- Participants agreed that “Nodding Syndrome” is the appropriate designation of the illness based on its presentation and what is currently known about it.
Although independent researchers and the respective ministries of health of the affected countries have conducted over ten investigations on NS, etiology, mode of transmission, pathogenesis and clinical course remain unknown.

NS appears to be an epidemic epileptic encephalopathy; the head nodding is caused by atonic seizures.

Estimates provided at the meeting indicate NS may affect up to 10,000 or more children and adolescents from South Sudan, URT and Uganda. However, the true burden of the syndrome in the three countries is unknown and requires systematic documentation.

Evidence provided at the meeting indicates an increasing trend in the number of new cases being detected, as well as a widening geographical coverage in South Sudan and in Uganda.

The most affected age group appears to be 5 to 15 years old, with no sex differentiation.

A number of causes have been ruled out. Genetic predisposition and other potential infectious, environmental and toxicological hypothetical causes require further investigation.

Studies from Uganda and South Sudan show low levels of serum vitamin B6 (pyridoxine) among the study population. The association of low serum B6 levels with the occurrence of this atypical seizure disorder requires further investigation.

Areas where NS is present are known to have high prevalence of both onchocerciasis and epilepsy. Current findings indicate significant association with onchocerciasis. This relationship, particularly the biological plausibility of a potential causality, requires further investigation.

The affected populations are impoverished, have experienced severe food shortages and have a history of internal displacement.

Case definitions used to date are inconsistent across countries and amongst researchers. Meeting participants agreed on case definitions for suspect, probable and confirmed cases.

NS management is not standardized and there is no established definitive treatment. Anti-epileptic drugs (phenobarbitone, sodium valproate), which have had various outcomes with patients, are the main drugs currently used for treatment. The meeting recommended a community-wide syndromic and holistic approach to NS case management focused on controlling seizures, nutritional supplementation in malnourished children and psychosocial support for the affected children, families and communities. Cognitive, physical and/or rehabilitation therapy was also identified as important treatments for long-term case management.

In order to maintain a collaborative research framework, it was recommended that national and international researchers plan and coordinate activities. Multidisciplinary research teams should aim to involve experts, where relevant, based on different methodologies required for a particular project.

Several general and specific recommendations resulted from the meeting. These included an agreement to create an NS research coordination body comprising national and international experts and to convene a follow-up meeting in two years. The conference also appealed to WHO to fulfill its leadership and coordination role in the fight against NS.

Outcomes from the meeting were presented to the National Task Force (NTF) on NS in Uganda and were used to review and update the Uganda National Response Plan. The following report covers only the three-day international scientific meeting.
PART I. MEETING METHODOLOGY

1. Background to the scientific meeting

Nodding syndrome (NS) is a neurological condition with unknown etiology. It was first documented in the United Republic of Tanzania (URT) in the 1960s, then later in the Republic of South Sudan in the 1990s and in northern Uganda in 2007. Typically, NS affects children between the ages of 5 and 15 years old, causing progressive cognitive dysfunction, neurological deterioration, stunted growth and a characteristic nodding of the head. Despite numerous and extensive investigations in all three countries, very little is known about the cause of the disease.

The current outbreak in northern Uganda has recorded 3,094 suspect cases and 170 deaths in Kitgum, Lamwo and Pader districts, as of 14 February 2012. Unverified cases have also been reported in Gulu and other districts in the north, indicating increasing geographical coverage.

The Ministry of Health of Uganda requested international assistance in investigating and responding to the current outbreak. A National Response Plan to NS was developed by the Government, which incorporated various research activities focused on the challenges of NS. The Government requested further support from WHO to convene a scientific meeting that would facilitate the sharing and exchange of information on the illness in order to help shape public health activities and define a focused NS research agenda.

WHO, in collaboration with the Ministry of Health of Uganda and the United States (US) Centers for Disease Control and Prevention (CDC), thus convened the first scientific meeting on nodding syndrome in Kampala, Uganda from 30 July to 1 August 2012.

More than 100 participants were invited to the meeting, including technical staff from the ministries of health of South Sudan, URT and Uganda. Representatives from related Ugandan ministries, such as the Ministry of Agriculture, Ministry of Disaster Preparedness, and Ministry of Information and National Guidance, among others, were also invited. Attendees included staff from training and research institutions, local nongovernmental organizations (NGOs) supporting NS interventions, technical and bilateral partners such as CDC, the Department for International Development (DFID), United Kingdom, the United States Agency for International Development (USAID) and representatives from WHO. A full list of meeting participants is included in Annex 3.

A one-day national meeting organized by the Ugandan NS National Task Force (NTF) followed the three-day conference. The goal was to provide feedback and to review and update the Ugandan NS National Response Plan, based on outcomes from the scientific meeting.

2. Objectives and expected outcomes

The general objectives were to create a framework for NS research and to outline a strategy for NS management. More specifically, objectives included:

- reviewing current knowledge on NS, identifying gaps in knowledge and defining critical research needs;
- developing a plan for further scientific investigations;
- harmonizing case definitions and defining key interventions in NS management and control; and
exploring the potential to establish a collaborative research framework, as well as identifying possible research funding sources.

Meeting outcomes aimed to provide a basis for the optimization of research agendas, response plans in the affected countries and resource mobilization and allocation.

3. Meeting methodology and proceedings

Over the course of three days, the meetings sessions were as follows:

- **Opening session.** The meeting opened with introductions of participating organizations and institutions, a viewing of documentaries on NS and opening remarks by the Director-General of the Ministry of Health of Uganda. During this session, speakers acknowledged the magnitude and severity of the problem, as well as the importance of effective, international collaboration focused on identifying the etiology and ultimately a cure. All speakers underscored the significance of this meeting in laying the groundwork for collaboration and in enabling affected countries to better optimize their response to the disease.

- **Plenary presentations.** Plenary presentations focused on different thematic areas, which included epidemiology, possible causes and risk factors, clinical presentations, laboratory and neurological findings, response plan and case management studies, and key concepts for collaborative research frameworks.

- **Technical sessions.** Seven different sessions were focused on technical issues, organized by thematic areas. In addition, posters covering various thematic areas, including response and interventions, were displayed.

- **Group work.** Three different group sessions were conducted during the meeting focused on identifying research gaps, defining a research agenda, defining NS, harmonizing case definitions, developing surveillance strategies and identifying lab criteria for diagnosis. Risk communication needs and interventions for clinical patient management were also outlined during group work.

- **Facilitated discussions.** The draft recommendations that were generated over the three-day discussions, including next steps, were summarized, presented, discussed and agreed upon during plenary.

- **Closing remarks.** Dr Jenny Amery of DFID, UK, stressed the importance of fighting NS. Dr Scott Dowell of the CDC, Atlanta emphasized the need to maintain a sense of urgency. The WHO country representative in Uganda highlighted the importance of using the outcomes of this meeting to improve the understanding of NS and the lives of those affected. The Director-General of Health Services, Ministry of Health of Uganda, Dr Jane Aceng, closed the meeting with an appeal to the three affected countries to coordinate their efforts to fight NS.

A full meeting agenda is outlined in Annex 2.
PART II. CURRENT KNOWLEDGE ON NODDING SYNDROME

4. History and epidemiology

To date, Nodding Syndrome is known to occur in the southern region of the United Republic of Tanzania (URT) (Mahenge mountains, Ulanga District), South Sudan (Western Equatoria State, Eastern Equatoria State, Central Equatoria State, and Lakes State) and northern Uganda (Pader, Kitgum and Lamwo districts, with new cases starting to present in Gulu, Amuru, Oyam and Lira districts).

Jilek et al (1962) first described several children with attacks of “head nodding” in Mahenge, a region in URT. The current burden of NS in URT is unknown but observations during case control studies in 2005 and 2009 in the Mahenge region do not suggest a notable increase in the number of cases relative to those detected in the late 1950s and early 1960s.

Samaritan Purse, a local NGO, described observations of head nodding among several children in southern Sudan in the Lui and Amadi villages of East Mundri County in the mid-1990s. A physician from Samaritan Purse reported the outbreak to WHO in 1997. The 2001-2002 investigations by WHO and partners estimated the prevalence of NS at 4.6% among a small population in Western Equatoria State, which appeared to have the highest burden of the illness. By 2003, an estimated 300 cases had been reported from this region. The Ministry of Health of South Sudan estimates the current burden of NS at between six and seven thousand cases, but no systematic large-scale prevalence study has been conducted. The Mundri region in the northeast of Western Equatoria is the presumed epicentre for the disease.

In 2008 and 2009, an illness consistent with NS was reported from Kitgum and Pader Districts in northern Uganda. As of February 2012, Uganda has reported over 3 000 cases of NS from the three districts of Kitgum, Lamwo and Pader. A community survey is underway in Uganda to determine the real burden of NS in the affected districts. Kaiser et al (2009) referred to a phenomenon of head nodding observed in the Kabarole District in Western Uganda as possibly constituting a feature of an epileptic syndrome caused by Onchocerca volvulus (O. volvulus).

The prevalence of both onchocerciasis and epilepsy in the areas affected by NS is high. The affected populations are impoverished and experience regular and prolonged periods of severe food shortages. In South Sudan and in northern Uganda, affected populations have a history of internal displacement and living in internally displaced persons (IDPs) camps.

Familial clustering has been observed in some families with NS patients, with more than one sibling with NS and/or siblings or relatives with other forms of epilepsy.

The age of onset in the vast majority of cases ranges between 5 and 15 years old, but cases have been reported in children as young as 2 years old and in adults up to 32 years old. There is no observed significant difference in the proportion of males to females among the affected, nor is there an observed seasonal variation.

Table 1 lists the investigations conducted to date whose results were presented by representatives of the investigative teams and discussed during the meeting in Kampala.
Table 1.

<table>
<thead>
<tr>
<th>Country and date</th>
<th>Reference</th>
<th>Type of data</th>
<th>Major findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>URT 1965</td>
<td>Jilek-Aal</td>
<td>Case descriptions</td>
<td>Noted nodding as a symptom in a description of epilepsy.</td>
</tr>
<tr>
<td>Liberia1983</td>
<td>Van der Waals (1983)</td>
<td>Case descriptions</td>
<td>Description of seizure disorders mentioned “dorsoventral movements of the head” and “nodding of the head.” The population recognized this as a distinct disorder. The majority of cases saw a progression to general tonic-clonic convulsions.</td>
</tr>
<tr>
<td>URT 2008</td>
<td>Winkler (2008)</td>
<td>Thorough clinical description of 62 patients.</td>
<td>Forty-eight Cerebrospinal fluid (CSF) samples were mostly clear and two of ten EEGs showed interictal changes. Eight of twelve cases showed nonspecific MRI changes.</td>
</tr>
<tr>
<td>Uganda 2009</td>
<td>Sejvar [In preparation]</td>
<td>Case series</td>
<td>Neurological and clinical characterization of the syndrome noted and EEGs documented atonic seizure as the cause for nodding. There were negative CSF and MRI findings.</td>
</tr>
<tr>
<td>Uganda 2009-10</td>
<td>Foltz [Under revision]</td>
<td>Descriptive epidemiology and case-control study</td>
<td>Weak associations with munitions and crushed roots noted; stronger association with antibodies against Onchocerca volvulus.</td>
</tr>
<tr>
<td>South Sudan 2011</td>
<td>Nyungura (2011)</td>
<td>Description of 96 cases</td>
<td>Documented the disease as the same syndrome in Uganda. Skin snips with microfilaria shown to be more common among cases than controls.</td>
</tr>
<tr>
<td>South Sudan 2011</td>
<td>Riek (2012)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Presentation by Dr. Scott Dowell, CDC, Atlanta. For further information on the investigation, see Bibliography. Note that case definitions differed between investigations.

Given that the various investigations used different criteria to identify cases, and that systematic evaluations of prevalence and incidence are outstanding, data is not necessarily comparable. Based on the data available, however, it can be concluded that in both South Sudan and northern Uganda, the number of cases has increased rapidly since the first reports in the mid-1990s and the 2000s, respectively, and that the geographic area from which cases are reported is expanding.
5. **Etiology and risk factors**

A considerable range of potential risk factors were examined in four case-control studies covering 486 subjects in South Sudan and northern Uganda, as well as in clinical case series in URT, South Sudan and northern Uganda. Definition of cases varied between studies and, given the currently available methods for NS diagnosis, it is not certain that the controls were indeed controls as opposed to children pre-NS onset.

Table 2 outlines the etiological and risk factors investigated to date and summarizes conclusions from the data.

**Table 2. Etiological factors and data conclusions**

<table>
<thead>
<tr>
<th>Factors evaluated</th>
<th>Conclusions based on results</th>
<th>Investigations and references*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Helminths</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onchocerca volvulus</td>
<td>Further investigations needed</td>
<td>• URT 2005 (case series, Winkler et al (2008))</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• South Sudan 2011 (case control, case series, NS meeting presentation, Riek et al (2011))</td>
</tr>
<tr>
<td>Mansonella streptocerca</td>
<td>Further investigations needed</td>
<td>• Uganda 2009-2010 (case control, case series, NS meeting presentation, Foltz et al (2012), Sejvar et al (2012))</td>
</tr>
<tr>
<td>Mansonella perstans</td>
<td>Further investigations needed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Uganda 2009-2010 (case control, case series, NS meeting presentation, Foltz et al (2012), Sejvar et al (2012))</td>
</tr>
<tr>
<td>Loa loa</td>
<td>Ruled out based on lack of Loa loa endemicity</td>
<td>• South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))</td>
</tr>
<tr>
<td>Wuchereria bancrofti</td>
<td>Ruled out based on case-control study</td>
<td>• South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))</td>
</tr>
</tbody>
</table>
### Other infections

<table>
<thead>
<tr>
<th>Condition</th>
<th>Ruled out based on lack of co-endemicity in URT, Pader/Kitgum in northern Uganda, rate of infection in case control study in Mundri County in South Sudan, serological testing in Uganda</th>
<th>South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))</th>
</tr>
</thead>
<tbody>
<tr>
<td>African Swine Fever (ASF)</td>
<td>Unlikely, based upon inconsistent epidemiology (ASF is not known to be a human pathogen), and failure to detect nucleic acid sequences of ASF on PCR</td>
<td>Uganda 2009-2010 (case control, case series, NS meeting presentation, Foltz et al (2012), Sejvar et al (2012))</td>
</tr>
<tr>
<td>Hepatitis E</td>
<td>Ruled out based upon inconsistent epidemiology, and failure of laboratory testing to demonstrate a preponderance of infection among NS children</td>
<td>Uganda 2009-2010 (case control, case series, NS meeting presentation, Foltz et al (2012), Sejvar et al (2012))</td>
</tr>
<tr>
<td>Cysticercosis</td>
<td>Not consistent with current data</td>
<td>URT 2005 (case series, Winkler et al. (2008))</td>
</tr>
<tr>
<td>Malaria</td>
<td>Unlikely since the presentation is inconsistent with cerebral malaria, and there was no difference in the presence of parasites on blood smears between cases and controls</td>
<td>Uganda 2009-2010 (case control, case series, NS meeting presentation, Foltz et al (2012), Sejvar et al (2012))</td>
</tr>
<tr>
<td>Meningitis</td>
<td>Unlikely since no consistent history of signs and symptoms suggestive of viral or bacterial meningitis could be elicited from cases</td>
<td>Uganda 2009-2010 (case control, case series, NS meeting presentation, Foltz et al (2012), Sejvar et al (2012))</td>
</tr>
<tr>
<td>Measles</td>
<td>Unlikely based on lower frequency of history of measles among cases compared to controls and biological plausibility</td>
<td>South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))</td>
</tr>
<tr>
<td>Prion disease</td>
<td>Unlikely based on incompatible clinical presentation, and uncharacteristic EEG and MRI findings. Histopathology, however, would be required to definitively exclude this possible etiology.</td>
<td>URT 2005 (case series, Winkler et al. (2008))</td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Relief food, seeds for planting</td>
<td>Ruled out based on case control studies</td>
<td>Uganda 2009-2010 (case control, case series, NS meeting presentation, Foltz et al (2012), Sejvar et al (2012))</td>
</tr>
<tr>
<td>Urinary thiocyanates</td>
<td>Ruled out based on case control studies and inconsistency of clinical presentation with characteristics of bitter cassava toxicity</td>
<td>Uganda 2009-2010 (case control, case series, NS meeting presentation, Foltz et al (2012), Sejvar et al (2012))</td>
</tr>
<tr>
<td>B12, A, Selenium</td>
<td>Ruled out based on case control studies</td>
<td>Uganda 2009-2010 (case control, case series, NS meeting presentation, Foltz et al (2012), Sejvar et al (2012))</td>
</tr>
<tr>
<td>“Local” foods (red and unripe sorghum, cassava)</td>
<td>Unlikely based on comparison of data for cases and controls</td>
<td>South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>Further investigations needed</td>
<td>South Sudan 2011 (case control, case series, NS meeting presentation)</td>
</tr>
<tr>
<td>Early malnutrition</td>
<td>Further investigations needed</td>
<td>South Sudan 2011 (case control, case series, NS meeting presentation)</td>
</tr>
<tr>
<td>Fungal contamination of local food</td>
<td>Further investigations needed</td>
<td>South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))</td>
</tr>
</tbody>
</table>
## Toxic/Environmental factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Status</th>
<th>References</th>
</tr>
</thead>
</table>
| Crushed roots (Herbal / traditional medicinal remedies) | Unlikely based on case control studies | - South Sudan 2011 (case control, case series, NS meeting presentation)  
| Exposure to ammunitions              | Unlikely based on the lack of data to support use of chemical weapons and lack of biological plausibility for exposure to other types of ammunition | - South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))  
- South Sudan 2011 (case control, case series, NS meeting presentation, Riek et al (2011)) |
| Mercury, arsenic, lead, copper       | Ruled out based on laboratory data | - South Sudan 2011 (case control, case series, NS meeting presentation)  
| Pesticides                          | Ruled out based on case control study | - South Sudan 2011 (case control, case series, NS meeting presentation)  
| Other environmental toxins           | Further investigations needed  | - South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002)) |

### Other causes

<table>
<thead>
<tr>
<th>Cause</th>
<th>Status</th>
<th>References</th>
</tr>
</thead>
</table>
| Genetic                              | Further investigations needed  | - URT 2005 (case series, Winkler et al (2008))  
- South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))  
- South Sudan 2011 (case control, case series, NS meeting presentation) |
| Psychogenic                          | Further investigations needed  | - Musisi, NS meeting presentation: Neuropsychiatric aspects of NS in Uganda: a possible role of psychotrauma |
| Population displacement, poverty     | Further investigations needed  | - South Sudan 2001-2002 (case control, case series, NS meeting presentation, Anker et al (2002))  
- South Sudan 2011 (case control, case series, NS meeting presentation) |

For further information on the study details, see the Bibliography. Note that case definitions differed between investigations.
None of the investigations to date have determined the cause (or causes) of NS. It is possible, and perhaps likely, that several potential aetiologies involving infectious agents, environments and hosts may be involved.

Several of the hypothesized causes were investigated and the list subsequently narrowed down, while others still require further examination. Of significance is the persistent epidemiological association with *Onchocerca volvulus*, *Mansonella streptocerca*, *M. perstans*, early malnutrition, vitamin B6 deficiency, fungal contamination of local food, genetic pre-disposition, population displacement and psychogenic causes. These were among the potential etiological/ risk factors identified during the meeting as requiring further investigation (see section 7).

**Infection with *O. volvulus***. The association between NS and *O. volvulus* infection has been investigated in South Sudan, northern Uganda and in the URT because of the high level of endemicity in the affected areas. A higher prevalence was found among children with NS than among children without NS. No evidence for the presence of *O. volvulus* in the cerebrospinal fluid was found.

A recent meta-analysis supports the conclusion that the prevalence of onchocerciasis is positively associated with the occurrence of epilepsy. The intensity of infection may be a key factor given the correlation between the microfilaria burdens in individuals with epilepsy and the level of endemicity in the area where they live.

The prevalence of *O. volvulus* increases with age. The rate of increase and the ultimate level of infection are dependent on the area’s endemicity. The severity of *O. volvulus*-related skin and anterior eye pathology is associated with the microfilaria burden in the skin or anterior chamber of the eye, mediated by inflammatory responses to the microfilaria (an exception is chronic hyperactive onchodermatitis). In contrast, posterior eye disease (chorioretinitis, optic neuritis) is not associated with the microfilaria burden and potentially due to antigenic cross-reactivity between *O. volvulus* and retinal antigens.

**Infection with *Mansonella streptocerca* and infection with *Mansonella perstans***. A higher prevalence of *M. perstans* infection in cases than in controls was found in South Sudan. Gene sequences from *O. volvulus* antibody-negative NS cases were more closely related to *M. streptocerca* and *M. perstans* than *O. volvulus*.

**Early childhood malnutrition***. All populations where NS occurs, including the Wapogoro in the Mahenge area in URT, have experienced and/or are continuing to experience severe food shortages. In South Sudan, a case-control study suggested a possible association between food shortages in the first two years of life and NS. Exposure to food shortage-associated potential risk factors needs further evaluation, as does pre-natal food deprivation.

**Vitamin B6 deficiency***. Case control studies from Uganda and South Sudan showed low levels of serum vitamin B6 (pyridoxine) among the study population of children. Although the low levels were more pronounced among cases than controls, the occurrence of low levels among both NS cases as well as non-affected individuals fails to establish a conclusive association. Of note is an association of low serum B6 levels with the occurrence of atypical seizure disorder among children, known as pyridoxine dependent seizures. This relationship requires further investigation.

**Fungal contamination of local food***. Investigations to date have not indicated an association with fungal contamination of local food, but they have not been thorough or systematic enough to consider mycotoxins as an unlikely or ruled out cause or contributing factor.
**Genetic pre-disposition.** In URT and South Sudan, multiple cases of NS and/or other types of epilepsy within the same family were observed without definitive conclusions about the potential role of genetic pre-disposition. It has been anecdotally reported that NS is not observed among the Dinka tribe, though they live near to and sometimes within the same communities as other tribes where NS is present. Note that the putative differences in prevalence among tribes may also be investigated from the perspective of diverse nutritional habits.

**Population displacement.** Both in northern Uganda and South Sudan, the populations where NS is known to occur have either suffered from displacement in the past or are currently displaced. In an observational study from South Sudan, NS cases were observed in three out of four villages; the one village without known NS cases was the only one that had not experienced internal displacement.

**Psychogenic causes.** Food shortages, war and displacement and the associated repeated or chronic trauma can lead to post-traumatic stress disorder, depression, conversion disorder and developmental trauma disorders. Any one of these could contribute or account for a number of the clinical, mental and psychiatric signs and symptoms observed in children with NS.

**Community perceptions regarding cause of NS.** Communities have reportedly attributed NS to causes ranging from war, ammunitions and displacement, to poor nutrition and witchcraft. In South Sudan, some community members regard the disease as contagious, resulting in the isolation of infected children.

6. **Clinical, laboratory and neurological features**

**Clinical features.** Head nodding with a frequency of approximately 5 to 20 per minute is the key symptom in NS and, in the vast majority of cases, caregivers noticed that it precedes other types of seizures. Determining the frequency between head nodding is deemed important for distinguishing between NS and tremors as well as psychogenic manifestations.

The nodding consists of a repetitive bobbing or dropping forward of the head due to loss of neck muscle tone. This is sometimes associated with muscle tone loss in the trunk and upper extremities. The most frequently reported stimuli are the presentation of food and exposure to cold, but nodding may also occur without (recognized) stimuli. Loss of consciousness, rhythmic jerking, staring, drooling and eye deviation may accompany nodding episodes.

NS is reported as a progressive syndrome, affecting physical and neurological development. In some children, observed physical features include stunted growth/dwarfism, muscle wasting and delayed sexual development. Lower height and weight per age Z scores were observed in South Sudan, as were lower body mass indices and height per age among cases when compared to controls. This provided objective information suggesting poor nutritional status among NS cases. Most nutritional indices among NS children are unremarkable; serum levels of vitamins B12 and folate were largely normal among both cases and controls in northern Uganda and South Sudan. Modest deficiencies in vitamin A and selenium were noted in northern Uganda, but the proportion of cases and controls with deficiency were not different.

Among populations in northern Uganda and South Sudan, considerable vitamin B6 deficiency (pyridoxine) has been found. Although this deficiency is observed in cases and controls in both populations, such an isolated vitamin B6 deficiency is unusual. It is also worth noting the association of defective pyridoxine metabolism with a rare type of intractable childhood epilepsy, known as pyridoxine-dependent seizures. This seizure type generally presents in infancy and results in intractable seizures that...
are unresponsive to conventional antiepileptic drugs, but may be treated with high doses of supplemental pyridoxine. While NS does not represent pyridoxine-dependent seizures, the low level of pyridoxine in the population is notable as a possible contributing or exacerbating factor.

Clinical evaluation and electroencephalography (EEG) have documented other types of seizures that the majority of patients eventually develop, including generalized tonic-clonic, partial complex and absence seizures. Patients have also been described as exhibiting cognitive decline and demonstrating difficulties in cognitive functioning, which supports the notion that NS represents an epileptic encephalopathy.

Affected children tend to be quiet and listless, not to play with others and to have apathetic expressionless faces. Other psychiatric manifestations include visual and auditory hallucinations reported from investigations in Uganda and South Sudan, and behavioural outbursts found during investigations in South Sudan.

**EEGs and MRIs features.** Thirty-nine NS patients in South Sudan, ten NS patients in URT, and ten NS patients in Uganda were evaluated by EEG. Major EEG findings among these children include a consistent demonstration of severely abnormal background activity with interictal diffuse slowing, as well as spike-and-wave and polyspike-and-wave epileptiform discharges. In several cases, ictal discharges of spike and slow wave activity were recorded with a clinical accompaniment of partial complex seizures. Several EEG tracings in all three areas have demonstrated 2.5 to 3 Hz spike and slow wave complexes, suggesting that atypical absence seizures are a component of the syndrome. In two cases in Uganda, children were recorded with video-EEG, with simultaneous electromyography (EMG) and electrocardiography during head nodding episodes. During the episodes, EEG demonstrated a dramatic electodecremental response that coincided with dropout of activity in neck muscles on EMG, followed by a burst of spike activity. These findings conclusively demonstrated that the nodding episodes themselves represented atonic seizures.

Twelve children with NS from the United Republic of Tanzania and five children from Uganda have undergone brain magnetic resonance imaging (MRI). Four of the five scans performed on children from Uganda demonstrated diffuse cortical and cerebellar atrophy disproportionate to age; in these studies, no focal lesions or white matter abnormalities were noted. It was not clear whether the observed atrophy in these children was a contributing factor to NS, whether it was related to ongoing seizures, or whether it was due to an unrelated factor such as malnutrition. Four of the scans performed in Tanzania were normal; eight of the scans demonstrated nonspecific white matter signal abnormalities interpreted as “gliotic lesions”, hippocampal abnormalities, or a combination thereof. The significance of these findings in terms of causation or contribution to NS is unclear.

**Laboratory parameters.** The limited available data does not suggest liver or kidney deficiencies or haematological abnormalities. Cerebrospinal fluid (CSF) examinations conducted did not indicate consistent abnormalities. Conclusions obtained from laboratory examinations addressing potential etiology and risk factors are summarized in section 5 above and in Table 2.

**Staging of Nodding Syndrome.** In Uganda, one study examined the neuropsychiatric aspects of NS among some children presenting with NS, and proposed to classify the syndrome into (1) Neurological NS, (2) Psychiatric NS, and (3) Mixed NS.
PART III. RESEARCH REQUIREMENTS

7. Knowledge gaps and critical research needs

Knowledge gaps and critical research needs identified during the meeting are summarized in Tables 3-7.

Table 3. Epidemiology

<table>
<thead>
<tr>
<th>Knowledge gap</th>
<th>Research need and suggested approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual geographic coverage and distribution of NS</td>
<td>Surveillance in other areas outside the current foci, such as communities with:</td>
</tr>
<tr>
<td></td>
<td>- High prevalence of onchocerciasis (recommended before mass distribution of ivermectin, however, given the extent of implementation of mass treatment, other areas need inclusion)</td>
</tr>
<tr>
<td></td>
<td>- High prevalence of epilepsy</td>
</tr>
<tr>
<td>Burden of NS in the currently reported three foci and surrounding areas</td>
<td>Conduct systematic surveys and surveillance in areas of known foci for an accurate estimation of the burden of illness (prevalence, incidence)</td>
</tr>
<tr>
<td>Overlap of areas of distribution of NS and etiological/ potential risk factors and other information of interest</td>
<td>Generate overlap maps for:</td>
</tr>
<tr>
<td></td>
<td>- Onchocerciasis (including ivermectin mass treatment history)</td>
</tr>
<tr>
<td></td>
<td>- Soil transmitted helminths</td>
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<tr>
<td></td>
<td>- Human African Trypanosomiasis (HAT)</td>
</tr>
<tr>
<td></td>
<td>- Epilepsy</td>
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<tr>
<td></td>
<td>- Other filarial infections</td>
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</table>

<table>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td>- Epilepsy</td>
</tr>
<tr>
<td></td>
<td>- Other filarial infections</td>
</tr>
<tr>
<td>Potential factors</td>
<td>Suggested research</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| **O. volvulus and other microfilariae**       | • Surveillance for NS in areas with high O. volvulus endemicity prior to ivermectin mass distribution (e.g. Cameroon, Burundi, Angola) and in highly endemic areas not yet under or with only a few years of ivermectin treatment (e.g. northeast Democratic Republic of Congo);  
  • Potential O. volvulus strain differences between areas with and without NS;  
  • History of population migration between areas of different endemicity;  
  • Determination of microfilarial load and aspects of illness (severity, etc.);  
  • Duration of infection and severity of illness;  
  • Neuro-invasive potential of O. volvulus; and  
    - CSF / brain tissue Polymerase Chain Reaction (PCR)  
    - Immunohistochemistry  
  • Further exploration of Mansonella streptocerca DNA results  
    - Do the microfilariae seen in children with NS represent M. Streptocerca?  
    - Morphologic assessments in skin snips  
    - Further PCR assays / deep sequencing  
    - Assessment of serologic cross-reactivity of O. volvulus and M. streptocerca. |
| **Other infections**                          | • Malaria-induced immunity deficiency  
  o Epstein – Barr Virus (EBV)/ Burkitt's Lymphoma  
  o Other viruses, retroviruses  
  • Unknown/ unrecognized infectious agent causing epileptic disorder  
  • Post-infectious/ autoimmune disease  
  • Further exploration of zoonoses  
  • Neurocysticercosis  
    - Unlikely based on MRI, serology, but common cause of epilepsy in region |
| **Hormones**                                  | • Assessment of cortisol levels  
  - Increase or decrease might be due to stress and may be a contributory factor in illness  
  - Increased cortisol levels are seen in some nematode infections  
  • Hypothalamic (pituitary axis)  
    - Growth hormone deficiencies  
    - Delayed sexual development  
    - Measurement of other pituitary hormone levels |
| **Genetics**                                  | • Family tree studies/ population genetics  
  • Genomic studies |
| **Nutrition**                                 | • Micronutrients (vitamins)  
  • Mycotoxins/ Aflatoxins |
| **Neurodegenerative disorders**              | • Spinocerebellar atrophies (suggested by findings of cerebellar atrophy on MRI studies from northern Uganda)  
  • Prion diseases, needs to be excluded by histopathology |
| **Environmental and nutritional factors**     | • Prior to and during internal displacement of affected populations  
  • In pregnant mothers, affected as well as unaffected children |
| **Other causes of potentially treatable forms of epilepsy** | • Neurocysticercosis |
### Table 5. Clinical, laboratory and neurological features

<table>
<thead>
<tr>
<th>Knowledge gap</th>
<th>Suggested research</th>
</tr>
</thead>
</table>
| **Clinical course/ natural history**<br>of NS | • Integrate all currently available data  
  • Complement with further (longitudinal, prospective) cohort studies over extended periods of time, including:  
  - Evolution of seizure types  
  - Child long-term development (physical, cognitive, functional)  
  - Progression (progressive worsening, stabilization/ clinical plateau, improvement)  
  - Mortality/ causes of death  
  • Identify children at "elevated risk" (e.g. siblings of NS-affected children) prior to onset of nodding  
  • Assess syndrome at incident stage of illness  
  • Identify clinical/ cognitive or electroencephalographic problems that may precede nodding  
  • Development, testing and use of suitable standardized cognitive assessment battery |
| **Pathology**                      | • Obtain viable autopsy tissue specimens from children dying with NS  
  • Histopathological examination of Central Nervous System (CNS) and other organ tissues, including:  
  - Whole brain, fixed in formalin, with representative sections taken prior to fixation  
  - Frozen sections for PCR (brain/ spinal cord/ peripheral nerve; other organs) |

### Table 6. Case management

<table>
<thead>
<tr>
<th>Knowledge gap</th>
<th>Suggested research</th>
</tr>
</thead>
</table>
| **How can health-care workers’ (HCW) capacity for case detection, evaluation, and treatment be optimized?** | • Knowledge, attitudes and practices (KAP) study  
  • Development and testing of decision algorithms for HCWs  
  • Evaluation of criteria for hospital admittance  
  - Frequency of seizures  
  - Affected functioning  
  - Severe malnourishment  
  - Severe injuries  
  - Social considerations (availability of family care)  
  • Full patient evaluation, nutrition needs assessment of patients, psycho-social evaluation  
  • Comprehensive approach to case management, including nutritional requirements, psychiatric, counseling, etc. |
| **How can case management be improved?**                        | • Symptomatic treatment  
  - Clinical study of different anti-epileptic drugs (used to date for NS and others) to optimize choice of drugs, dosing and knowledge on efficacy and adverse reaction in NS  
  • Supportive treatment for children and families (nutrition, psychiatric counseling, psycho-social and economic support for families) |
| **What is appropriate community involvement?**                 | • Knowledge, attitudes and practices (KAP) study  
  • Role of traditional healers and medicine |
Table 7. Communication and research needs for communities and other stakeholders

<table>
<thead>
<tr>
<th>Knowledge gap</th>
<th>Suggested research</th>
</tr>
</thead>
<tbody>
<tr>
<td>KAP of target groups of communications</td>
<td>• Conduct KAP study in patients/ caregivers, communities, HCW, other stakeholders (e.g. local politicians) and media</td>
</tr>
<tr>
<td></td>
<td>• Focus group discussions</td>
</tr>
</tbody>
</table>

Table 8. Community perspective on priority research needs

<table>
<thead>
<tr>
<th>Information and research needs identified by parents of affected children</th>
<th>Information and research needs identified by health-care workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cause of NS</td>
<td>• Cause of NS</td>
</tr>
<tr>
<td>• Origins/ beginning of NS</td>
<td>• Origins/ beginning of NS</td>
</tr>
<tr>
<td>• Predisposing factors</td>
<td>• Why children and not adults are affected?</td>
</tr>
<tr>
<td>• Does it run in families?</td>
<td>• Which gender is affected most and why?</td>
</tr>
<tr>
<td></td>
<td>• Family and genetic studies</td>
</tr>
<tr>
<td></td>
<td>• Relationship between onchocerciasis and epilepsy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mode of transmission</th>
<th>Mode of transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution of the syndrome in terms of region, streams</td>
<td></td>
</tr>
<tr>
<td>Curative drugs</td>
<td>Research into other drugs other than sodium valproate</td>
</tr>
<tr>
<td>Disease progression</td>
<td>• The natural course, outcome and duration of nodding syndrome</td>
</tr>
<tr>
<td></td>
<td>• Clinical features, presentation and diagnosis</td>
</tr>
<tr>
<td></td>
<td>• What causes severe malnutrition?</td>
</tr>
</tbody>
</table>
Prevention

- Extent of damage already caused by NS
- How parents with children of NS should cope and manage their lives as they take care of their children
- Research into how families can best be supported
- Setting up special needs schools for NS children

<table>
<thead>
<tr>
<th>Prevention</th>
<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research on how children can regain their normal mental state</td>
<td></td>
</tr>
</tbody>
</table>

No suggestion

Community beliefs

The study also evaluated the type of research that communities and health-care workers would not want to see conducted. For instance, parents expressed discontent with research that focused on couples that divorced because of NS, or research that did not aim to provide treatment to cure or alleviate side effects from NS. Research on healthy children was also condemned.

HCWs expressed disapproval of research that would not produce positive change or would threaten to present families in a negative way. Any research that does not include interventions or deemed to be discriminatory (i.e. is conducted in only one family or tribe) was likewise frowned on. Both parents and HCWs were opposed to research that “counts those who died of NS”. HCWs furthermore deemed research unacceptable if no feedback on the results were provided.

<table>
<thead>
<tr>
<th>Table 9. Parent and health-care worker attitudes towards research approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent</td>
</tr>
<tr>
<td>Research into couples who divorced because of NS</td>
</tr>
<tr>
<td>Failure to get treatment that cures NS</td>
</tr>
<tr>
<td>Research on healthy children</td>
</tr>
<tr>
<td>Number of children who died of NS</td>
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Research design, implementation and related communication with communities, parents, caregivers and patients must consider these results.

8. **A collaborative research framework for Nodding Syndrome**

National and international researchers should coordinate and collaborate on planned research. Multidisciplinary research teams are needed and should include experts in all scientific areas addressed and methodologies required during a particular research project. Inclusion of anthropologists and experts in the cultures and attitudes of the affected populations will help ensure appropriate communication and
consideration of the needs and sensitivities of these vulnerable communities and extremely vulnerable patients.

Institutions not currently involved in NS research, which should be approached for collaborations include, inter alia:

- African Programme for Onchocerciasis Control (APOC)
- Onchocerciasis control programmes on national and APOC project level
- Institut de Recherche pour le Développement (France)
- Institutions that can provide capacity-building for research and diagnosis of NS by HCWs (e.g. EEG).

9. Potential funding sources for nodding syndrome research

Advocacy for funding for NS research and interventions should target a variety of health and developmental donors, including those with interests in orphaned or neglected diseases.
PART IV. DESIGNATION OF ILLNESS, RESPONSE AND INTERVENTIONS

10. Designation of the illness

Based on research conducted and the current knowledge of NS, conference participants concluded that:

- NS is an epidemic epileptic encephalopathy;
- Atonic seizures cause head nodding; and
- Despite numerous investigations, the cause of NS remains unknown.

Participants agreed that the illness be referred to as “Nodding Syndrome”. This recommendation is based on (1) the presentations and constellation of clinical features of the illness; (2) the fact that its etiology is unknown; and (3) the consideration that spasmus nutans is also known as “head nodding”.

10.1 Case definitions

Across countries, different case definitions were used for various purposes at different times. The following harmonized case definitions were recommended to ensure consistent case identification for surveillance and treatment and comparable research results.

Suspected case:
(Used at the community level, primarily by marginally trained health teams when asking the mother /caretaker).

- Reported head nodding in a previously normal person. Head nodding is defined as repetitive, involuntary drops of the head to the chest on two or more occasions.

Probable case: Suspect case of head nodding with:

- Both of the following major criteria:
  - Age at onset of nodding between 3 and 18 years old
  - Frequency of nodding 5 to 20 per minute

- Plus at least one of the following minor criteria:
  - Other neurological abnormalities (cognitive decline, school dropout due to cognitive/behavioural problems, other seizures or neurological abnormalities)
  - Clustering in space or time with similar cases
  - Triggered by food and/or cold weather
  - Stunting or wasting
  - Delayed sexual or physical development
  - Psychiatric symptoms.

Confirmed case: Is a Probable case
- Plus a documented nodding episode that is:
  - Observed by trained healthcare worker, or
  - Videotaped, or
  - EEG/EMG.
These case definitions will need to be reviewed and modified as new data becomes available.

11. **Nodding Syndrome response and interventions**

11.1. **Case management**

NS is a form of epilepsy, and more specifically, an epileptic encephalopathy, within the continuum of other forms of epilepsy such as Lennox-Gastaut syndrome, myoclonic-astatic epilepsy and others. These epileptic disorders are very difficult to treat, even with multi-drug therapy. There is no established definitive treatment for NS.

The current anti-epileptic drugs (AEDs) in use are mainly phenytoin, which is widely available and inexpensive, and sodium valproate, which is more expensive, but potentially the AED of choice. A clinical treatment trial to assess the potential efficacy of these conventional AEDs, as well as the use of high-dose pyridoxine supplementation to control NS, is planned. CDC and the Ministry of Health of Uganda reported that the protocol is currently under consideration by the Institutional Review Boards at both agencies. In the meantime, Uganda MOH is using sodium valproate to empirically treat children with NS at treatment centres.

Participants agreed that a holistic approach to NS management is critical. This should include nutritional supplementation in malnourished children and cognitive, physical and occupational therapy for long-term case management of children. Psychosocial support for affected children, families and communities is an important component of a community-wide approach to managing what is likely a chronic health problem.

11.2. **Risk communication**

Significant communication challenges are posed by the fact that the etiology of NS is unknown and likely multifactorial. Communication needs to consider community perceptions, including around the contagiousness of NS, in order to reduce neglect and isolation of affected children.

Communication should occur from the bottom up (i.e. from communities to community leaders to politicians) and tailored to the needs of the affected populations. Any communication strategy should consider targeting children. Children could receive education about NS in schools, which will allow them to serve as vehicles for knowledge transfer to their elders. Information provided to the media needs to be agreed upon in order to ensure the use of laymen language, thereby minimizing the risk of misunderstandings and consequent misrepresentation.
PART V. RECOMMENDATIONS, ROLES AND RESPONSIBILITIES

12. Recommendations

12.1. General recommendations

Basic recommendations and conclusions from the meeting are outlined below.

1. The appropriate designation is “Nodding Syndrome”. Researchers and health-care systems should adopt and implement the harmonized case definitions for NS.

2. Current findings on Nodding Syndrome should be presented to the International League Against Epilepsy for consideration as official classification.

3. The incorporation of Nodding Syndrome into the list of Neglected Tropical Diseases should be advocated for.

4. A holistic, multi-disciplinary approach to NS management and training of HCWs should be adopted.

5. A comprehensive response to NS that considers the needs of the affected at all relevant levels should be adopted.

6. Community-directed treatment with ivermectin (CDTI) for onchocerciasis control should be implemented in the NS affected areas with the APOC recommended therapeutic and geographic coverage. The impact on the prevalence of NS should be monitored.

7. Clear risk communication principles must be implemented.

12.2. Recommendations for research priorities

Research priorities agreed upon by meeting participants were as follows:

1. Improve knowledge on the prevalence, burden and geographic distribution of NS through:
   a. Conducting systematic surveys in the three known affected regions.
   b. Strengthening surveillance for Nodding Syndrome through the Integrated Disease Surveillance and Response (IDSR) strategy.
   c. Conducting NS surveillance in areas where Nodding Syndrome may exist but is not currently recognized or documented, in particular in areas with high endemicity of onchocerciasis (including those who have not or only recently started CDTI, as well as those with long term CDTI) and in areas with high levels of epilepsy without onchocerciasis.

2. Implement on-going systematic surveillance to determine incident cases of NS.

3. Determine best method of management and symptomatic treatment of NS for:
   a. Definitive treatment—i.e. identifying the best choice of anti-epileptic drug (randomized, controlled clinical trial); and
   b. Supportive management (including but not limited to, nutritional, psychosocial and psychiatric counseling).
4. Establish long-term prospective cohort assessment through:
   a. Determining natural history of NS
   b. Identifying cases in early phases of illness
   c. Identifying children at higher risk of developing NS (unaffected siblings) so as to detect incident cases.
5. Continue efforts to obtain pathological specimens from children who died with NS.
6. Conduct studies on etiology and risk factors.

12.3. Recommendations for a collaborative research framework

National and international researchers should coordinate and collaborate on research activities. Multidisciplinary research teams are needed and should include experts in all relevant scientific disciplines and methodologies used during a particular research project.

Specific recommendations for a framework to encourage and promote collaborative research that effectively addresses the needs and challenges of NS research are outlined below.

1. Establishment of a Nodding Syndrome Research Coordination Group that includes representation from key stakeholders to:
   - Coordinate research activities to ensure they are complementary;
   - Encourage and facilitate on-going dialogue among stakeholders;
   - Provide a mechanism to ensure that new knowledge on NS is shared and used to inform policy, practices and standards in a timely manner.
2. Research studies conducted by different groups and in different countries need to generate comparable findings. Participating countries and institutions can help facilitate this by sharing ideas and protocols during study preparation, as well ensuring on-going dialogue on experiences.
3. National research institutions should get involved to ensure country ownership and capacity-building.
4. National institutions should take the lead on disseminating and utilizing research findings.
5. Expert committees on NS should be established on international, national and disciplinary levels (e.g. neurology, pediatrics, nutrition).
6. Including subject matter experts from all relevant fields (anthropology, environmental sciences, onchocerciasis, veterinary medicine and others, such as education and agriculture) on research teams is needed in order to advise on issues, approaches and methodology.
7. A follow-up scientific meeting on NS should be conducted in two years to assess progress, status and share newly acquired knowledge.
13. **Roles and responsibilities**

Meeting participants identified the roles and responsibilities at the national and international level, as well as among a variety of other stakeholders.

13.1. **National level**

The following is recommended at the national level:

- Form or activate National Task Forces that develop national strategies and plans, oversee and coordinate NS interventions and response, and advocate for resource mobilization from respective governments and partners;
- Collaborate with stakeholders and partners to implement recommended NS interventions; and
- Coordinate and implement priority research needs on NS in collaboration with partners and stakeholders, ensuring that research findings inform policy and public health interventions.

13.2. **World Health Organization**

It is recommended that WHO:

1. Provides leadership and coordinates collaborative research and interventions. This includes:
   - Facilitating inter-country collaboration;
   - Sharing and exchanging information between partners;
   - Supporting guidelines, standards and criteria development for NS research, management and response;
   - Advocating for resources for NS interventions and research; and
   - Updating stakeholders on research planning, implementation and emerging results.

2. Supports affected countries through:
   - Providing technical guidance and support to countries in developing research proposals;
   - Assisting countries with coordinating, advocating and mobilizing resources for research and NS interventions; and
   - Translating research findings into norms and standards for NS management and control.

13.3. **Other Stakeholders**

Stakeholders across all levels should:

1. Provide technical support to affected countries on implementing NS interventions and the research agenda in a mutually-beneficial way; and
2. Support resource mobilization activities for NS interventions and the research agenda.
PART VI. NEXT STEPS

14. Next steps and action points

The following details the next steps and action points participants recommended for implementation across the national, regional and global level.

14.1. National level

- Relevant units in the Ministry of Health of Uganda, South Sudan and URT, respectively, should receive and use outcomes from the meeting as a basis for MoH decisions on next steps. (The Ministry of Health of Uganda provided feedback to the Ugandan NS National Task Force and other stakeholders on 2 August 2012. The aim is to further develop the Ugandan NS Response Plan based on meeting recommendations and to mobilize additional resources for implementation).

- National Task Forces should develop national strategies and plans, oversee and coordinate NS interventions and response at the country, level and advocate for resources.

- URT, South Sudan and Uganda should collaborate on NS.

14.2. Regional and global level

- The APOC Technical Consultative Committee and Joint Action Forum should receive a copy of the meeting report and, if possible, a summary presentation of the conference.

- WHO/APOC should encourage the ministries of health of URT, South Sudan and Uganda, respectively, as well as their partners, to accelerate and improve CDTI implementation as necessary to control and eliminate onchocerciasis.

- WHO should help to establish and lead a collaborative, research-coordinating group with representatives from different stakeholders as part of a framework for harmonizing research on NS. This research-coordinating group should:
  - Follow-up with meeting participants on their research plans and commitments following debriefings within their respective organizations.
  - Coordinate various planned research activities and support the development of research protocols and proposals, including for resource mobilization.
  - Establish a framework for monitoring and evaluating progress.

- Establish a platform to facilitate collaboration and information-sharing.

- Mobilize resources to support NS research, interventions and response.

- Advocate for NS to be recognized as a neglected tropical disease.
PART VII. ANNEXES

Annex 1: Nodding Syndrome bibliography

Scientific articles on Nodding Syndrome: Specific


Scientific articles on Nodding Syndrome: Unpublished, submitted and abstracts


Articles on Nodding Syndrome: news reports, updates and abstracts


Articles and descriptions similar to Nodding Syndrome


General References

Articles on onchocerciasis and epilepsy:


**Articles on childhood epilepsy / epileptic disorders**


Articles on epilepsy in the United Republic of Tanzania and Uganda


Note: No articles on epilepsy in South Sudan were identified.
## Annex 2: Meeting agenda

### DAY ONE: OPENING SESSION
**Chair and Master of Ceremony:** A. Mbonye, CHS, Ministry of Health, Uganda

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Presenters/Facilitators</th>
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<tbody>
<tr>
<td>7.30</td>
<td>Registration</td>
<td>Secretariat/WHO Country Office, Uganda</td>
</tr>
<tr>
<td>8.20-8.30</td>
<td>Group introduction of participants by institutions/organizations</td>
<td>Miriam Nanyunja, WHO, Uganda</td>
</tr>
<tr>
<td>8.30-8.40</td>
<td>Presentation of objectives, expected outputs, agenda and meeting structure</td>
<td>Yoti Zabulon, WHO Regional Office for Africa</td>
</tr>
<tr>
<td>8.40-8.50</td>
<td>Documentary video on NS</td>
<td>Refugee Law Project</td>
</tr>
<tr>
<td>8.50-9.30</td>
<td>Opening remarks and group photo</td>
<td>Director-General, MoH, Representative of CDC, Representative of Riek, WHO Representative, Uganda, Minister of Health, Uganda</td>
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<tr>
<td>9.30-10.00</td>
<td>Coffee/tea break</td>
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### DAY ONE: TECHNICAL SESSION
**Chair:** Nelson Sewankambo, Makerere University. **Co-Chair:** Peter Gaturuku, WHO Regional Office for Africa

#### Session 1: WHAT?
- Epidemiology: geographical, time, place and person attributes; community perception
- Designation: Nodding Disease? Nodding Syndrome? Head-nodding Syndrome?
- Case definition: harmonizing case definition

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<tr>
<th>Time</th>
<th>Activity</th>
<th>Presenters/Facilitators</th>
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<tbody>
<tr>
<td>10.00-10.30</td>
<td>Thematic presentation</td>
<td>Scott Dowell, Anthony Mbonye, Lul Riek</td>
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<td></td>
<td>- Overview of Nodding Syndrome</td>
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<tr>
<td>10.30-11.30</td>
<td>Country experiences</td>
<td>Debora Kiusa Kabudi, Kaat Vandemaele, Lul Riek</td>
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<td></td>
<td>- Tanzania</td>
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<td></td>
<td>- South Sudan 2001-2002</td>
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<td></td>
<td>- South Sudan 2011</td>
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<tr>
<td>11.30-12.30</td>
<td>Discussions</td>
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<td>- Common features</td>
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<td>- Proposed designation</td>
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<tr>
<td>12.30-13.30</td>
<td>Lunch break</td>
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#### Session 2: WHY?
- Etiology: possible causes
- Risk factors

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<th>Time</th>
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<th>Presenters/Facilitators</th>
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<tbody>
<tr>
<td>13.30-14.10</td>
<td>Thematic presentations</td>
<td>Tom Nutman, Peter Spencer</td>
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<tr>
<td></td>
<td>- Nodding disease and Onchocerciasis</td>
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<td></td>
<td>- Nodding disease and nutritional and environmental factors: South Sudan 2001-2002 investigations</td>
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<tr>
<td>14.10-15.10</td>
<td>Country experiences</td>
<td>Scott Dowell and MoH Uganda, Erich Schmutzhard, Sudhir Bunga and MoH Sudan</td>
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<td>- Uganda</td>
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<td>- Tanzania</td>
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<td></td>
<td>- South Sudan, 2011</td>
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</table>
15.10-15.45 Discussions  
- What is known?  
- What are the critical gaps in our current knowledge?  
- Scientifically unproven/ruled out causes?

15.45-16.00 Coffee/tea break

**Session 3: HOW?**
- Clinical presentation  
- Laboratory findings  
- Neurological investigations

16.00-17.55 Clinical, laboratory and neurological findings: country experiences  
- South Sudan 2001/2002  
- South Sudan and Uganda 2009-2011  
- Tanzania  
- Mulago Hospital, Uganda  

<table>
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<tr>
<th>Presenters</th>
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| James Tumwine  
| James Sejvar and Angelina Kakooza  
| Andrea Winkler and Erich Schutzhard  
| Richard Idro |

17.55-18.30 Discussions  
Key common features: clinical, laboratory, neurological  

Day One chair and co-chair

**END OF DAY ONE**

**Posters:**

- Prevalence and etiologic factors of epilepsy in northern Uganda, Joyce Kaducu
- Natural progression and clinical staging of the Nodding Syndrome in northern Uganda; implications for treatment, Deborah Atai
- Epilepsy and Nodding Syndrome, Joyce Kaducu
- What is the relative role of traumatic experience in the etiology of Nodding Syndrome in northern Uganda? Emilio Ovuga
- The stigma of Nodding Syndrome: perceptions of health workers in the affected region of northern Uganda, Mutamba Byamah
- Perceptions of the population in the Acholi sub-region to Nodding Syndrome, David Kitara
- Malnutrition and onchocerciasis: the major risk factors to NS in northern Uganda: A casecontrol study, David Lagoro Kitara
- The role of onchocerca volvulus in people with generalised epilepsy or nodding syndrome in southern Tanzania, Andrea Winkler
- Clinical characteristics of head nodding syndrome among 97 children in Kitgum and Pader districts, Joyce Kaducu
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<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter(s)</th>
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<tbody>
<tr>
<td>8.00-8.30</td>
<td>Brief review of Day One presentations and discussions</td>
<td>Day One rapporteurs, Day One Chair</td>
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<td>Presentation on summary of current knowledge and key emerging issues</td>
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<tr>
<td>8.30-9.05</td>
<td>Session 4: Response plan including case management</td>
<td>Musisi Segane</td>
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<td>Thematic presentations: Case management</td>
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<td></td>
<td>Neuropsychiatric aspects of Nodding Syndrome in northern Uganda</td>
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<td>9.05-9.45</td>
<td>Country experiences</td>
<td>Richard Idro, Hanifa Namusoke MoH/WHO CO, South Sudan, Andrea Winkler</td>
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<td>- Uganda</td>
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<td>- clinical case management</td>
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<td>- nutritional management</td>
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<td>- South Sudan</td>
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<td>- Tanzania</td>
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<td>9.45-10.15</td>
<td>Discussions</td>
<td>Day Two Chair, Co-Chair, Rapporteur</td>
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<td>10.15-10.30</td>
<td>Coffee/tea break</td>
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<td>10.30-10.50</td>
<td>Session 5: Development of critical research agenda</td>
<td>Catherine Abbo</td>
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<td>Introduction to research agenda:</td>
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<td>- Community versus MoH research agenda on NS: implications for clinical research</td>
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<td>- Discussion</td>
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<tr>
<td>10.50-12.00</td>
<td>Group work:</td>
<td>Group moderators</td>
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<td>- Identify gaps for research</td>
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<td>- Develop critical research agenda</td>
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<td>12.00-13.00</td>
<td>Presentations and plenary discussions:</td>
<td>Day Two Chair, Co-Chair, Rapporteur</td>
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<tr>
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<td>- Knowledge gap</td>
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<td>- Proposed critical research agenda</td>
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<td>13.00-14.00</td>
<td>Lunch break</td>
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<tr>
<td>14.00-15.30</td>
<td>Session 6: Surveillance standards and control interventions</td>
<td>Tom Nutman, Peter Spencer</td>
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<td>Group work:</td>
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<td></td>
<td>- Define NS</td>
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<td>- Harmonize case definitions (surveillance and clinical)</td>
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<td>- Surveillance strategy and ideas</td>
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<td>- Laboratory criteria for diagnosis</td>
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<td>- Recommended interventions for clinical management of patients</td>
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<td>- Risk communication aspects</td>
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<td>15.45-16.00</td>
<td>Coffee/tea break</td>
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<tr>
<td>15.45-16.30</td>
<td>Group work (continued)</td>
<td>As above</td>
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<tr>
<td>16.30-18.00</td>
<td>Plenary presentations and discussions</td>
<td>Day Two chair, co-chair and rapporteurs</td>
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END OF DAY TWO
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<tr>
<th>Time</th>
<th>Activity</th>
<th>Presenter/Leaders</th>
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<tbody>
<tr>
<td>8.00-9.00</td>
<td>Review of Day Two achievements</td>
<td>Day Two chair and rapporteurs</td>
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<tr>
<td>9.00-10.15</td>
<td>Presentation of outline for collaborative research framework Group work</td>
<td>Peter Gaturuku, WHO Regional Office for Africa Chair and co-chair Group moderators and rapporteurs</td>
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<tr>
<td>10.15-10.30</td>
<td>Coffee/tea break</td>
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<tr>
<td>10.30-10.45</td>
<td>Develop summary presentation and report from group work</td>
<td>Group moderators</td>
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<tr>
<td>10.45-11.30</td>
<td>Presentation and discussion of the research collaborative framework</td>
<td>Day Three chair and co-chair Rapporteurs</td>
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<tr>
<td>11.30-13.00</td>
<td>Formulation and discussions of recommendations for next steps</td>
<td>Day Three chair and co-chair Rapporteurs</td>
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<tr>
<td>13.00-14.00</td>
<td>Lunch break</td>
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<tr>
<td>14.00-16.00</td>
<td>Wrap-up of technical discussions</td>
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<tr>
<td>16.30-17.00</td>
<td>Closing remarks</td>
<td>Representatives of CDC, DFID, WHO and MoH-Uganda</td>
</tr>
</tbody>
</table>

**MEETING ENDS**
Annex 3: List of participants

Delegation of South Sudan

Ministry of Health of South Sudan (central and district health office)

Dr Gregory Wani Dumo, MOH Republic of South Sudan
Dr Hosea Dima Enosa, Health Director Maridi District, SS, MO, Maridi District, South Sudan
Mr Jackson Hassan, State Surveillance Officer, WES, SMOH-WES, South Sudan
Dr John Lagu, Director of Epidemiology and Communicable Diseases, MOH-RSS, South Sudan
Dr Lul Rick, Director-General, Planning and External, MOH-RSS, South Sudan
Dr Mounir Lagu, Director of Endemic Diseases, MOH-RSS, South Sudan
Dr Victor Furangi, Director-General, State MOH-WES, South Sudan
Mr Yona Kenyi, State Surveillance Officer, CES, SMOH-CES, South Sudan

Training and research institutions, South Sudan

Dr Rose Poni Gore, Head of Community Medicine and Public Health, College of Medicine, University Juba, South Sudan

Partners in South Sudan

Dr Dricile Ratib, Medical Officer/AAH-I, Action Africa Help International (AAH-I), South Sudan
Dr Martin Swaka, Senior Health Program Management Specialist, Juba USAID SS, South Sudan

Delegation of the United Republic of Tanzania

Ministry of Health of the United Republic Tanzania (central and district health office)

Ms Debora Kiusa Kabudi, Regional NTD CO, Morogoro URT, MOHSW URT
Mr Elibariki Reuben Makapeje, MOHSW URT

Training and research institutions, URT

Professor William Matuja, Paediatrician, NS research team, Muhimbili University Dar es Salaam

Delegation of Uganda

Ministry of Health Uganda (national and district health offices, and referral hospitals)

Dr Alex Olwedo, District Health Officer, Kitgum District, Uganda
Dr Anthony Mbonye, Commissioner, Community Health Services, Ministry of Health Uganda
Ms Barbara Olum, Nursing Officer, Kitgum Treatment Centre, Kampala, Uganda
Dr Beatrice Apong, District Health Officer (Ag) Lira District, Uganda
Dr Bernard Opar, National Coordinator, Nodding Syndrome response, Uganda
Dr Byamah Mutamba, Psychiatrist, Butakiba Mental Referral Hospital, Uganda
Dr Charles Oyoo Akiya, District Health Officer, Lamwo District Local Government, Uganda
Dr Deborah Atai, Physician, Mulago Hospital, Uganda
Dr Esther Namukose Muwanguzi, Secretary, NTF on NS, MOH, Uganda
Dr Henry Luzze, Senior Medical Officer, Clinical Services, Ministry of Health, Uganda
Dr Issa Makumbi, Assistant Commissioner, Epidemiology Surveillance Division, MOH, Uganda
Mr Jackeys Onyut Luciyamoi, For DHO SMCO/OCO/IC, Pader District Atanga H/C III, Uganda
Dr Jackson Amone, Assistant Commissioner, Clinical Services, MOH, Uganda
Dr James Okello, Psychiatrist, Gulu Regional Referral Hospital, Uganda
Dr Jane Ruth Aceng, Director General of Health Services, Ministry of Health Uganda
Dr John B. Rwakimari, Chief of Party, Uganda IRS Project, Uganda
Mrs Lilian Luwaga, Senior Health Educator, Ministry of Health, Uganda
Ms Mbaziira Rukia, Communications Officer, Ministry of Health, Uganda
Mr Milton Stephan Okello, NS Focal Person/DSFP, Amuru District Local Government, Uganda
Dr Narcis Kabatereine, Schistosomiasis Control Initiative, Uganda
Dr Jessica Nsungwa Sabiiti, Assistant Commissioner, Child Health, Ministry of Health, MOH, Uganda
Dr Patrick Odong Olwedo, District Health Officer, Amuru District, Uganda
Dr Paul A. Onek, District Health Officer, Gulu District, Uganda
Dr Richard Idro, Paediatric neurologist, Mulago Hospital, Kampala, Uganda
Mr Saint Okello, Lira Regional Referral Hospital, Uganda
Dr Sheilla Ndyanabangi, Principal Medical Officer, Mental Health, Ministry of Health, Uganda
Dr Stanley Bubikire, Programme Manager Disability and Rehabilitation, MOH, Uganda
Dr Vincent Owiny, District Health Officer, Oyam, Uganda
Dr Vincent Oyet, Health Educator, Pader district, Uganda

Other ministries in Uganda

Mr Benedict Okweda, Ministry of Gender, Labour and Social Development, Kampala, Uganda
Hon Betty Bigombe, Minister of State for Water Resources and Environment, Uganda
Ms Catherine Ahimbisibwe, Office of the Prime Minister, Disaster Preparedness Management, Uganda
Ms Freda Ssengoba, Ministry of Information and National Guidance, Uganda
Mr Fredrick Luyimbazi, Ministry of Agriculture, Animal Industry, and Fisheries, Uganda
Mr Joseph Kajumba, Ministry of Education, Uganda
Mr Raymond Kirungi, Program Officer, Disaster Preparedness and Management, Office of the Prime Minister
Mr Joseph Semakula, Directorate of Information and National Guidance (DOING), Office of the Prime Minister, Uganda
Training and research institutions in Uganda

**Makerere University**

Mr Adam Branch, Fellow, Makerere Institute of Social Research, Uganda  
Dr Amos Deogratius Mwaka, Physician, Makerere University, Uganda  
Dr Angelina Kakooza, Pediatric Neurologist, Makerere University, College of Health Sciences, Uganda  
Ms Karin van Bemmel, Medical Anthropologist, Makerere University /Ghent University (Belgium) /African Studies Centre (Holland), Uganda/Belgium  
Dr Catherine Abbo, Lecturer/Psychiatrist, Mulago Hospital, Uganda  
Dr Ezekiel Mupere, Makerere College of Health Sciences, Kampala, Uganda  
Dr Hanifa Namusoke, Nutritionist, Makerere University, Kampala, Uganda  
Dr Isaac Okullo, Makerere College of Health Sciences, Uganda  
Professor James Tumwiine, Professor of Paediatrics and Neurology, Makerere University, College of Health Sciences, Uganda  
Professor Nelson Sewankambo, The Principal, Makerere University College of Health Sciences, Uganda  
Dr Jane Achan, Paediatrician, Infectious Diseases Institute, Makerere University, Uganda.  
Ms Justine Namakula, School of Public Health, Makerere University, Uganda  
Dr Margaret Kabahenda, Nutritionist, Makerere University, School of Food Science and Technology, Uganda  
Professor Musisi Seggane, Professor of Psychiatry, Makerere University, College of Health Sciences, Kampala, Uganda  
Dr Robert Opoka, Paediatrician, College of Health Sciences, Makerere University, Uganda  
Dr Ronald Anguzu, School of Public Health, Makerere University, Uganda  
Dr Samuel Majalija, Lecturer-Microbiologist, Makerere University, School of Veterinary Medicine, Uganda  
Dr Adrian Yen, Medical Anthropologist, MISR (Makerere Institute of Social Research), University of California Davis, Uganda

**Gulu University, Uganda**

Dr Beatrice Odongkara, Pediatrician, Endocrinology fellow, Gulu University, Uganda  
Dr David Kitara, Epidemiologist, Gulu University, Uganda  
Professor Emilio Ovuga, Psychiatrist and Dean, Gulu University, Uganda  
Dr Joyce Kaducu, Paediatrician, Gulu University, Uganda  
Professor Pontiano Kaleebu, Immunologist and deputy Director of Uganda Virus Research Institute, and Head of Medical Research Council at UVRI, Uganda

**AFENET and other research institutions in Uganda**

Dr David Mukanga, Executive Director, African Field Epidemiology Network (AFENET), Kampala, Uganda  
Dr. Mande Busulwa, Programme Officer, AFENET, Uganda
Mr Sam J. Ekulet, Director, Research, NACAS, Uganda
Dr Sam Okware, Director-General, Uganda National Health Research Organization (UNHRO), Uganda

Acholi Parliamentarians (Uganda)

Major (Rtd) Dr A. Okullo, Kampala, Uganda
Honourable Amos John Okot, Member of Parliament, Agago County, Uganda
Honourable Beatrice Atim Anywar, Member of Parliament, Kitgum, District, Uganda
Honourable Lowila CD Oketayot, Member of Parliament, Pader District, Uganda Parliament, Kampala, Uganda
Honourable Regan Okumu, Member of Parliament, Uganda
Honourable Sarah Lanyero Ochieng, Member of Parliament, Acholi Parliamentary Group, Lamwo District, Uganda

NGOs and other partners in Uganda

Mr George Ntambi, Director, Action for Disadvantaged People (ACDIPE), Uganda
Mr Jackson Odong, Research Advocacy Officer, Refugee Law Project, Uganda
Dr Joa Ja’keno Okech-Ojony, Public Health Consultant, Capacity Systems Link (CSL), Kampala, Uganda
Ms Joan Kipwola, Program Officer, Democratic Governance Facility (DGF), Uganda
Mr John Mpande, Youth Empower Foundation, Uganda
Ms Lisa Marie Gomez, Gulu Hope, Kampala, Uganda
Ms Lorri Moore, Gulu Hope, Kampala, Uganda
Ms Paige Crum, Gulu Hope, Kampala, Uganda
Mr Patrick Edeet, National Program Coordinator, Natural Cancer Awareness, Uganda
Dr Patrick Okello, Medical Teams, International Uganda
Ms Samantha Atyie, Basic Needs Foundation
Ms Sarah Richards, Executive Director Global Nurse Initiative; RN, CCRN, Uganda/South Sudan
Mr Geoffrey Smith, Chairman, Essential Micronutrients Foundation, Uganda
Dr Victoria Masembe, JSI/AIDSTAR-One, Uganda

External training and research institutions

Professor Peter Spencer, Professor of Neurology (South Sudan mission outbreak 2002) and senior scientist, Global Health Center for Research on Occupational and Environmental Toxicology (CROET), Oregon Health and Science University, Portland, Oregon, USA
Dr Andrea Winkler, Neurologist, Department of Neurology, Technical University of Munich, Munich, Germany
Professor Erich Schmutzhard, Neurologist, Department of Neurology, University of Innsbruck, Innsbruck, Austria
Professor Christian G. Meyer, Infectious disease expert, Bernhard Nocht Institute for Tropical Medicine, Department Molecular Medicine, Hamburg, Germany
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Dr Stefan Schmiedel, Infectious disease expert, Hamburg University Hospital, Hamburg, Germany
Dr Michel Boussinesq, Oncho Expert/Epidemiologist, Technical Advisor to APOC, Institut de recherche pour le développement (IRD), Montpellier, France

Others in attendance

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Mr Aloisi Gaetano, Medical Student, University of Brescia, Italy
Ms Andrea Zanoletti, Medical Student, University of Brescia, Italy
Mr Andrew Green, Medical Student, University of Brescia, Italy
Ms Elena Zanardini, Medical Student, University of Brescia, Italy
Mr Galderisi Feliciano, Medical Student, University of Brescia, Italy
Mr Fini Missagh, Medical Student, University of Brescia, Italy
Ms Sara Monteverdi, Medical Student, University of Brescia, Italy
Mr Lorenzo Suardi, Medical Student, University of Brescia, Italy
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Dr Joel Montgomery, CDC Kenya, Kenya
Dr John Lule, Epidemiologist, CDC Uganda, Uganda
Dr Joseph Ojwang, CDC Uganda
Ms Juliet Kasule, CDC Uganda
Mr Justin Williams, Health Communication Specialist, CDC Atlanta
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Mr Jyoti Shankar Tewari, Health Adviser, DFID, Uganda
Ms Lilian Akot, Communications and Transparency Manager, DFID, Uganda
HE. Philip Mani, Deputy High Commissioner, British High Commission, Uganda
Dr Pius Ojara, Recovery and Development Adviser for northern Uganda, DFID, Uganda
Ms Robinah Lukwago, Health Adviser, DFID, Uganda
Ms Ying Staton, Program Manager, DFID, Uganda

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