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Selecting Essential Information for Biosurveillance—A Multi-Criteria Decision Analysis

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Objective

To describe how multi-criteria decision analysis can be applied to identifying essential biosurveillancce information and demonstrate feasibility by applying it to prioritize data streams.

Introduction

The National Strategy for Biosurveillance defines biosurveillance as "the process of gathering, integrating, interpreting, and communicating essential information related to all-hazards threats or disease activity affecting human, animal, or plant health to achieve early detection and warning, contribute to overall situational awareness of the health aspects of an incident, and to enable better decision-making at all levels." However, the strategy leaves unanswered how "essential information" is to be identified and integrated, or what the metrics qualify information as being "essential". Multi-Attribute Utility Theory (MAUT), a type of multi-criteria decision analysis, provides a structured approach that can offer solutions to this problem. While the use of MAUT has been demonstrated in a variety of fields, this method has never been applied to decision support in biosurveillance. We have developed a decision support analytic framework using MAUT that can facilitate identifying data streams for use in biosurveillance. We applied this framework to the problem of evaluating data streams for use in a global infectious disease surveillance system.

Methods

Our approach to the evaluation of data streams followed four broad stages—problem structuring, value elicitation, ranking, and sensitivity analysis—that could be sub-divided into seven steps, each of which were critically important to ensuring high confidence in our rankings. We employed three approaches to identify biosurveillance goals, data streams, metrics and values: a review of local, national and international surveillance systems, consultation with subject matter experts, and a review of literature. The four goals identified were: Early Warning of Health Threats, Early Detection of Health Events, Situational Awareness, and Consequence Management. Sixteen data streams were identified: Ambulance/EMT records, Clinic/Healthcare Provide Records, ED/Hospital Records, Employment/School Records, Established Databases, Financial Records, Help Lines, Internet Search Queries, Laboratory Records, News Aggregators, Official Reports, Police/Fire Department Records, Personal Communication, Prediction Markets, Sales, and Social Media.

Results

Four data stream categories consistently ranked within the top 5 for every single goal: Internet Search Queries, ED/Hospital Records, Clinic/Healthcare Provider, and Laboratory Records. Three of these—ED/Hospital Records, Clinic/Healthcare Provider, and Laboratory Records—are commonly used in current systems; only Internet Search Queries are not frequently used as a data stream in operational biosurveillance systems.

Social Media, Help Lines, and Sales data streams were all ranked at least once amongst the top five. There was a significant drop off in the ranks for the other data streams. Sensitivity analysis was performed and found that the results were robust. Using the framework and MAUT, it was possible to rank each of the data streams in multiple criteria for each goal in order to create a prioritized list that can inform decision makers.

Conclusions

This project introduces a generic framework for biosurveillance data stream that can assess multiple attributes, both quantitative and qualitative, and link them to a biosurveillance. We further demonstrate the utility of the framework by applying it to assist in the decision making process of selecting biosurveillance data streams. This framework is applicable to surveillance practitioners, regardless of health domain, to assist in prioritizing the selection of data streams for inclusion into their surveillance programs.

MAUT models and decision frameworks should be used with concern as to the sensitivity and robustness of results and should be seen not so much as a decision making tool but rather as a decision aid to support the prioritization and selection of data streams for specific biosurveillance goals. The decision maker should use this prioritized list to inform their thought process and to help make justifiable and transparent decisions.

Keywords

Biosurveillance; Evaluation; Data Stream; Multi-criteria decision analysis; identification

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