Modeling medical intelligence and surveillance for global safety

MENIZIBEYA O. WELCOME
World Scientific and Engineering Academy and Society, Ioannou Theologou 17-23, 15773 Zografou, Athens, GREECE
email: menimed1@yahoo.com
NIKOS E. MASTORAKIS
Department of Industrial Engineering, Technical University of Sofia, 8, Kl. Ohridski Blvd. 1000 Sofia, BULGARIA;
World Scientific and Engineering Academy and Society, Ioannou Theologou 17-23, 15773 Zografou, Athens, GREECE
email: mastor@tu-sofia.bg

Abstract: - Medical intelligence and surveillance is the active and ongoing manual and automatic gathering of large data from different sources to effectively monitor the outbreak of communicable diseases, pattern of behavioral disorders, chemical, radiological or biological attack, and provide prompt preparedness and response measures to mitigate the incident, and rehabilitation measures for victims. As a key area that will enormously shape global diplomacy and safety in the future, there utmost need in enhancing development of effective medical intelligence and surveillance around the world, particularly through technological advancement and intelligence. Several lines of evidences show that development of effective medical intelligence and surveillance could have tremendous importance for an efficient global security network that will promptly and effectively manage future events. Various models that will account for effective medical intelligence and surveillance are presented.

Key-Words: - Medical intelligence and surveillance, models, global safety

1 Introduction

From the dawn of the last century, medical intelligence and surveillance (MIS) has undoubtedly played a pivotal role in shaping effectiveness safety measures throughout the world. Beginning from the late part of the last century, occurrence of diseases that were initially thought to have been defeated and the emergence of new diseases that wreaked havoc raised series of suspicion on the effectiveness of MIS generally in the world. These re-emerging and emerging transmissible diseases could easily be spread over hundreds of thousands of distances, thereby making the control and mitigation processes even worse. This effect of globalization has been recognized some decades past and its full effects are yet to be felt. Globalization has brought both negative and positive results. Whether the negative or positive effects predominate, depends on the geographical region and indices of human development under analysis [1-4]. Notwithstanding, however, even those nations with relatively better technological intelligence on MIS will be greatly affected if another part of the world, which has less developed technological intelligence on MIS is affected. Therefore, setting up a global safety measures on control and mitigation of future events is paramount. In addition, socio-economic growth, overall quality of national intelligence and surveillance, as well as healthcare delivery of goods and services are areas that must be routinely addressed to avoid unnecessary occurrences of loss of lives and property [1,5-7].

This paper focuses on possible ways in enhancing MIS for global safety that will efficiently account for future global events. Models to account for effective MIS in global safety are presented.

2 Brief History of MIS

The evolutionary developmental phases of intelligence and surveillance suggest that MIS is at least six centuries old. The evolution of MIS is multiphasic – from the traditional manual detection to present-day automated techniques [2].

Before the late twentieth century, public health was seen as a distinct arm of national development,

without national security interest attached. Today, there is no doubt that infectious agents or toxins, chemical or radiological agents can be used to target a particular group of population. Healthcare specialists could track victims of such events at its very early stage of attack. Interestingly, even in minor attacks, healthcare specialists would be at the forefront to observe an attack as people who are sick would mostly likely report ill health to their healthcare professional [2,8].

Over the past decades, analysis of symptoms to locate a likely attack has been used in numerous occasions. However, the advantage here is that an attack has occurred before resources are mobilized for mitigation process. Over the years numerous systems together with relatively high prognostic potential had been developed. MIS system such as MedISys, and PULS are important not only for their peculiar tracking techniques, but also serve as high-wire news systems. Literature data report on the huge development of MIS systems in Europe and most especially in the United States during the last few decades. For instance, the MedISys is used by at least eleven national public health agencies of Europe and four supranatural organizations, including World Health Organization. The leading MIS is BioWatch [1,2,8]. BioWatch has survived two generations. Generation-2 BioWatch recorded considerable success, but there was need to set up Generation-3 BioWatch system due to the necessity for automaticity and speed of processing. Generation-3 BioWatch system represents a significant improvement on Generation-2 BioWatch. It was expected that Generation-3 BioWatch system would have been functional by now, unfortunately, probably, because of several reasons; an unexpected delay has been encountered [9,10].

There is a list of safety and intelligence systems that can be adequately managed to meet the current needs of biological, radiological and chemical terrorism threats. For instance, electron beam scanners can be managed adequately as tracking tool to locate bioterrorism threat [2,8]. Unfortunately, no one system provides overall coverage of events of public health concern. Notwithstanding, however, the trends of events over the last century strongly suggest the need to step up technological intelligence for MIS to meet unexpected future occurrences that could jeopardise the lives and property of world citizens and may probably put our planet in chaos [11-15].

3 MIS and State Politics

If concrete global treaties are not put in place to regulate individual state behaviors on global or national MIS, regional political ideologies can to a far extent affect the effectiveness of MIS [2,8]. Another issue is that not all states may sign up if all a treaty is lunched.

Figure 1 shows how state politics may affect the efficiency of MIS. Data sources may be compromised which may affect the results of analysis and put lives of citizens at higher risk of an attack. However, if adequately managed as outlined in Figure 1, MIS can function to effectively track and mitigate perceived events of possible public health concern.

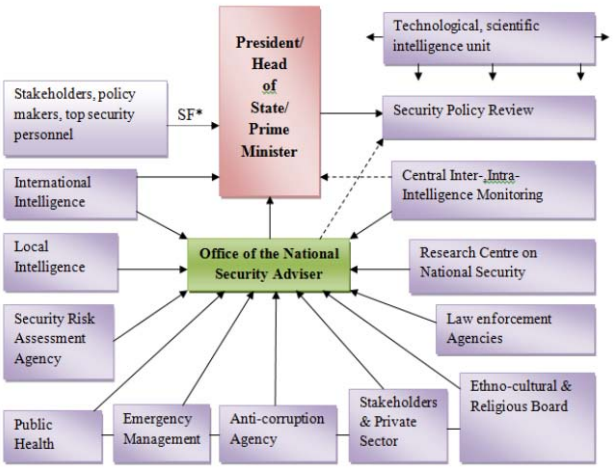

Figure 1: A model of national security architecture. *SR – Suggestion Forum. In this model, security management is viewed as interplay between several government agencies, interagency as well as international collaboration. Sub-controllers as shown in the figure subordinate the President and National Security Adviser being the security heads. To reduce system error, analogical system maybe set up at all levels of administration of a nation. All responsible state agencies in addition to giving their report to their federal centers must be mandated to provide routine security report to the security advisers of their state government, who will report likewise to the Office of the President on National Security. Routine security reform, national security policy amendment, and review are to be carried out under stipulated period. Specific ministries relate directly to the president, but it might be necessary for them to relate to the Office of the National Security Adviser, if a situation is considerably considered a security concern [2,8].

If concrete and effective global MIS measures are not put place, state politics will likely affect the efficiency of MIS. This could be fostered by the outbreak of emerging and remerging diseases able of spreading over a wide range of geographical region over a very short interval of time. This was a

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strong indication that even the International Health Regulation (2005) of the World Health Organization may be found not applicable in certain cases [16]. As with global safety, MIS represents a shared responsibility at the various levels of government and administration of a nation. In this regard, diplomatic ties must be enhanced at various levels – national or federal, state, local, tribal, territorial and private sector levels. Diplomatic relationships can significantly affect the management of MIS for global safety and may be achieved in some cases through by economic, political power, and technological intelligence.

4 MIS and Global Safety

MIS and global safety are closely related and interlaced. Both ensure close monitoring of events to ascertain the safety of lives and property. However, MIS is majorly concerned with the active and ongoing manual and automatic gathering and analysis of large data from different sources to effectively monitor the outbreak of communicable diseases, or events of interest (precisely chemical, radiological, biological events) that are potential sources of health or physical harm to the population, and providing prompt response measures to mitigate the incident, and rehabilitation measures for victims. Global safety is concerned with the maintenance of security and peace in all areas of human living through the use of both military, diplomatic, and state power. An efficient MIS plays a key role in enhancing national or global intelligence and security. For instance, inadequate MIS system, that cannot promptly detect and manage diseases outbreak can lead to huge loss of lives, property and resources of a nation and put the country into a state of depopulation, socio-economic crisis and possible isolation if further measures are not taking to address the situation [1-8]. This is recently seen in the recent Ebola Virus Disease outbreak, where deeply affected countries had been further isolated as business, transportation had been completely cut off by countries that fear for getting the infection into their territory [17].

MIS also involves investments in critical infrastructure; food, water, economic, and environmental safety, which are also paramount in global safety. Although could be profoundly modulated by political ideologies and national interest, efficient MIS must be rooted, among many other things, in professionalism, diplomacy and strong intelligence network [1,2,8].

5 General Mechanisms of MIS Functioning

MIS systems are critical in everyday life. Surveillance systems may be setup for specific national or international event as antiterrorism measures, without which the state is freely open to attack from outside and within. MIS system can be:

1. Monomodal – The system is modeled to cover only one type of threat;
2. Bimodal – The system is modeled to cover two types of threats;
3. Multimodal – The system is modeled to cover multiple types of threats.

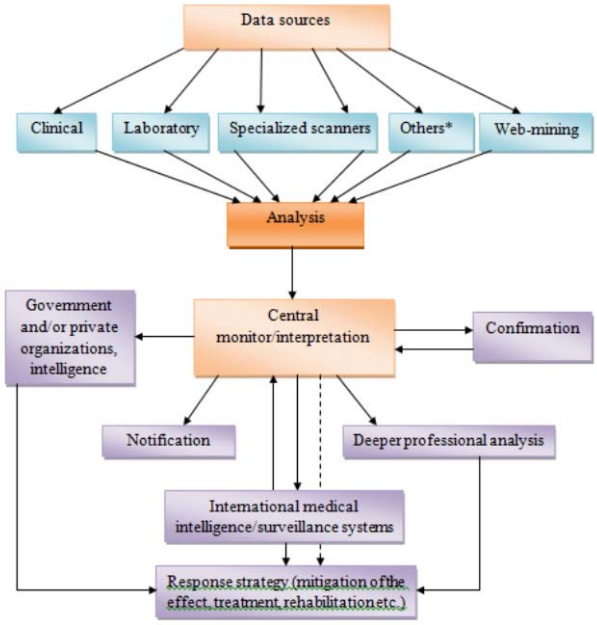

Figure 2: A model of medical intelligence and surveillance designed to meet the needs of adequately locating and neutralizing current threats. Data sources may be diverse. Clinical information may include major clinical complaints of patients during visits to health care centers, signs and symptoms of ailments reported, medication sales etc. Laboratory information includes test results and orders. Web-mining tracks or traces reports or search behaviors of individuals in the geopolitical domain of interest. Specialized automated scanners trace and search for substances or devices of interest and maybe placed at strategic location. Other data sources might include school absenteeism etc. The central monitor and interpretation unit helps to address the response strategies by constantly providing information on the trends of events, and also, providing recommendations on possible, best strategy in mitigating the effect/threat. Special professional scientists, apart from analyzing the interested event or substance/agent could also make meaningful contribution to the response strategy. The major part of the response comes from government and private organizations and intelligence agencies (both national and international, depending on the severity of the threats).

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The model presented in figure 2 is an example of multimodal MIS system. The model performs the same functions as with other MIS systems [1,2] – text mining from a variety of sources and track bioterrorism (like airport bio-threat etc); diseases (contagious, sexually transmitted diseases etc); chemo-terrorism, event course etc. The function of the central system is to analyze current result of reports and web data received against keywords entities and perform selective processing of results. By selective processing, the system sends information, where appropriate to local points, government organizations and intelligence; perform professionalized and deeper analysis of critical information or search results of critical importance. The model matches acquired data against taxonomy of named entities, names of infectious diseases, states, cities, villages, health agencies etc. In addition, the system functions to file-out reports, send requests, issue alerts, perform several system commands and have several databases access. In addition, the model tracks the progression and captures ongoing events and dynamics of events to others by selective processing. This MIS model remains a good match for nations of the world as it is modeled to meet current threats. To optimize information, the system links up with other international monitoring systems to effectively manage and control outbreaks of communicable diseases and bioterrorism or other threats.

6 Emergency Preparedness and Response Strategies as Key Components of MIS

Adequate emergency preparedness and response strategies are, inevitably some of the building blocks of any MIS system [18-20]. Emergency preparedness and response strategies must be closely integrated into the model in figure 2 to ensure efficient MIS. Emergency preparedness and response strategies are closely linked with the following:

1. Information management system: Adequate and timely management of information are necessary to build effective MIS system.
2. Management of space weather and storm: This aspect of surveillance has a strong relationship with global safety, particularly health security.
3. Laboratory surveillance: There is utmost need for the development of specific laboratory surveillance system that can, adequately and timely, locate emergency even at its lowest level of threat. In addition, ongoing response strategy must be designed to involve constant gathering of data from laboratory surveillance.
4. Border surveillance: This strategy is necessary to effectively combat and control or manage the spread of the outbreak.

6.1 Principal Components of the Emergency Preparedness/Response Strategy

The major components of the response system include human, non-human agents (including robots, unmanned devices), technological tools, appliances and equipment. These components are necessary to maintain and manage threats or disaster through:

1. State power;
2. Diplomacy;
3. Medical technologies (treatment, first aid, vaccines, search for substances with anti-effect to any known substances-radiation or chemical), educating the populace on subtly pathological cases of behavioral disorders etc.;
4. Technological defense (high-tech system, satellite response system, etc.).

7 Terrorism Types and Risk Analysis for Global Safety

The basic types of terrorism are biological, chemical and radiological [1,21,22]. A general model of surveillance of locating terrorism trend is presented in Figure 3.

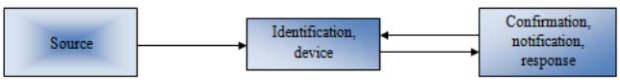

Figure 3: General model of surveillance of terrorism types.

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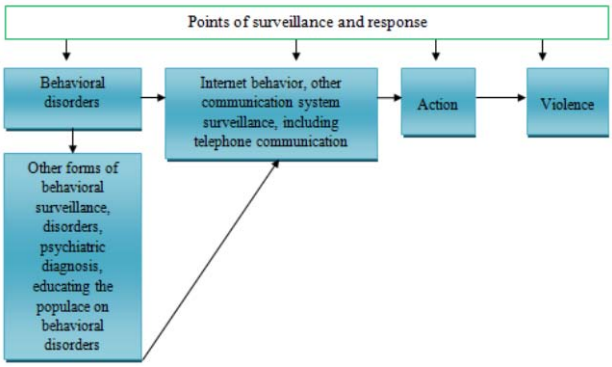

Figure 4: Model of inter-relationship and response in biological surveillance. Building such model will adequately monitor and track from several indices to control and manage impending or possible occurrence of threats.

7.1 Biological Surveillance

Biological surveillance involves traditional surveillance techniques such as syndromic, etc. [13,14]. It also includes surveillance of behavioral and psychopathological indices. Importantly, the psychopathological analysis of terroristic behavior, internet search behavioral pattern may provide useful information on biological surveillance. This allows adequately monitoring, tracking and forecasting future occurrences in a given geopolitical location of interest. Search trends of specific word pattern such as name of toxins, chemical or radiological substances may be modeled to identify risk areas. Suspicious pattern may be exported for further expert review for adequate measures. The model in Figure 4 shows mechanisms of threat identification and a likely pattern of response.

7.2 Chemical Surveillance

This type of surveillance addresses issues of potential threat to the population or living things in our society. It involves the precision monitoring of possible chemical events (of public health concern) through the air, waterways, food, or other products or items at strategic locations of interest to effectively track and mitigate possible harm that may result through intentional or unintentional use of chemicals to cause destruction to plants, food, animals or humans in the society [21,22] (Figure 5).

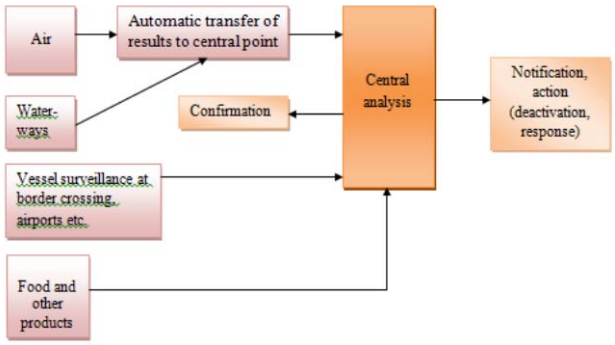

Figure 5. A model of chemical surveillance technique.

7.3 Radiological Surveillance

This type of surveillance is exceptionally useful in everyday life without which the state is particularly prone to uncontrolled mass disaster. Health professionals and security agencies are particularly, the principal agents in controlling this sort of outbreak (Figure 5). Healthcare professional and technological surveillance devices could effectively locate possibility of even low-level attack [21,22]. Efficient MIS is unavoidably necessary to identify early threat posed by radiological attack by promptly reporting to the security apparatus of the state based suspected signs and symptoms of ailments.

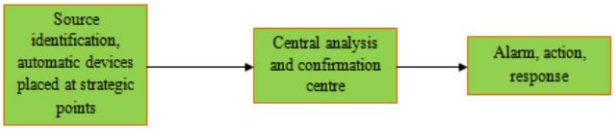

Figure 5: A summary model of radiological surveillance technique.

7.4 Prognostic Model

To effectively locate or monitor threats, a prognostic system must be incorporated into every MIS system. This allows to effectively locating or monitoring early or likely occurrence, and forecasting the likelihood of a threat of particular interest to the geopolitical region of interest [1,23] (Figure 6).

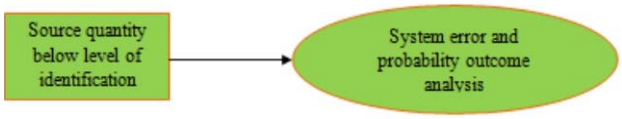

Figure 6. A summary prognostic model of surveillance.

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8 Futuristic MIS in Global Safety

Without doubt, further strengthening of MIS through techniques highlighted in this present section will provide opportunity for adequately curtailing futuristic occurrences of public health concern. These techniques might include, but not limited to efficient solar intelligence network system, molecular rays and imaging utilizing molecular registers.

8.1 Solar Intelligence Network System

The possibility that the Earth might face detrimental damage from extra-planetary bodies like huge asteroids is not to be discarded at any given instance. This threat has become even more real than ever before [24,25] and requires the development of adequate solar intelligence network and response system. The risks of electromagnetic and solar storms are particularly becoming a health security issue. These threats pose substantial risk to human existence. Regrettably, the level of scientific and technological intelligence necessary to deterring huge extra-planetary invasion or electromagnetic and solar storms of the Earth is presently not available. Consequently, there are all reasons to garner efforts on solar intelligence, defense network and response system.

8.2 Molecular Rays and Imaging

The trends in technological breakthrough in the last decades, coupled with the prevalence of emerging and reemerging diseases point to the need to develop a futuristic MIS system in enhancing global safety, precisely health security [23, 26-29]. The proposed MIS system molecular "floating" registers that could detect the substrate of interest; produce an automated signal that will be detected by a system that identifies the signal properties, including location and substrate types to produce an alarm response. A likely concern for such a molecule will be reaction with microbes or other particles. In addition, if such a molecule is designed to trace a specific virus or toxin of interest, the genetic polymorphisms of the microorganisms and their genetic variability might influence the results of analysis.

8.3 Accounting for System Error in MIS

Humans and non-human systems are prone to error commission; therefore, there is paramount need to research ways in avoiding error in these systems. This will have meaningful outcome on the efficiency of MIS. Analysis of this error system is provided in our recent paper [30].

9 The Way Forward

The following recommendations, in addition to the models presented in this paper may help in advancing MIS.

1. Improve diplomatic ties among nations of the world;
2. Develop error response system, involving prompt detection and correction to avoid the human factor in real life or unmanned situations;
3. Research etiological factors and mechanisms of behavioral disorders and other conditions of considerable interest;
4. Develop super scanners for substances or agents of interest. With development of 3D influenza modeling of viruses and food scanners, there is hope that improvement in scientific and technological research will provide information that will further strengthen global safety.

10 Conclusion

MIS systems must be designed to efficiently address the present and future emergencies: detecting, forecasting of event trends, and providing the readiness to effectively mitigate and control possible harm and efficiently manage potential future events of public health concern. MIS systems, besides adequate management, must be integrated with strong leadership principles, national and global diplomacy. Research to advancing the functions and roles of MIS must be focused on multisystem integration from development scientists and uphold global safety for the future of the planet.

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