

**Ebola Transmission Dynamics among Household Contacts in West Africa:  
a Public Health Response Evaluation in Western Area, Sierra Leone**

**Request for OMB Approval for a  
New Information Collection Request**

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**Supporting Statement B  
Collections of Information Employing Statistical Methods**

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**Ebola Transmission Dynamics among Household Contacts in West Africa:  
a Public Health Response Evaluation in Western Area, Sierra Leone  
Emergency Information Collection Request**

**B. Collections of Information Employing Statistical Methods**

**1. Respondent Universe and Sampling Methods**

1.1 Respondent Universe

In Western Area (Urban and Rural), Sierra Leone, this public health response evaluation will enroll multiple household cohorts associated with a convenience sample of individual cases of Ebola virus disease (EVD) in the community. Each cohort will consist of the primary case-patient (the first person in a household diagnosed with EVD) and all members of the case-patient's household that have been identified as a "contact." A household contact in this project will include any member of the case-patient's household who has lived with, touched, or spent time within a meter of the case-patient throughout the course of the patient's illness.

This project will build on standard contact tracing practices routinely conducted by the Sierra Leone Ministry of Health and Sanitation (MOH). Standard practices are notated with an "\*" below. A flowchart of the response and data collection process is included in **Appendix C**. Household contacts will be the respondents in the project; however, they will be identified by the case-patient to which they are connected. In collaboration with the Ministry of Health and Sanitation (MOH), project staff will identify and select case-patients through the existing alert system or when they appear in the holding center as walk-ins.\* Household contacts of all eligible case-patients identified during the recruitment period will be considered for inclusion.

Household inclusion criteria are as follows:

- The household has a primary case
  - Household is the primary residence of case at the time of diagnosis;
  - Case spent at least one night in the house after symptom onset;
  - Household is within the project area.
- o

Household exclusion criteria are as follows:

- One or more previous EVD cases within household;
- Case was confirmed more than 21 days after illness onset.

1.2 Sampling Methods

The data collection for this Public Health Response Evaluation will be conducted within the existing Ebola surveillance system in Sierra Leone with some additional data collected on cases and contacts at the suspected-case level by the District Surveillance Officer (DSO), and then on contacts later after finishing 21 day monitoring period in the form of a contact exit questionnaire. After receiving the alert from the 117 EVD response system, the DSO will investigate the case and fill out the case investigation form on suspected live cases plus fill out a contact listing form to list all the contacts\*. Project assistants (called study assistants by Sierra Leone MOH) will go with the DSO to the home of the suspect case patient to explain the purpose of the project, to invite eligible household members to participate, and to collect additional data on cases and contacts after consent is obtained.

### 1.3 Sample Size

As this project will be conducted in the midst of an ongoing public health response, participants will be invited to participate based on their status as a contact of a convenience sample of case-patients. A selection of eligible household contacts of primary case-patients within the catchment area will be invited to participate during the investigation period. To ensure that a sufficient number of participants are recruited to answer the key questions of interest, a target sample size has been determined as described below. Household contacts of approximately 119 case-patients will be targeted for recruitment, for an estimated 1,120 household contact participants targeted for recruitment.

The primary outcomes of interest in this project are to measure the secondary attack rate among household cohorts and individual household contacts and to compare rate of disease between exposure groups (direct and indirect contacts). Based on response experience to date, a conservative estimate of the number of household contacts per case-patient is 10. Dowell, et al. found that the secondary attack rate among household cohorts was 56%, among individual household contacts was 16%, and amongst family members who had direct contact with the case-patient was 29%, while it was 0% in those who did not have direct contact (1999). Using these figures, estimated sample sizes for this project were calculated for 1) estimating a single proportion for the secondary attack rate among household cohorts, 2) estimating a single proportion for the secondary attack rate among individual household contacts, and 3) comparing two proportions for the secondary attack rate among direct and indirect contacts.

For estimating the proportion of household contacts being infected (secondary attack rate), assuming a proportion of 56/100 and a 95% confidence interval width of 20%, we would need a total of 95 households. The lower 95% limit would be 46% and the upper 95% limit would be 66%.

For estimating individual household contact secondary attack rate, assuming a rate of 16% and a 95% confidence interval width of 10% (11%, 21%), we would need a total of 207 household contacts or, at 10 contacts per household, 21 household cohorts.

For estimating the difference in secondary attack rates between direct and indirect household contacts, we assume 30% (n=3/household) contacts are in the direct contact group and 70% (n=7/household) in the indirect contact group. Assuming a 29% secondary attack rate among direct contacts and a 15% attack rate in indirect contacts (increased from the previous estimate of 0% to enable us to detect a smaller difference), a significance level of 0.05, and 80% power, a sample of 93 direct contacts and 217 indirect contacts (total sample of 311 household contacts; 32 households) would be needed.

Because this sample is clustered around the case-patient household there will be two sources of variability that impact sample sizes for secondary attack rates among individual household contacts – within cluster and between cluster—called the intracluster correlation. This increase in variability has the impact of decreasing statistical power for a given sample size-- the greater the number of clusters, the lower the intracluster correlation coefficient (ICC). Assuming an intracluster correlation of 5%, the design effect (DEFF) can be calculated as such:

$$DEFF = 1 + ICC(n-1), \text{ where } n = \text{average household size.}$$

For this project, household size is assumed to be 10. Therefore,  $DEFF = 1 + 0.05(10 - 1) = 1.45$ . Assuming a 20% non-response rate, the following samples sizes are needed:

<b>Estimate Secondary Attack Rate</b>	<b>Crude Sample Size</b>	<b>Adjusted for Clustering (DEFF=1.45)</b>	<b>Adjusted for 20% Non-Response</b>
Household cohorts	95 households	N/A	119 households
Individual household contacts	207 household contacts from 21 households	301 household contacts from 31 households	375 household contacts from 38 households
Comparison of direct and indirect contacts	311 household contacts from 21 households	451 household contacts from 46 households	564 household contacts from 57 households

## 2. Procedures for the Collection of Information

This project is part of an outbreak response and does not involve procedures or interactions that will place the participants at significant increased risk above that already involved with the containment. Before project implementation, all project personnel will be trained in infection control procedures, including proper hand hygiene and the correct use personal protective equipment as per national guidelines for contact identification and tracing.

Project assistants will be hired specifically for this project in collaboration with the MOH. Project assistants will be trained on ethics, privacy and the protection of respondents, and safety. They will be trained to conduct case, household, and contact interviews using tablet computers, with paper questionnaires as a back-up.

### 2.1 Case Information

To capture detailed information about the course of illness in the case-patient, a project assistant will administer the case-patient questionnaire (**Attachment 1**); the project assistant will accompany the case investigation team to complete the questionnaire with the case at the household and/or complete the questionnaire with a caregiver or other person knowledgeable about the case-patient's illness (proxy respondent) after the case-patient has been removed from the household (pending input by the MOH), during a household visit with MOH contact tracers.

## 2.2 Contact Tracing

Contact tracers will be hired in accordance with standard MOH practices; however, supplemental training, supervision, and resources will be provided by the project to ensure high quality monitoring and data collection. Contact tracers will follow standard MOH practices for collecting verbal consent for contact monitoring. However, since contact tracing is being conducted as part of the routine response effort, no consent for contact tracing will be documented for the purposes of this project. Contact tracers will complete the standard contact tracing form (previously approved by OMB) following national guidelines. Ideally, the case-patient is removed from the house before contact tracing begins, and contact tracers conduct their visits outside the house at a safe distance. Contact tracers complete a single paper form for each contact including a list of EVD-related symptoms that are tracked over a 21-day period. If contacts report any symptoms, the contact tracer will inform their supervisor and project staff. The contact tracer will indicate on the form any contacts that refuse to participate in contact tracing. After the 21-day period, the contact tracer will submit completed forms for data entry.

## 2.3 Household and Contact Questionnaires

For contacts, a team of project assistants will accompany the MOH contact tracer during a household visit to explain the purpose of the project and to invite eligible household contacts to participate. After informed consent and enrollment of household contacts of confirmed case-patients, project assistants will administer a standardized household questionnaire to the head of household (**Attachment 2**) and a standardized contact questionnaire to all consenting household contacts (**Attachment 3**). As with contact tracing procedures, project assistants will administer questionnaires after the case-patient has been removed from the house, outside the household at a safe distance from the household and respondents. If there is a delay in removing the case-patient from the house, project assistants will wait until the case-patient is removed, to administer the questionnaires after the time of last interaction between the contact and the case-patient.

- The household questionnaire collects information on characteristics of the household, quarantine status, and household experience calling 117; it takes approximately 20 minutes to complete.
- The contact questionnaire collects information on age, gender, location, relationship to confirmed case-patient, occupation, signs and symptoms, and underlying conditions of the contact. It also collects detailed information on exposure risk factors for Ebola infection, including the nature, duration, and intensity of interaction between the household contact and the case-patient and the stage of illness of the case-patient at the time of isolation and last interaction with the contact. The contact questionnaire takes approximately 30 minutes to complete.

Interviews of the case-proxy and the household members will be augmented by use of a visual diagram of the time course of case-patient symptoms and the exposures/protective behaviors of the household members during the time the case-patient was in the household (**Attachment 4**). The diagram will be used to display information obtained during the interviews and to confirm the answers from the respondent (household contacts of the case-patient). This diagram method has been used in qualitative studies to better understand complex processes in their cultural context (5,6). The diagram was pilot-tested and refined with input from persons knowledgeable of the local situation and with approximately 3-5 eligible households in Sierra Leone before the main project began.

At the end of the 21-day monitoring period for each contact, a project assistant will conduct a brief contact exit questionnaire (**Attachment 5**) in order to identify any possible external (non-household) exposures that occurred during the monitoring period, after the case-patient was removed from the household.

Data on the household and household contacts will be linked by a unique identifier to the case-patient of the household cohort.

#### 2.4 Specimen Collection, Transportation, Testing

In the event that a household contact becomes symptomatic, he/she will be tested for Ebola and managed according to the MOH contact monitoring protocol, regardless of whether or not he/she consents to participate in the project. No additional collection of human specimens will be done for this investigation.

Specimen collection, transport, and testing will be done according to current national guidelines for case investigations for suspect cases in order to: 1) to confirm case-patients for selection into the project; 2) to confirm transmission among symptomatic contacts; and, as secondary objectives, to 3) to look at the association between viral load of the cases as a risk for transmission among contacts; and 4) to test the current and alternate case definitions among contacts. A proxy for viral load, measured as threshold cycle (Ct) values, will be obtained for the specimen that tests positive most recently after the case-patient was last in the household. Per national guidelines, suspect cases are taken to a holding center for testing. The lab samples are processed through one of five laboratories in country, one of which is run by CDC. Testing results from all the labs in the country are sent to the CDC data analyst in Freetown who then disseminates the lab results to the various epi teams/data entry clerks in the districts. The CDC data analyst will send test results to project staff; staff will record results for the case-patient and contact-cases on the Laboratory Record for Cases and Contact-Cases (**Attachment 6**).

#### 2.5 Data Management

A CDC data manager will oversee data management and data integration activities. Project assistants hired and trained for this project will conduct household and contact questionnaires using tablet computers programmed with an Epi Info data entry platform (paper questionnaires will be used as backup; local data entry staff will be hired and trained as needed to enter questionnaire data). Contact tracing data will be entered into the Epi Info VHF Application

following standard procedures; in collaboration with the MOH, the project will provide supplementary support for hiring and training contact tracing data entry staff as needed. Case information will be entered by project staff into the project database. The CDC data manager will integrate all data sources for analysis using SAS or SPSS. A de-identified data set will be shared with CDC staff in Sierra Leone and Atlanta for analysis. The MOH will maintain ownership over all data.

### 3. Methods to Maximize Response Rates and Deal with Nonresponse

Respondents may refuse to participate. However, the purpose of the project and the importance of their participation in gaining necessary information to stop the transmission of EVD within households will be emphasized to all respondents. Experience from the response to date indicates that households have become compliant with quarantine procedures, and thus they are expected to be willing to participate.

### 4. Tests of Procedures or Methods to be Undertaken

During project staff training, each data collection form was pilot tested among nine or fewer case-patients and their household contacts, who were male and female respondents of various ages; revisions were made as needed.

### 5. Individuals Consulted on Statistical Aspects and Individuals Collecting and/or Analyzing Data

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- Appendix E. Sierra Leone Monthly Minimum Wage Statute
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- Attachment 4. Visual Storyboard (interview aid – burden included in Attachments 1&3 estimates)
- Attachment 5. Contact Exit Questionnaire
- Attachment 6. Patient Laboratory Record