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EVALUATION OF BIOHAZARD MANAGEMENT OF THE ITALIAN NATIONAL FIRE BRIGADE

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ABSTRACT

Biohazards are non-conventional threats that are very difficult to manage. This is due to difficulties in the identification of biological agents that are responsible for the onset of a disease, which can be bacteria, viruses, fungus or toxins. In Italy, the first response system to biohazards is provided by the National Fire Brigade (NFB) (Corpo Nazionale dei Vigili del Fuoco - CNVVF). The aim of this work is to evaluate the procedures adopted by the NFB for the management of biohazards. This is done by comparing the statistics of NFB interventions in 2000-2010 for potential biohazard events, and chemical and radioactive risks. A series of solutions is then proposed to improve the NFB's national response system for biohazards.

Keywords: *National Fire Brigade (NFB); biohazards; chemical, biological, radiological and nuclear (CBRN); interventions; specialist biologists.*

1. INTRODUCTION

Biohazards is a very complex subject which is not easily explored. In fact, while for chemical and radiological-nuclear hazards we can often refer to well-known data, it is not the same for risks in the biological context (Kaszeta, 2012). The reason for this lack of information is clear; biohazards have still not been completely understood. For example, the molecular mechanisms of cancer development have only recently been associated with viruses directly transmitted (Butel, 2000). Moreover, commercialised systems and instruments do not currently exist to identify several biological agents, and the ones that exist do not allow instant infield identification. Hence, it is often necessary to use complex laboratory instrumentation for certain and rapid determination. The use of laboratory techniques require extended periods of

time to get an answer. Additionally, the appropriate response is not always clear.

In Italy, the first response system to biohazard events is provided by the National Fire Brigade (NFB) (*Corpo Nazionale dei Vigili del Fuoco* - CNVVF). In the last decade, the NFB had to create a new division to operate in these "new risk scenarios" (we used the term "new" taking into account the classical background of infield operators). Following events involving biohazards, such as envelope and package contamination with anthrax spores (2001), and the potential spread of the avian influenza pandemic (2006)), circulars decrees were issued *ad hoc* by the Ministry of Interior (MOI) in order to provide operative directions for firefighters (MOI, 2001a; MOI, 2006). Immediately afterwards, the NFB was equipped with modern facilities for the detection and management of biological agents (e.g. mobile laboratories, decontamination units, etc.).

The aim of this work is to evaluate the procedures adopted by the NFB for the management of biohazard events. This is done by comparing the statistics of NFB interventions in 2000-2010 for potential biohazard events, and chemical and radioactive risks. A series of solutions is then proposed to improve the NFB's national response system for biohazard events.

2. THE NFB AND THE ITALIAN MANAGEMENT OF CBRN RISKS

2.1 NFB's Role in CBRN Events

The NFB, a key element of the Italian civil protection system, is part of the Department of Fire, Rescue Service and Civil Defense, which operates under the MOI. It consists of approximately 35,000 units. The NFB ensures urgent technical rescue, even in circumstances of unconventional risks. Its original primary objective is "*to protect the safety of persons and things, by preventing and extinguishing fires and providing technical services in general, including those related to air defence*" (MOI, 1941). The functions of the NFB was formally updated in MOI (2006), whereby the role of the NFB for chemical, biological, radiological and nuclear (CBRN) events is also defined, particularly in terms of counteracting the risks arising from CBRN substances, including from possible non-conventional crimes aimed at damaging people or property, using adequate instruments and mobile units. Therefore, in order to respond effectively to CBRN events, the NFB requires suitable technical skills, resources and specialised equipments.

2.2 NFB's Response Levels

NFB's model response for CBRN events is described in the NFB intervention model (MOI, 2001b). It is a mechanism of response that involves three different competency levels related to the complexity of the handling of the event. According to the intervention model, the local team (normally the closest one, the "basic team") must reach the location of the event first. This team will then evaluate the situation, and determine the requirements for adequate means and support of other teams more qualified for that type of intervention. The intervention teams based on the level of qualification are as follows:

a) Basic team: Locally qualified to ensure the first intervention;
b) Province specialists: Present in each provincial command;
c) CBRN regional operative unit: Present in each command in the regional capital towns.

Some of the regional commands are equipped with mobile analytical CBRN laboratories. It is specifically built for the CBRN unit of the NFB to carry out chemical, radioactive and biological sample analyses at the event site. Thus, they are able to obtain results in a shorter amount of time (Gulli *et al.*, 2008).

2.3 Scenarios and Type of Intervention

In the case of biohazard events, the NFB refers to MOI (2001b) to define the standard scenarios of intervention. Several possible scenarios of action are presented:

a) Presence of suspicious material without clear traces of powder or liquid;
b) Presence of suspicious material with clear traces of powder or liquid dispersed on surfaces but not spread within the environment;
c) Presence of suspicious material with clear traces of powder dispersed on surfaces and also spread within the environment.

Similarly, the types of events can be traced to the following three categories:

a) Release (or risk of release) without (or no risk of) fire or explosion;
b) Release (or risk of release) with (or risk of) fire or explosion;
c) Recovery of hazardous substance (or suspect) without (or remote) risk of loss.

3. BIOHAZARDS

Biohazards are linked to the exposure to biological agents and represent a potential danger for public health. Biohazards may arise from a variety of events involving biological agents, such as the natural diffusion; the accidental diffusion (e.g., spill from a biotechnology industry) or the intentional release into the environment (e.g., for terroristic attacks or war actions) (EC, 2012).

Biological agents are microorganisms, including those which have been genetically modified, cell cultures and human endoparasites, which can cause any infection, allergy or toxicity (EC, 2000; MOL, 2008; DOL, 2012). According to EC (2000), biological agents can be classified into four risk groups depending on their level of risk of infection:

a) Group 1: Agents that are unlikely to cause human disease.
b) Group 2: Agents that can cause human disease and might be a hazard to workers. They are unlikely to spread to the community, and there is usually effective prophylaxis or treatment available.
c) Group 3: Agents that can cause severe human disease and present a serious hazard to workers. They may present a risk of spreading to the community, but there is usually effective prophylaxis or treatment available.
d) Group 4: Agents that cause severe human disease and are a serious hazard to workers. They may present a high risk of spreading to the community, and there is usually no effective prophylaxis or treatment available.

CDC (2012) further classifies the most important biological agents into three categories:

a) Category A: Agents that can be easily disseminated or transmitted from person to person. They result in high mortality rates and have the potential for major public health impact. They might cause public panic and social disruption, and require special action for public health preparedness.
b) Category B: Agents that are moderately easy to disseminate. They result in moderate morbidity rates and low mortality, and require specific enhanced diagnostic capacity and disease surveillance.
c) Category C: Emerging agents that could be engineered for mass dissemination in the future because of their availability. They are easy to produce and disseminate. They are potentially linked to high morbidity and mortality rates, and major health impact.

Biological agents can be further classified according to certain characteristics that define the hazard to health (NATO, 1996):

a) Infectivity: The aptitude of an agent to penetrate and multiply in the host;
b) Pathogenicity: The ability of the agent to cause a disease after penetrating into the body;
c) Transmissibility: The ability of the agent to be transmitted from an infected individual to a healthy one;
d) Ability to neutralise: Means to have preventive tools and/or therapeutic purposes.

Each biological agent can be transmitted through one or more ways. The transmission modes are mainly (La Placa, 2010):

a) Parenteral: Agents that are transmitted through body fluids or blood;
b) Airway (by droplets): Agents that are emitted by infected people, which can then be inhaled by surrounding people;
c) Contact: Through which the agents present on the surface of the infected organism can infect another organism;

d) Oral-fecal route: Through objects, foods or other items contaminated with the feces of infected patients, or through sexual contact.

4. STATISTICS FOR NFB INTERVENTIONS FOR CHEMICAL AND RADIOLOGICAL RISKS, AND POTENTIAL BIOHAZARDS

Since 2000, the NFB publishes on their website statistics of province command interventions for yearly periods (NFB, 2012). For this work, statistics regarding CBRN was collected for analysis. In particular, as shown in Table 1, the interventions involving chemical and radiological risks were examined. The total number of interventions involving chemical substances was obtained by adding all the events classified as "*chemical substances involved*" and "*other inflammable and liquid and/or gaseous combustibles*", which includes "*accident with a vehicle transporting dangerous substances*", "*flipping over of a truck transporting dangerous substances*" and "*a gas leak*". The total number of interventions involving radioactive substances is reported in the official NFB statistics *tout court* and includes, among others, "*recovery of radioactive lightning rod*" and "*recovery of radioactive substances*".

Table 1: NFB interventions in 2000-2010 involving chemical and radioactive substances. (Adapted from NFB (2012)).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	*Mean*
Total interventions	646.395	751.388	706.556	713.184	736.434	750.617	716.053	717.892	745.572	782.897	736.673	
Chemical substances involved	28078	35570	37763	34301	34091	32786	31834	31388	27737	31174	28361	
% of total interventions	4,34	4,73	5,34	4,81	4,63	4,37	4,45	4,37	3,72	3,98	3,85	**4,42**
Radiactive substances involved	207	276	216	205	392	213	173	197	326	1929	243	
% of total interventions	0,03	0,04	0,03	0,03	0,05	0,03	0,02	0,03	0,04	0,25	0,03	**0,05**

The estimation of the percentages of interventions involving chemical and radioactive substances over total interventions is calculated for yearly periods. The mean percentage is obtained by averaging the annual percentages calculated over total yearly interventions.

While chemical and radiological risks are clearly evaluated in the NFB's statistics, this is not done for biohazards, which is neither considered nor put into a table. For this reason, in order to conduct a statistical analysis, we considered the types of interventions that can be potentially associated to biohazards (natural, human related or voluntary) as the following:

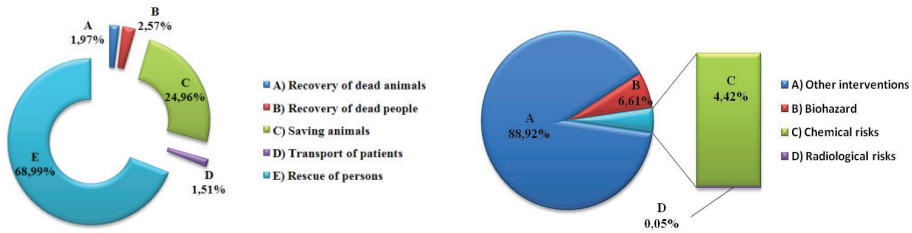
a) Saving of people;
b) Recovery of dead people;
c) Saving of animals;
d) Recovery of dead animals;
e) Transport of patients.

The non-specific category "*general assistance services*" was not considered. Following this notional evaluation, surprising results are obtained, as shown in Table 2. By taking the mean of the 2000-2010 data, we have a high percentage value (6.61%) as compared to chemical and radiological risks (Figure 1). However, it should be noted that since it is a notional estimation, this value can be far from the reality. It is nevertheless important because it highlights potential incidences of biohazards over the total of the interventions.

Table 2: NFB interventions in 2000-2010 potentially involving biohazards. (Adapted from NFB (2012)).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	*Mean*
Total interventions	646.395	751.388	706.556	713.184	736.434	750.617	716.053	717.892	745.572	782.897	736.673	
Potential biohazard involved interventions	38460	45999	48704	46466	48106	51782	48161	45933	49161	52941	53676	
% of total interventions	5,95	6,12	6,89	6,52	6,53	6,90	6,73	6,40	6,59	6,76	7,29	**6,61**

The estimation of the percentages of interventions involving biohazards over total interventions is calculated for yearly periods. The mean percentage is obtained by averaging the annual percentages calculated over total yearly interventions.



(a) **(b)**

Figure 1: Statistics of NFB interventions involving potential biohazards for 2000-2010 and comparison other interventions: (a) Types of interventions considered for the evaluation of potential biohazards. The percentages represent the mean percentages obtained for each type of intervention. (b) Rates of interventions involving biohazards, chemical and radiological risks, and other interventions.

5. PROPOSALS FOR IMPROVING THE NFB'S BIOHAZARD MANAGEMENT

The NFB is responsible for first response in case of biohazard events in the context of civil protection and defence. For this reason, the NFB has to be equipped with the necessary apparatus and consequently specialised personnel who can use it. While the NFB has developed its own competencies for chemical and radiological risks since the 1960s, for biohazards, there has been less time spent to put them into action, with all related developments happening in the last decade.

Although there is significant effort in trying to provide guidelines to first intervention operators for biohazard events, it evident that there is a high margin of uncertainty concerning the ability to provide immediate response to an event. There is also a lack of field instruments that can allow the detection and management of biological agents, excluding sheltered labs and rapid reverse transcription polymerase chain reaction (RT-PCR). While rapid RT-PCR allows the identification of a number of biological agents, it requires the right primers to be used and only works in specific analysis conditions.

The correct management of biohazards is very important to ensure that the operators' efforts are not in vain. It is common to consider the ON/OFF emergency response[1], but it is questionable whether it can be applied to biohazard management. In fact, responding with a wrong ON can lead to results that are more damaging as compared to not providing any response at all. This is understandable if we consider the extreme variability and the different pathogenicity, infectivity and transmissibility mechanisms of biological agents, and, consequently, the related methods to contain the dissemination. In addition, the correct identification of the biological agent involved in a biohazard event allows the intervention to take place in a generally secure situation. As the NFB does not have specialist biologists, the training of NFB operators in using instruments, such as rapid RT-PCR, is conducted by specialist biologists, mainly involved in CBRN defence, in the Italian Army.

In order to improve the response to biohazard events, the NFB should be provided with equipment and complex instrumentation for the sampling and detection of a large number of biological agents. This would require the hiring of specialist biologists in the NFB. They can have several important tasks both in the context of prevention and protection, and also in emergency management. Their key roles will include:

a) Development of biological agents detection systems;
b) Central coordination activities;
c) Collaboration with the healthcare offices for risk evaluation of the operators;
d) Updating guidelines, and technical and procedure indications;
e) Specific training for personnel operating in prevention, identification and risk management;
f) Inspecting products and equipment used in the mobile laboratories;
g) Participating in external communications in case of biohazard events.

6. CONCLUSION

Biohazards are, among the non-conventional risks, the most complex and difficult to manage. In this work, we evaluated the responsiveness of the main actor involved in the response to biohazards in Italy, the NFB. It reviewed procedures of NFB operators, in particular present

1 The ON/OFF emergency response is aimed at providing fast response to potential spread of a biological agent. In this first stage, in order to start the procedures, just one question is considered: is the agent present? (ON) or not present? (OFF), not taking into account the biological nature of the agent.

processes specifically developed for the management of biohazards. Although these actions have been developed and are applicable in specific situations (such as deliberate release of anthrax spores or pandemic diffusion of influenza virus), the possible strategies to approach the problem are limited. An effective solution to compensate for this would be the introduction of specialist biologist in the staff of the NFB in order to develop methods and procedures for the management of biohazards.

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