Chemical and Biological Mobile Laboratory: infrastructure employed by Brazilian Army in emergency response actions

Cardozo M[1], Oliveira V G M [1], Sousa R B [1], de Paula R L [1,2]

[1] Chemical Analysis Laboratory (LAQ) - Institute of Chemical Biological Radiological and Nuclear Defense (IDQBRN) - Brazilian Army Technological Center (CTEx), Av das Américas, 28705, Rio de Janeiro, RJ, Brazil.

[2] Postgraduate Program in Biotechnology (PPGBIOTEC) - National Institute of Metrology, Quality and Technology (INMETRO), Av. Nossa Sra. das Graças, 50, Prédio 32, 25250-020 Xerém, Duque de Caxias, RJ, Brazil.

E-mail: reuel.lp@gmail.com

Abstract: In order to meet the need to confirm with more precise analytical techniques the information obtained by the field teams in the emergency response, in a fast and mobile way for displacement in different scenarios of the national territory, the Brazilian Army specified and acquired a mobile chemical and biological laboratory. This paper describes the laboratorial structure, the material flow and the deployment of this defense product in different major international events occurred in Brazil from 2011 to 2016, with the objective of to provide *in situ* identification of chemical and biological threats.

Keywords: CBRN; mobile laboratory; *in situ* analysis; defense; army.

1. INTRODUCTION

Nowadays, is increasing in the world a concern over the possible use of Chemical and Biological (CB) agents by non-state actors. Brazil hosted a series of High Visibility Events (HVE) in the last years such as FIFA 2014 World Cup and Rio 2016 Olympic Games. By all those reasons, Brazil has gaining international attention and the probability of terrorism attack has increased. In this context, the Brazilian Army, together with other national authorities need to be prepared to be deployed into theatres where there are CB threats.

To operate effectively, the Brazilian Army requires CB agent prevention, detection and identification capabilities. CB agent identification in the field uses a limited number of instruments that are relatively sensitive and easy to operate. However, they are very susceptible to respond to the environmental interferers, which can generate a large number of false positive responses [1].

To provide a more reliable response an in-depth analysis is required. To do that, samples must be sent to a laboratory with a suitable structure and an improved analytical capability. However, in a continental country as Brazil, a specialized laboratory can be thousands of miles away of a site of attack. Besides that, in the case of a CB threat, the response must be fast to quickly lead the teams in the field to the best possible protective actions, such as area isolation, decontamination and even properly medical care.

In this sense, the Brazilian Army Technological Center (CTEx) initiated, in 2008, a project to specify and develop a mobile chemical and biological laboratory (MCBL). This paper describes the main structure and capability developed and tested by scientific advisory board of Brazilian Army. It also includes the experience of deployment of MCBL in HVE. All those things demonstrate the potential of using MCBL during operations.

2. LABORATORIAL INFRASTRUCTURE

After all technical specifications made by scientific advisors to guarantee that the MCBL would attend the necessity of an expected defense product, the acquisition of MBCL was made by an international procurement process. The company that achieved the better conditions was Cristanini (Italian). However, part of bodywork was completed in Brazil with in house resources and equipment purchase from other companies such as Agilent Technologies (Brazil).

2.1. Container characteristics

The main objectives and characteristics (Table 1) of the Brazilian Army MBCL project were:

- enhance the identification capability with a reduced number of false positives;
- have a complete laboratorial structure, to quickly and safely detect and identify the presence of CB agents; and
- have mobility to dislocate laboratory structure to any part of Brazilian territory.

The internal walls of shelter are made of stainless steel resistant to decontamination actions. All system is completely airtight and watertight.The structure of MBCL container is composed of three separate areas: utilities; changing room and laboratory.

2.2. Utilities area

The shelter is equipped with a self-leveling pistons system that allow the lifting of the whole structure without external aid. The lower part of the container contains clean water tank, waste reservoir and fuel tank with capacity to maintain autonomy of 72 hours without refueling. On the back of the container is all necessary machinery for the general operation of the laboratory, which includes power generator, air-conditioning compressor, equipment of pressurization system, NBC filter and other appliances.

Table 1. Brazilian Army MCBL characteristics.

Dimensions	Standard Container: 6,0 m x 2,45 m x 2,45 m
Weight	8500 Kg
Portability	Transportable by truck, train, ship and plane; Two (2) people required for field deployment; Less than 15 minutes for unfolding on the ground
Endurance	Continuous operation for 72 hours without refueling; 17 KVA electric generator; Self-leveling piston system; Water tank of 1000 L; Liquid effluent reservoir; Refrigerator and Air Heater;

2.3. Changing room and Laboratorial area

The changing room is placed right after the entrance door of MBCL. This serves to prevent entry of any contamination into the laboratory environment. There is a shower, which can work with decontamination solution, and a chemical bathroom to provide minimum hygiene conditions in isolated operating situations.

The Laboratorial area works normally with an over pressure system to avoid that any contamination penetrate into the lab. There is also an air filtration system consisting in both particulate (High Efficiency Particulate Airborne – HEPA) and chemical (activated carbon) filters.in an NBC filtration system.

Moreover, once the laboratory is closed it remains isolated from the external environment.

All samples are manipulated inside a chambers system that includes one for receiving samples, a glove box to manipulate them and a final passage with an autoclave to guarantee safety on the exit of materials. This system operates in an integrated way, with the entrance in each chamber only being allowed when the previous chamber has been completely closed.

In addition, the MBCL has a laminar flow chamber where it is possible to handle biological samples. There is also equipment for conducting necessary CB analyses, refrigerator and freezer for storing samples besides supplies and storage cabinets.

3. MATERIAL FLOW

Sample collection will never be done randomly. It will occur after a suspected use of CB agents (attacks, injured or dead persons/animals, abandoned material in HVE, alarm in a CB detection equipment, etc.). After the suspicion, the primary detection/identification is made with the available means in the following order:

- Discard the threat of explosion (bomb teams, sniffer dogs and specific detectors)
- Eliminate the existence of radiological and nuclear risk (use of detectors and identifiers)
- Since only the possibility of a CB threat remains, use available field detectors to guide the collection of representative samples.

3.1. Receiving samples

There is no contact between the team collecting samples and the laboratory personnel. Sample enter in a safe way through a pass box. After that, samples are delivered directly inside the isolator (glove box) of the lab where they are manipulated and prepared for analysis. If possible, samples are divided into four parts: two will be analyzed in MCBL and two will be delivered in CB reference laboratories.

3.2. Initial screening

First step is to check if the sample has characteristics of a biological threat. For unknown suspicious powders the BioCheck® Screening Test Kit can be used. The kit quickly (5 min) identifies the presence or absence of a biomolecule found in all living materials and many toxins. For some biological targets, it is possible to use immunochromatographic tests intended for the rapid (15 min), *in vitro* qualitative presumptive identification.

For solids and liquids, the other two technologies that provide relevant information are Infrared and Raman. Using portable equipment, it is possible to check for the existence of amino acid content in case of biological threats. In addition, these devices are able to identify some CB agents, even in mixtures, by similarity with spectral data in specific libraries.

3.3. Sample preparation and Analysis

For chemical analyses, air and vapor samples can be collected in thermal desorption (TD) tubes where volatile and semi-volatile analytes are captured on the adsorbent. The TD tube can be analyzed by Gas Chromatography (GC) using a suitable TD-GC interface. To identification purposes is used Mass Spectrometry (MS) [2]. In the same way, solid material can be primary prepared separating a fraction and dissolving the material in a suitable organic solvent. The liquid phase is separated and filtered through a syringe filter to be analyzed directly in a GC-MS system.

Liquids need to be separated into organic and aqueous. For organic a fraction can be separated, carried out a filtration and proceeded analysis by GC-MS of the content with an additional dilution, if necessary. Aqueous solutions can not be analyzed directly by GC-MS, it is necessary to remove the water or to extract the analytes of interest. One of the most efficient procedures of this type in MCLB conditions is to use solid phase micro extraction (SPME), with the immersion of the fiber directly in the sample for adsorption. In addition to these procedures, others can be required such as extractions under different pH conditions, solvent exchange and derivatizations depending on the desired targets.

Biohazards are very complex threats. In fact, existent commercial system and instrumentation to be used in mobile applications are limited to certain conditions and types of agents [3]. In MCBL the principal instrument for molecular biology analyses is RAZOR EX System. It works with polymerase chain reaction (PCR) technique to amplify segments of DNA, but even this solution is limited to at least 13 targets.

3.4. Decontamination

In the glove box, the previously prepared and sealed samples as well as all the material used are decontaminated with appropriated solutions. The autoclave can be used as additional measure whenever possible. After decontamination process, samples can be analyzed without present risks.

4. DEPLOYMENT OF MCBL

There are two possible modes that the MCLB can be used, either as a pre-deployed facility used in support of a major event or as a reactive asset following an incident [4]. Fortunately, at the time of writing this paper, Brazilian MCLB has not been required for a large-scale response to an incident. However, the experience in major international events hosted in Brazil indicated the effectiveness of integrating the MCLB in a CBRN response.

4.1. Experience in HVE

The World Military Games in 2011 was the first event where the MCBL was used, when was verified the first difficulties for operation and adaptation of the analytical methodologies to the available means. In 2012, in United Nations Conference on Sustainable Development (Rio+20) there were some suspicions of the use of chemical and biological agents. One of the examples was the case of an abandoned bag in an area of conference containing a white powder inside. The analyses revealed that it was biological yeast and it was discovered later on that the bag belonged to a chef who was working on the event. The MCBL also operates in World Youth Day (2013) and FIFA Confederations Cup (2013).

During the 2014 FIFA World Cup an analysis was conducted to rule out a possibility of chemical threat, more specifically Sarin. Conclusions pointed to a kind of cleaning products that have a response similar in portable detection equipment. For Rio 2016 Olympic Games, the Army decided to increase its analytical capacity by acquiring one more MCBL. All of these examples attest that MCBL is a defense solution that meets the objectives listed in its specification as a defense product.

5. CONCLUSIONS

The use of MCBL as auxiliary mean in a scenario with CB threats made possible to provide fast and reliable information to guide the actions of first responders and the choices of public decision-makers. The entire structure proved to be capable of carrying out the necessary for the chemical and biological analysis of dangerous agents in environmental samples with safety and comfort, without losing the characteristic of mobility.

6. REFERENCE

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