

When Medical History is Not Enough: A Targeted Questionnaire for the Investigation of Novel Vector-Borne Diseases

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Medical care among humans is a long and storied profession, which carries with it all the successes and failure inherent in attempting to change the outcome of pathogens and wounds on a person. While techniques and understanding of bodily processes have changed over time, one constant among healers is the need to understand a patient's history in order to properly treat a malady. Medical students are taught to ask the proper questions in the proper way, and to interpret those answers to make the best possible diagnosis and prescribe the best possible treatment (Thrush 2002). The task is so important that most medical personnel, from emergency responders to records specialists have some level of training to ensure accurate data gathering directly from the patient (Sadrollahi, Gharataghani et al. 2018).

The need for an accurate and thorough patient history is especially important in cases of suspected vector borne disease. Unlike injury or well-known diseases, vector borne pathogens may not be the first or most obvious diagnosis (Gubler 2009). In fact, most medical professionals have little specialized knowledge in vector borne diseases, and require extensive training to better catch and treat novel, rare, or especially virulent pathogens. The first critical step in ensuring that a vector borne disease is eventually properly diagnosed and treated is to create a robust patient history, focusing on the entomological aspects of exposure (National Academies of Sciences and Medicine 2016). This paper represents a starting point for such histories, and attempts to integrate well known practices with arthropod-specific language to

ensure all medical personnel have the information necessary to diagnose a vector borne pathogen.

The questionnaire herein was developed following guidelines from the U.S. Department of Health and Human Services, the USDA, and the CDC. The questionnaire is designed to allow medical professionals to quickly choose the proper questions based on unique circumstances. This questionnaire is organized with the most important questions for anyone suspected of suffering from a vector borne disease listed first, and should be used in conjunction with standard medical histories developed for specific offices. If an emergency history is necessary, the first five questions of this paper may be viewed as the most critical in determining the presence of a vector borne disease. If more detailed questions are necessary, it is recommended that personnel consult a medical entomologist or other professional with specialized training in vectors and vector borne disease.

Taking a History

Using this questionnaire: The use of these questions should only be done with the express permission of the attending physician or other medical professional. All information should be recorded following the standard operating procedures, HIPA laws, and other guidelines as appropriate. The questions are designed to gather additional information when a vector borne disease is expected, and not as a replacement for other medical history.

Background information: It is assumed that all patient vitals, demographics, disease history, and other standard questions have been obtained through routine medical histories as dictated by standard operating procedures. Prior to using this questionnaire, ascertain what data have been recorded to avoid wasting time or stopping treatment unnecessarily.

Case familiarization: Prior to engaging a patient, all information regarding the case at hand should be gathered, along with common vectors, vector-borne diseases, and arthropod pests should be identified to ensure proper question choice. A medical entomologist can help with the gathering of such information in any given area.

Question style: Medical questions are personal in nature, and therefore may elicit varying results. Questions should be asked in a relaxed, professional manner, while maintaining eye contact with the patient. Any nonverbal cues should be noted by the interviewer, and proper follow up questions used as necessary. Additional training in interviewing techniques may be required to best use this tool.

Vector Borne Disease Questions

Questions can be grouped into five topics, from most important to least:

1. Environment Questions
2. Travel Questions
3. Experience Questions
4. Miscellaneous Questions
5. Medical History Questions

Environment questions are designed to determine if the patients have come into contact with environments known to support common vectors, the likelihood that those vectors came into contact with the patient, and the frequency of those encounters. Travel questions attempt to determine if the patient may have been exposed to novel vectors or pathogens, and if there is the possibility that the patient moved the pathogen and/or vector to a new environment. Experience questions attempt to elucidate areas of contact between patient and vector that may not be

immediately obvious to the non-entomologist: work places, hobbies, and the like. Miscellaneous questions give each interviewer a chance to ask questions that may seem irrelevant to the untrained observer. Finally, medical history questions are the least important, as most offices will have a full medical history available to the entomologist. If there is time, or if a particular disease is suspected, it may be prudent to add some specific questions about medical history. However, reiteration of questions answered to other interviewers may cause annoyance to an ill patient, and should be avoided.

A medical entomology questionnaire should include the following characteristics:

1. Entomologically focused
2. Responsive to known information
3. Non-judgmental
4. Clearly stated
5. Focused on commonly overlooked information
6. Specifically ask for what is needed

The questions here are presented with reasoning behind their inclusion to better give interviewers a guide as to when each is most appropriate. Each question also has a list of suggested follow-up questions. These questions may or may not be relevant given the answer to the main question. Interviewers should use their judgement and facts of the case to determine the best course forward. Keep in mind that patient personality varies, and while some patients may give lots of details to simple questions, others will only answer specifically what is asked¹. Make sure that the chosen questions allow for patients who give simplistic answers speaking only to the specific questions, and follow up with more specific questions when needed. Finally, following up with open-ended questions such as “can you elaborate on that?” or “Can you give me the circumstances around that situation?” may prod the patient into revealing details not normally thought to be important. Avoid simply yes or no questions, or questions that have discrete answers when you are probing for information. Remember that patients don’t know what is important.

To best gather information efficiently, interviewers should pick the most important

¹The mathematician’s answer: Mathematicians, engineers, data scientists, and other personalities with these qualities are much more likely to answer the asked question precisely with no elaboration. For example, if you were to ask someone “Have you seen my keys?” the type of answer depends upon the person answering. Some will answer “they are on the table,” understanding that you cannot find them and need to know where they are. Others will

questions from each group and get those answers first. This will inform the follow up questions. A unique questionnaire should be created using the questions below in light of the facts of the case, prior knowledge of the environment, and consultation with an entomologist.

Special note: questions highlighted in red are the most critical of this list.

Questionnaire:

Environment Questions.

1. **Have you been bitten by an insect within the last three weeks?**
 - a. Do you know what type of insect bit you, or can you describe it?
 - b. What did the bite look like?
 - c. Did you keep the insect that bit you?

This is the most critical question to ask when a case of a vector borne disease is suspected. While most patients don’t remember specific instances of insect bites, some arthropods are especially memorable (i.e., ticks) or unusually frequent. The follow up to these questions is important, as with the advent of camera phones, social media, and other communication devices patients are much more likely to document the insect and resulting bite. Public health campaigns have also suggested that patients of potential vector-borne diseases save suspect organisms and show them to the doctor. It is possible the patient has not yet been asked if they had saved the insect, and some patients do not

answer “yes” with no follow up information. This is called the mathematician’s answer, and is characterized by only answering what was asked without any other information. When dealing with a mathematician’s answer, be prepared to ask a series of specific questions and do not assume that the patient will give details unprompted. Understand the patient’s personality before beginning your interview.

volunteer this information. Ask for the physical insect when possible.

2. Do you have any pets?
 - a. What types?
 - b. How long have you owned these pets?
 - c. Do they have any pest problems? Bites? Stings?
 - d. Have the pets exhibited any symptoms?

Pets often live in the same environment as humans, and therefore may be exposed to the same insects as those humans. Pets are also potential reservoirs for vector borne disease, and may harbor the disease agent without showing obvious symptoms. If a pet is present in the home, investigators should take samples from the pet to compare to the patient.

3. Do you interact with animals?
 - a. What type?
 - b. In what capacity?

It is important to clarify this question if it has not been answered in other areas (i.e. through questions in other groups). Patients that work with animals may have a distinct delineation between production animals and pets, and therefore not indicate their exposure to animals if asked about pets in the home. Patients may also not work with animals in a professional capacity, but interact with those animals on a regular basis through leisure activities, volunteer opportunities, or hobbies. Precise questions of this nature ensure that all the information is gathered regardless of the patient's personal views on animal roles.

4. What do you do for work?
 - a. Do you spend significant time indoors or outdoors?
 - b. What is your workplace like?

- c. Do you often come into contact with insects or animals during your work day?

This question is repeated in subsequent groups, and may or may not be appropriate at this juncture. It may also be covered in the medical history and other materials. It is important to ascertain the day-to-day movements of the patient, and work often takes a significant amount of time in any given person's life, therefore this question should be asked if information is not forthcoming.

5. Where do you live?
 - a. Would you describe it as urban or rural?

Again, this question may be answered in other groups or through the routine information gathering upon check in of a patient. If the information is not available, it should be asked specifically to ensure investigators understand the environment the patient is normally within. This is especially important if the patient is traveling, or has recently been in an unusual environment since it could indicate a novel host situation.

6. Do you have any pest problems?
 - a. What type?
 - b. How did you treat them?

This question is included to ensure clear communication of the type of information necessary. When asking a patient if they come into contact with insects on a regular basis, the patient may not volunteer information that is considered embarrassing. Asking specifically about pest problems with out judgement will give the patient a way to

give this information without embarrassment. Additionally, patients may not understand that common household pests (cockroaches, ants, flies, moths) and uncommon pests (bedbugs, kissing bugs, lice) can vector disease in certain situations. Ask the question clearly and ask follow up questions to get a better understanding of the exposure risk.

Travel Questions.

1. **Have you traveled recently?**
 - a. Have you traveled inside or outside of the country?
 - b. When?
 - c. Where?
 - d. For how long?
 - e. What were you doing?
 - f. Did you bring anything home with you, including animals or insects?

This is the most important question set of this group. These questions are designed to determine if the patient may have been exposed to novel diseases, or if the medical entomologist needs to expand their information gathering to include potential vectors and diseases in areas apart from the home and work places of the patient. Patients will often not realize the risk of vector borne disease while traveling, and therefore may not have volunteered this information on intake. This question is especially important when attempting to determine the source of a local outbreak, as patients who have recently traveled may have brought a novel disease agent, vector, or reservoir back with them. Asking patients if they brought animals back with them is key, and it is important to reiterate that no legal repercussions will be forthcoming. Wildlife smuggling is a high value, low

risk crime, and can be the source of an outbreak. The interviewer's job is to find the source rather than prosecute a crime.

2. Have any members of your family traveled outside of the country?
 - a. Who?
 - b. Where?
 - c. When?
 - d. For how long?
 - e. How often are you in contact with them?
 - f. What were they doing?
 - g. Did they bring anything home?

This question accounts for exposure of a patient without that patient personally leaving the country. Due to the nature of vector borne disease transmission, a patient may catch a disease if a close family member has it in their system and is in contact with the patient and a competent vector. A patient that is immunosuppressed may therefore catch a novel disease without traveling.

3. Have you come into contact with anyone who has recently traveled outside the country?
 - a. Where did they go?
 - b. Did they come home sick?
 - c. Did they get bitten by an insect?
 - d. Did they work with animals?

This again allows the patient to talk about anyone not specifically referred to in previous questions. Question specificity is key, as some patients may only answer what is asked without understanding that certain details or clarification are necessary. (See "mathematician's answer" footnote).

Experience Questions.

1. **Do you spend a considerable amount of time outdoors?**
 - a. What activities do you do?

- b. Do you come into contact with insects or other arthropods during these activities?
- c. What's the environment while outdoors?
- d. Do you come into contact with insects while outdoors?

This question is designed to ascertain the likelihood of patients being exposed to vectors. Patients who do not work outdoors nor live in rural areas may have hobbies, social activities, or other events in areas where vectors are abundant without realizing the importance. This series of questions should be phrased in a way to allow for exploration of possible exposure.

- 2. Where do you work?
 - a. What are your duties?
 - b. Have you noticed any insects at your place of work?

Only ask this question if the information cannot be gleaned from other sources. It is helpful to ask the specific question about insects at work, however, and may help to clarify exposure risk.

- 3. Do you use insect repellent or protective clothing on a regular basis?

This question is designed to get information about exposure risk without requiring the patient to understand insect biology or other scientific principles.

Miscellaneous Questions.

- 1. **Is there anything else you think we should know?**

This is the most important, open ended question an interviewer can ask. It gives the patient a place to voice observations, concerns, thoughts, or any other facts that

the interviewer did not know to ask. Be careful not to phrase this as a yes-or-no question; clarify that this is a point where the patient can fill in any gaps in knowledge. This type of question is critical when dealing with an unknown disease of unknown origin, and has yielded investigative breaks of immeasurable value. Use the answers given here to ask follow up questions or to clarify new information.

- 2. Do you collect insects?
 - a. What types?
 - b. Can you identify insects or bugs?

As strange as this question may sound, the general public does have a sub set of amateur and professional entomologists. These patients are much more likely to understand what bit them and the importance of identifying the pest. It is likely that the patient has the specimen curated which could help the investigation immeasurably.

- 3. Have any of your family members been ill recently?
 - a. With what?
 - b. What were the symptoms?
 - c. For how long?
 - d. Did they recover?

This question may be answered in a general medical history, but should be asked if not answered elsewhere. The outbreak of a disease is often clustered within family groups due to their close proximity, and while the patient may be having a significantly worse reaction to the disease, they may not be the first to experience it.

- 4. Have you come into contact with someone else's bodily fluids?
 - a. What type?
 - b. When?

c. Were they ill?

Again, this is designed to get the patient thinking about uncommon routes of transmission. Some vector borne diseases are also passed through bodily fluid (blood, semen, urine, fecal material, breast milk) and can be passed without the presence of a vector. It can help to explain strange cases of illness in people not exposed to a vector.

Medical History Questions.

1. Do you have any insect bites?
 - a. Do you have any rashes, bumps, or welts?
 - b. Are you having a localized reaction that is itchy or painful?

Most medical questions should be answered in the patient's medical records well before an interview of this type. However, when patients are experiencing major symptoms, doctors tend to ignore "minor" complaints such as possible insect bites. Specifically asking about this type of symptom may help to determine the cause of the illness.

2. Has your normal diet and/or exercise regimen changed recently?

This question is an attempt to determine if the patient might have been exposed to an environment or pest source that was previously excluded from their life. It can lead to further questions about the new environment in the case of an exercise regimen, or new pest sources, in the case of new diets. This question should be worded ambiguously to ensure full disclosure.

Conclusion

The investigation of a potential vector borne disease is a complex, multi-faceted process that requires collaboration and communication among a large team of experts (Kaya, Sokol et al. 2004, Kimaro, Toribio et al. 2017, Bilgin, Turan et al. 2020). An incomplete medical history may result in an incomplete investigation (Cruvinel, Zolnikov et al. 2020, Wilson 2020). This questionnaire was designed to focus on those areas that traditional medical investigations miss, and elucidate areas of investigation that may assist the team as a whole. These questions should be used as a guideline rather than a checklist, however. Investigators should apply their knowledge of the case, of the circumstances, the potential vectors, and other scientific facts to guide the questions and subsequent investigation. When necessary, continued communication with all patients and family members is key. Further development of this list is encouraged.

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