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► **To cite this version:**

A. Guinet, Housseem Barkaoui, Tao Wang, Eric Dubost. An Emergency Management Plan to Face a Foodborne Criminal Attack. 7th International Conference on Information Systems, Logistics and Supply Chain (ILS 2018), Jul 2018, Lyon, France. hal-01895901

HAL Id: hal-01895901

<https://hal.science/hal-01895901>

Submitted on 19 Oct 2018

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An Emergency Management Plan to Face a Foodborne Criminal Attack

A. Guinet¹, H. Barkaoui¹, T. Wang¹, E. Dubost²

¹ Université de Lyon, INSA Lyon, DISP Laboratory, Villeurbanne, France.

² Centre Hospitalier Soins et Santé, Rillieux-la-Pape, France

{a.guinet@insa-lyon.fr, housseem.barkaoui@insa-lyon.fr, tao.wang@univ-st-etienne.fr, e.dubost@hadlyon.asso.fr}

Abstract. Food poisoning is frequent in mass catering. Infections could occur with the raw materials used, the process of food preparation, the means of transport and preservation employed, etc. In this paper, we study the scenario of a malicious food poisoning involving patients of a home health care structure. Home health care patients are mainly disabled and/or elderly people. Being non-autonomous, they order meals to caterers. A criminal employee of a caterer could infect the foods which poison part of the home health care patients and some valid people. To face such threat, the home health care structure has planned to collaborate with conventional hospitals to better care people during the acute and recovery phases of the infection, in the framework of an emergency management plan. A linear program is proposed to simulate the studied scenario and assess its consequences. It models the foodborne infection and the medical response.

Keywords: Biological Attack, Food Defense, Disease Control, Home Health Care Management, Decision Support System.

1. Introduction

In the framework of the project PrHoDom (Protection of Home Health Care Structures) we are working with the 3rd biggest HHC in France, which is the hospital center "Soins et Santé", in order to develop decision making tools to support the different phases of the crisis management plans. In this paper we focus on the response to a biological risk. Food poisoning transmitted to man is frequent in our societies whatever the continent could be. They can be of accidental or malicious origin. The source of the infection can come from the raw materials used, the process of food preparation, the means of transport and preservation employed or even more generally from the environment. This work concerns deliberate contamination against the food supply chain. It is part of food defense studies [1], [2], [3]. Food defense can be defined as the process to ensure the security of food and drink and their supply chain against malicious attacks searching to harm or to make money [2]. First studies appeared after September 11 attacks [4], [5]. Food defense is focused on protecting the physical food supply chain. It differs from other food safety studies where the food contamination is unintentional. In our case the food contamination is targeted, i.e. criminal. Such criminal attacks can take place in farms, food processing plants, distribution chains, retail stores or restaurants [6]. Pre (farms) and post-production (stores or restaurants) steps are more vulnerable due to the easy access to the food [3]. Processing plants can be the most critical step due to the large dispersion of products to customers [4]. Attacks are anonymous during the contamination period in order to deliberately poison a largest number of consumers. Criminals could be fired employees, malicious competitors, terrorists, etc. [1], [2]. More general studies about supply chain defense can be found in Sheffi [5] who specified some general countermeasures about supplier choice, plant location, inventory management, standardization of processes, etc.

Most food poisoning occurs in mass catering. This sector of industry has major human resources management problems because of its working conditions: working hours, working cadences, days off, etc [7]. Catering that includes meal production and delivery represents a vulnerable sector where accidental or malicious food poisoning is very likely. In order to investigate the worst case scenario giving the most harmful consequences over time, we hypothesize a criminal attack which is longer to detect and can contaminate several different foods.

We study the scenario of a malicious food poisoning of the patients of a home health care structure. Home health care patients are mainly disabled and/or elderly people. Being non-autonomous, they order meals to a caterer recommended by the home health care structure. A criminal employee of the caterer infects the foods which poison part of the home health care patients and some valid persons outside the

hospitalization structure. A foodborne outbreak is launched. To face such threat, the home health care structure has planned to collaborate with conventional hospitals to better care people during the acute and recovery phases of the victim infection, in the framework of an emergency management plan.

Firstly, we present the different biological agents which can be used for a malicious food infection. Secondly, after having detailed the foodborne attack scenario, we present the medical response to such a criminal attack. In a third step, the mathematical model specifying the people infection and the medical response deployed is presented and commented. In the last section, optimization results are discussed.

2. Previous Food Poisoning Outbreaks

To our knowledge, there is no official record of criminal or accidental food poisonings. A food poisoning in Karbala (Iraq) on March 2005 is mentioned in the Global Terrorism Database. We have selected from the literature some of them involving different contamination agents: Botulinum A toxin, Escherichia Coli, Hepatitis A, Listeria, Salmonella, Shigella Dysenteriae and Staphylococcus Aureus. The main characteristics of these biological agents are specified in Table 1.

Table 1: Main food poisoning biological agents.

Agent	Cause	Consequences	Incubation	Lethality	Treatment	Vaccine
Botulinum A	Bacteria	Nerve impairment	1-3 days	5%-25%	Antitoxin	Yes
Escherichia Coli	Bacteria	Kidneys impairment	3-8 days	3%-5%	Rehydration	Experimental vaccine
Hepatitis A	Virus	Liver impairment	14-28 days	0.6%	Analgesics, antipyretics	Yes
Listeria	Bacteria	Sepsis, brain infection	10-28 days	17%	Antibiotics	Yes
Salmonella	Bacteria	Gastroenteritis, dehydration	1-2 days	1%	Antibiotic therapy for elderly	Experimental vaccine
Shigella Dysenteriae	Bacteria	Dysentery, acute intestinal inflammation	1-7 days	20%	Antibiotics	Experimental vaccine
Staphylococcus Aureus	Bacteria	Vomiting, Dysentery	1-8 hours	0.02%	Antibiotic therapy	Yes

A foodborne illness outbreak with “Botulism A” toxin took place in Peoria (Illinois) in 1983 [8]. Botulinum toxin blocks neuronal transmissions that cause muscle paralysis extending from the neck to the limbs and lungs. 28 persons were hospitalized, and 20 patients were treated with Botulinum antitoxin. 12 patients required ventilator support. The source was sautéed onions served on sandwiches.

A Shigella Dysenteriae occurred among the staff of a Texas hospital laboratory on October 1996 [9]. This outbreak was most likely due to a criminal contamination of food with a hospital stock culture, due to the revenge of an employee. 12 people were contaminated and 4 were hospitalized.

An outbreak of Hepatitis A took place in Monaca (Pennsylvania) on November 2003 [10]. Hepatitis A is a highly contagious liver infection. Approximately 555 persons with hepatitis A have been identified and 3 persons have died. The infection was from green onions served at least in 13 restaurants in Pennsylvania.

An outbreak of Listeria took place in Colorado on October 2011 and infected 147 people [11]. Listeria can cause fever, diarrhea, headache, confusion, loss of balance, and convulsions. Contaminated cantaloupes resulted in 33 deaths. The 2011 Listeria Cantaloupe outbreak was the most deadly in the United States.

Smoked salmon tainted with salmonella has sickened hundreds of people in the Netherlands [12] and in the United States on 2012. People infected by the salmonella bacteria suffered from fever, vomiting and diarrhea.

An Escherichia Coli outbreak at Litchfield Park (Arizona) contaminated 79 people in 2013 [13]. At least 30 people have been hospitalized. This is the largest Escherichia Coli outbreak in the United States. At least two people have developed severe infection that can destroy the kidneys.

In April 2013, a food poisoning caused by Staphylococcus Aureus in ice cream occurred in Freiburg (Germany) [14]. The ice cream was produced at a hotel. 13 people were contaminated and 7 were

hospitalized. None of the personnel of the hotel presented some symptoms of illness. Either the equipment used or a contaminated ingredient could be the poisoning source if unintentional.

3. The Case Study

3.1. The Biological Agent

As a biological agent choice for our foodborne attack scenario, the Botulinum A has been selected for the following reasons: Spores of Clostridium Botulinum are heat-resistant and are widely present in nature (soil, river, sea). They produce toxins in the absence of oxygen. There are 7 different forms of Botulinum toxin. Botulinum toxin A is the most lethal for humans. The intoxication can be caused by intestinal infection, wound infections or inhalations. The Clostridium Botulinum is not transmitted from person to person. The Immunogenicity of Botulinum toxins has only been studied for Botox (Botulinum toxins A used to treat severe spasms in the neck muscles, and post-stroke spasticity) treatments. The immunogenicity rate is equal to 15% [15]. Botulinum toxin A blocks neuronal transmission in muscles and progresses from neck, to arms and to lungs [16]. It is odourless, colourless, and tasteless. Without medical resources, the fatality rate can reach 78% [17].

An antitoxin exists but it must be administered as soon as the neurologic signs of Botulism appear i.e. approximately between 24 hours and 72 hours after the exposure [18]. Antitoxin administration requires a 7 days hospitalization [19] which can be done in a home health care structure. After 72 hours, the therapy of Botulinum toxin consists mainly in supportive cares which require mechanical ventilators and feeding by enteral tube or parenteral nutrition, more precisely an hospitalization of 14 days in an intensive care unit (ICU) and 14 days of home health-care (HHC) [19], [20]. Intensive cares could be delayed if patients are mechanically ventilated in Emergency unit, but the fatality rate for the delayed patients (more than a half day), is equal to 36% due to respiratory infections [21].

3.2. The Investigated Scenario

A caterer prepares and carries meals for a group of inhabitants of the metropolis of Lyon. A significant portion of its customers is made up of patients of a Home Health Care Structure (25%). Meals are delivered to patients once or several times a week. Catering is a field of activity where employee turnover (158%) [7] and foodborne illness origin (55%) are high [22] in France. A newly hired employee is spreading Botulinum toxin in milk desserts [23]. Botulinum toxin is colourless, odourless and tasteless. Lots of customers are contaminated, who may belong to the home health care structure. An antitoxin exists, it must be administered as soon as the symptoms appear and that is to say between 12h and 72h after ingestion. Beyond that period, the infected person must be cared in an intensive care unit without delay to substitute the respiratory and digestive dysfunctions. In the absence of medical care, the case fatality rate can reach 78%.

3.3. The Medical Response to the Outbreak in the Framework of an Emergency Management Plan

Home Health Care (HHC) refers to a health facility that provides care at home for patients requiring complex postoperative treatments, or patients suffering from a chronic illness, a disability, or patients needing palliative care and in general patients enduring a loss of autonomy. In HHC, it is up to the resources to move and coordinate their services in order to provide cares at the patient's bedside, while in the conventional hospital, it is the patient who moves to the clinical resources. In France, a HHC has the same rights and duties as a conventional hospital, for example the requirement to establish emergency management plans in collaboration with other hospitals if possible. One of the objectives of the French government implementing the HHC structures is to avoid hospitalization to disabled people and to reduce the hospitalization length of stays by coordinating HHC and conventional hospital stays.

The Home Health Care structures cover 24 primary care modes that belong to three major families: rehabilitation cares (for example after the acute phase of a neurologic or cardiologic pathology), heavy and frequent technical cares (i.e. chemotherapy, radiotherapy, antibiotic therapy, etc.), continuing care (i.e. palliative care, heavy nursing care, enteral or parenteral nutrition, respiratory support, etc.).

As long as the collaboration between HHCs and conventional hospitals is concerned, HHCs may provide restorative cares while the conventional hospitals might be dedicated to the acute cares. This coordination could offer a lot of mutual benefits. Home rehabilitation shorter the care length of stay of the patient, improves the patient physical health and family reintegration [24], [25]. This is particularly true for cardiologic pathologies [26], [27], [28] and respiratory failures [29], [27]. Another improvement resulting from the combination of HHC and the conventional hospitalization is the emergency department freeing, HHC discharging directly the emergency system without requiring hospitalization beds [27]. Such combination with the emergency department or another hospitalization department can be planned at the patient admission without difficulty, minimizing staff and patients' stress.

HHC structure and conventional hospital require a good coordination between them in terms of drug administration (for example using a common pharmaceutical booklet) and of nursing technical cares (i.e. care protocols). The pharmaceutical booklet defines a list of drugs and medical devices (recommended for the treatment of pathologies) and provides information on their dosage and contraindications. The goal of a care protocol is on one hand to minimize the iatrogenic risk due to prescription errors, and on the other hand to simplify the technical cares so that the caregiver is less stressed and pays more attention to the patient.

Cooperation between Home Health Care structures and Conventional Hospitals can be benefit only if these actors are accustomed to work together routinely. Under this assumption, they can both face crisis situation with efficiency in the framework of an emergency management plan, by exchanging acute patients and recovering patients. Sharing human resources such as physicians or nurses is also a good opportunity to discover different patient worlds and to imagine cooperation opportunities. Furthermore, a digital communication tool will improve the information sharing required by cooperation.

Considering the studied scenario, we retain the hypothesis of an approved emergency management plan between a conventional hospital and a home health care structure. The objective of such an emergency plan is to improve the efficiency of resources (beds and nurses) by dedicating acute cares to the conventional hospital and recovery cares to the home health care structure. Beds are not a constraint for home health care and nurses are flexible as they are self-employed. However the number of places is limited regarding the number of patients treated per nurse because the working legislation constrains the employment of liberal nurses instead of employees.

4. The Linear Programming Model

4.1. An Extension of the SIR Model

The SIR (Susceptible-Infectious-Recovered) model is known as a compartmental model in epidemiology. The SIR model, in the simplest case, stratifies the population into three health status: susceptible to the diseases (denoted by S in Figure 1), infected by the diseases (denoted by I), and removed from the diseases (denoted by R). In most literature cases, the infected people will be divided into several stages, such as (Latent i.e. without symptom, Prodromal i.e. with symptom and Fulminant i.e. severe/deteriorated state) [30].

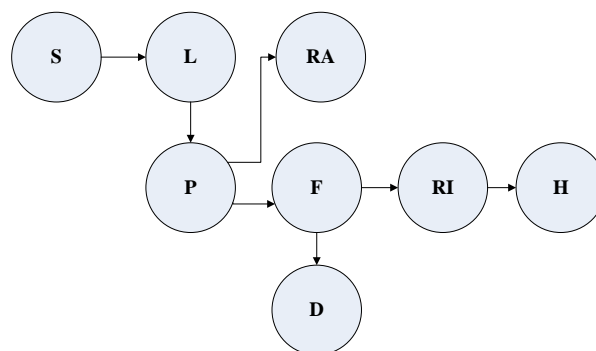


Figure 1: The illness states.

In Figure 1, we have detailed the recovery state R into RA (i.e. recovered with antitoxin), RI and H (i.e. recovered with intensive cares followed by home health care). It enables us to model the two independent medical responses. One other state D for death has also been defined for more clarity in the linear program below.

We use a discrete representation of the SIR model over a horizon of daily periods. When the disease is not transmitted directly from person to person or when the infection rate is constant, the SIR model can be linearized [31].

4.2. Data

- Nbstat: Number of patient states, 8 states have been defined (S for susceptible, L for latent, P for prodromal, RA for recovered with antitoxin, F for fulminant, RI for hospitalized in ICU, H for hospitalized in HHC, D for dead),
- Nper: Number of periods in days (a horizon of three months is studied),
- Nipat: Number of HHC patients susceptible to be poisoned i.e. delivered by the caterer, 100 persons,
- Nepat: Number of outside people susceptible to be poisoned i.e. delivered by the caterer, 300 persons,
- Irat: infection rate, i.e. percentage of non contaminated people infected by the poisonous meal (a person orders in average 4.5 meals per week over 7) i.e. 64%,
- Prate: prodromal rate, i.e. percent of people developing symptoms, 85% = 1-15%, [15],
- Drate: death rate, i.e. percent of people who died waiting ICU cares, 36% [21],
- Canti: antitoxin cost and hospitalization cost for medication in a home health care structure for 7 days, respectively 2500 € and 300 € * 7 i.e. 4600 €,
- Cicu: cost of patient admission during two weeks in ICU followed by two weeks in home health care for breathing assistance, respectively 2300 € * 14 and 300 € * 14 i.e. 36400 €,
- Hlife: Human life cost estimation regarding legal indemnity in France for a 65 old victim, i.e. 300 000 € according to ONIAM [32],
- Nbed: Number of ICU beds which are available to receive victims at the conventional hospital,
- Nhome: Number of places which are available to receive victims at the HHC, HHC have no bed capacity limit but a limited number of nurse visits and medical equipment limits, i.e. 130 places,
- HCdose: Number of antitoxin doses available at the HHC pharmacy,
- CHdose: Number of antitoxin doses available at the conventional hospital pharmacy,
- Pdet: Period when the attack is detected and located knowing that the criminal attack is anonymous, i.e. 4 days later,
- Alos: Length of hospitalization in HHC for antitoxin treatment, i.e. 7 days,
- Ilos: Length of hospitalization in ICU, i.e. 14 days,
- Hlos: Length of hospitalization in HHC after ICU, i.e. 14 days
- Mlos: Maximum between Alos and Hlos, i.e. 14 days.

4.3. Variables

- EV_{ksp} : Number of persons of origin k (external or internal to HHC) who evolve to state s = {S,L,P,RA,F,RI,H,D} during period p,
- CHexch: Number of antitoxin doses sent from the conventional hospital to HHC,
- HCexch: Number of antitoxin doses sent from HHC to the conventional hospital.

4.4. Objective Function

$$\text{Minimize} \quad \sum_{k=1}^2 \sum_{p=1}^{Nper} EV_{kDp} * Hlife + \sum_{k=1}^2 \sum_{p=1}^{Nper} EV_{kRIp} * Cicu + \sum_{k=1}^2 \sum_{p=1}^{Nper} EV_{kRAp} * Canti \quad (1)$$

The medical response costs are minimized, i.e. the compensation cost for the deceased persons, the cost of the antitoxin treatments and the intensive cares costs. As the compensation cost is around ten times

higher than other costs, the minimization of the death number is the prime criterion. Other authors used the same criteria integration approach in risk analysis [33].

4.5. Constraints

$$EV_{1S1} = N_{epat} \quad (2)$$

$$EV_{2S1} = N_{ipat} \quad (2bis)$$

$$EV_{1Sp} = EV_{1S(p-1)} * (1 - Irat) \quad p = 2, \dots, Pdet + 3 \quad (2ter)$$

$$EV_{2Sp} = EV_{2S(p-1)} * (1 - Irat) \quad p = 2, \dots, Pdet + 3 \quad (2quart)$$

People can be infected from the first period to the period where the attack is detected and located (state S). Symptoms appear at most 3 days after the last period (Pdet). The other persons are safe.

$$EV_{kLp} = EV_{kS(p-1)} * Irat \quad p = 2, \dots, Nper \quad k = 1, 2 \quad (3)$$

People eating poisoned meal are infected (state L).

$$EV_{kPp} = EV_{kL(p-1)} * Prat - EV_{kRA(p-1)} \quad p = 2, \dots, Nper \quad k = 1, 2 \quad (4)$$

The next days, only a part of people develops symptoms (state P). Antitoxins are administrated as soon as symptoms appear (state RA), without waiting medical test confirmation [18].

$$\sum_{p=1}^{Nper} EV_{1RAp} \leq CHdose + HCexch - CHexch \quad (5)$$

$$\sum_{p=1}^{Nper} EV_{2RAp} \leq HCdose + CHexch - HCexch \quad (5bis)$$

The number of antitoxin doses is limited but can be shared by both hospitalization structures. They are dispensed only to prodromal patients.

$$EV_{kFp} = EV_{kF(p-1)} * (1 - Drat) + EV_{kP(p-1)} - EV_{kRI(p-1)} \quad p = 4, \dots, Nper \quad k = 1, 2 \quad (6)$$

From period 4 to the end of horizon, victims wait for hospitalization in ICU units (state F), part of them are admitted (state RI) and part of them begin to died.

$$\sum_{q=p}^{p+Ilos-1} EV_{kRIq} \leq Nbed \quad p = 1, \dots, Nper - Ilos + 1 \quad k = 1, 2 \quad (7)$$

The number of ICU beds is limited for each period. Patients admitted in ICU from period p to (p+Ilos-1) will occupy a bed for the Ilos periods, related to the length of stay. Beds' capacities must be verified for each (p+Ilos-1) value with a range of admissions on the Ilos preceding periods. For p = 1, if the constraint is satisfied for period (1+Ilos-1), it is satisfied for the previous periods 1 to (1+Ilos-2) thanks to the sum.

$$EV_{kH(p+Ilos)} = EV_{kRIp} \quad p = 4, \dots, Nper - Ilos \quad k = 1, 2 \quad (8)$$

Home health care stay follows ICU stay in the conventional hospital (state H) Ilos periods later.

$$\sum_{q=p}^{p+MLos-1} EV_{1RAq} + \sum_{q=p}^{p+MLos-1} EV_{1RIq} \leq Nhome \quad p = 1, \dots, Nper - MLos + 1 \quad (9)$$

The number of HHC places is limited but they are used only for a defined length of stay, previous HHC patients do not increase the HHC workload because they are already admitted and planned. Over a horizon of M_{los} periods, the outside patients receiving antitoxin treatments and the recovering external patients coming from ICU, both stay in HHC. We calculate the number of new patients at the period $(p+M_{los}-1)$ for p varying. Same property of equation 7 is observed.

$$EV_{kDp} = EV_{kF(p-1)} * Drat \quad p = 4, \dots, N_{per} \quad k = 1, 2 \quad (10)$$

Non-treated people died (state D).

5. Scenario Study

5.1. Experiments

French strategic stockpiles of Botulinum antitoxin is around 50 doses [34]. However, the available doses will range from 50 to 100, per hospital. We hypothesize that the available doses are distributed over the HHC and the conventional hospitals so antitoxins are immediately available.

There are around 200 ICU beds in the Metropolis of Lyon located in 5 different places [35]. Knowing that ICU beds are required for surgery and for several pathologies of different medical specialties; we suppose that from 1/4 to 3/4 of the beds can be freed by hospitals to receive infected patients. The number of available ICU beds ranges from 50 to 150. We assume an infinite number of mechanical ventilators i.e. of positive airway pressure ventilators.

Symptoms appear generally in the first 72 hours [18]. On day 4, enough victims who ate the foods of the caterer are suspected to have botulism; consequently the caterer is aware of the attack at the earliest at the end of period 4 and stops its activity. Accidental poisoning has not been retained because it would have led first to a discovery of the incident earlier and second to a shorter outbreak duration thanks to a single source of contamination instead of several criminal sources of contamination. The worst case scenario is studied.

The medical response to the biological attack is the emergency management plan sharing HHC places and conventional hospital beds. ICU beds are the required resource for the acute phase of botulism and home health care can support breathing and nutrition assistance for the recovery phase of botulism. A patient admission during two weeks in ICU followed by two weeks in HHC defines the patient pathway. Its cost is equal to $2300 \text{ €} * 14$ and $300 \text{ €} * 14$, i.e. 36400 €. The equivalent full stay in hospital costs $2300 \text{ €} * 14$ and $1000 \text{ €} * 14$, i.e. 46200 € if the hospital has enough resources i.e. nurses and beds. Collaboration between ICU and HHC enables to leverage human and material resources. The cost difference is explained by fixed charges which are lighter for home health care structures which do not own heavy medical equipment because the patient diagnosis is known. Its efficiency has been noted for several pathologies such as congestive heart failure, chronic respiratory failure, multiple sclerosis, etc. [20], [29], [26].

5.2. Results

15 instances have been solved with CPLEX [36] for 5 different numbers of freed ICU beds and 3 different levels of antitoxin strategic stockpiles.

Table 2 presents the number of deaths, the cost of the medical response in K Euros, and the number of ICU stays used by home health care and conventional hospital victims, for the 15 instances solved.

The number of deaths goes from 189 to 0. It decreases according to the increasing number of available ICU beds in the same proportion. An ICU bed is never used twice or more because no victim can wait until 14 days i.e. the ICU length of stay. The number of deaths decreases in the same proportion with the increasing of antitoxin stockpiles when these latter are not in excess. The medical cost goes from 59 027 K Euros to 6 006 K Euros. It is inversely proportional of the resource intensity and it results from human life costs. Regarding the best medical response, a minimum of 190 antitoxin doses with 150 ICU beds or of 200 antitoxin doses with 140 ICU beds are required for a death absence. These latter situations have been assessed with our model. ICU beds are mainly used for victims outside the home health care

structure and they are the most numerous. Home health care patients are mainly treated with antitoxin for a location reason; they have already a HHC place. Regarding the antitoxin exchanges between pharmacies, the exceeding antitoxins are proposed to the partner hospital. The optimal number of HHC places set to 130 has been calculated with our model, less places increase the number of casualties because of the antitoxin treatment which takes place in HHC.

Table 2: Number of deaths and medical response cost according to the resource intensity.

Number of doses for Home Health Care Hospital	Number of doses for the Conventional Hospital	Number of ICU beds	Number of deaths	Medical cost	Number of ICU stays for HHC patients	Number of ICU stays for CH patients
50	50	50	189	59 027	0	50
50	50	75	164	52 450	0	75
50	50	100	139	45 873	0	100
50	50	125	114	39 298	0	125
50	50	150	89	32 728	20	130
50	100	50	139	44 283	0	50
50	100	75	114	37 708	0	75
50	100	100	89	31 138	0	100
50	100	125	64	24 568	0	125
50	100	150	39	17 999	24	126
100	100	50	89	29 548	0	50
100	100	75	64	22 978	0	75
100	100	100	39	16 409	0	100
100	100	125	15	9 851	11	114
100	100	150	0	6 006	15	125

6. Conclusion

This work studied the impact of a foodborne attack with Botulinum toxin i.e. one of the most poisonous substance known in mass catering. An optimization tool based on a linear programming model is proposed, in order to calculate the human and economic consequences of the attack in terms of the number of deaths and the cost of the medical response. It enables us to assess the medical responses based on hospital and HHC collaboration, to size the human and material resources, to anticipate the victim admission in ICU and HHC, to calculate the consequences of the attack in order to judge the opportunities of mitigation countermeasures (e.g. a home meal delivery service dedicated to several hospitals). The number of deaths can reach two hundred victims and the hospitalization cost is of several millions of Euros. To face such crisis, collaboration between Conventional Hospitals and Home Health Care structures is a good response and it must be carefully studied and prepared to increase the efficiency of the medical resources in the framework of an emergency management plan. Beyond the objectives specific to each structure, the goal is to save the largest number of victims founding the best medical response.

The number of beds in conventional hospitals is limited due to the financial budget. The collaboration between a hospital and a home health care structure in the framework of regular activities or a response to a threat, allows them to increase the patient admission possibilities relaxing the hospital bed capacity constraint with the bed flexibility of home health care structure. The hospital centre “Soins et Santé” is currently negotiating an emergency management plan with a conventional hospital of Lyon which owns an emergency department and intensive care units. The project PrHoDom (Protection of Home Health Care Structures) enables us to give indicators in order to assess the common interest of such collaboration in terms of patient safety, economic costs and employee working conditions. This paper relates to the work done about CBRN attacks.

7. Acknowledgments

Funding for this project was provided by a grant from la Region Auvergne-Rhône-Alpes (ARC2). The authors would like to thank the reviewers for their helpful comments.

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