Environment and health

Comparison of three European countries (United Kingdom, the Netherlands and France) in terms of epidemiological response and preparedness for a disaster

Practicum Dissertation

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EHESP

FRENCH INSTITUTE FOR PUBLIC HEALTH SURVEILLANCE

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This report was written and presented by Marta Sala Soler, to obtain a second year Master's degree of Public Health (MPH) of the French School of Public Health (EHESP), Rennes. It was part of an internship that took place from February to June 2010 at the French Institute for Public Health (InVS), within the Accidents and Physical Risks Unit of the Environmental Health department.

At the InVS, participants to this work were:
Marta Sala (collection and analysis of literature, drafting of the report);
Philippe Pirard (methodological support , participation in the analysis of literature and drafting of the report);
Yvon Motreff (participation in the drafting of the report);

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List of Acronyms

ASN: *Autorité de sûreté nucléaire* : Nuclear Security Authority

CIP: *Cellule d'information du public* : Public Information Cell

Cire: *Cellule interrégionale d'épidémiologie* : InVS Regional Unit

Cnam: *Caisse nationale d'Assurance maladie* : National Insurance Body

COD: *Centre opérationnel départemental* : Division Operational Centre

CODIRPA: *Comité directeur pour la gestion de la phase post-accidentelle d'une urgence radiologique*: Steering committee for the management of the post-accident phase of a nuclear or radiological accident

Ddass: *Direction départementale des affaires sanitaires et sociales*: Division Direction of Health and Social Affaires.

Drass: *Direction régionale des affaires sanitaires et sociales* : Regional Direction of Health and Social Affaires.

ENT: Ear-Nose-Thought (Otorhinolaryngology)

GALA: *Gestion de l'alerte local automatisée* : Automatic local alert management

HPA: Health Protection Agency

HRA: Health Risk Assessment

Insee: *Institut national de la statistique et des études économiques* : National Institute of Statistics and Economic Studies

Ineris: *Institut national de l'environnement industriel et des risques* : French Institute of Industrial Environnement and Risks

InVS: *Institut de veille sanitaire* : French Institute for Public Health Surveillance

NHS: National Health Service

NIVEL: *Nederlands Instituut voor Onderzoek van de Gezondheidszorg :* Netherlands Institute for Health Services Research

NUC: *Numéro unique de crise* : Unique Crisis Number

OrgActOuPOST: *Organisation des acteurs et des outils pour la gestion des impacts post-accident des accidents industriels non nucléaire sur les populations et l'environnement :* Tools and Stakeholders organization for management of environmental and population consequences after an industrial non-nuclear accident

PCS: *Plan communal de sauvegarde* : Municipal Protection Plan

Peraic: *Préparation en réponse aux accidents industriels et catastrophes* : Preparedness for Industrial and Natural Disasters.

POI : *Plans d'opération interne*: Internal Operational Plans

PPI: *Plan particulier d'intervention:* Specific Action Plan

PSS: *Plan de secours spécialisé*: Specialized Rescue Plan

RIVM: *Rijksinstituut voor de Volksgezondheid en Milieuhygiene*: National Institute for Public Health and Environment

SCG (GCG): Strategic Coordination Group (Gold Coordination Group)

1. Introduction

Disasters constitute a major Public Health problem as they can affect large groups of people and their consequences in terms of physical, psychological and social health may be long lasting.

In the event of a major accident (natural or man-made disaster), usual emergency measures are evacuation, provision of shelter and intake restriction of water or certain foods.

However, the disaster is not over once the emergency phase is under control. Once the emergency teams and the main emergency management organization leave the scene, the **post-accident phase** begins. During this stage, management problems related to the consequences of the disaster often continue (environmental pollution, material loss, etc.) and additional problems appear (social repercussions, psychological distress and other long-term health risks). It is therefore essential to support the affected communities during the evolution into their new post-disaster life by launching screening, treatment and other care initiatives to deal with their health problems as well as with social and compensatory issues.

France has a well-established organization to deal with the emergency phase. Since 2004, a new device called ORSEC (Organisation de la réponse de sécurité civile i.e. “Organization of Civil Security Response”) is entrusted with overseeing all urgent situations. Its main objective is to establish a permanent and unique operational management organization. It constitutes a common response tool for any kind of event: accident, disaster, terrorism, health crises, etc. [1]. The management of the post-disaster phase, on the contrary, is not organized in a structured way in France. First, there is no unique management organization to deal with all the post-disaster stakeholders and second, there is no link with the emergency phase which constitutes a real challenge.

This lack of organizational ties between the emergency and post-accident phases and the lack of coordination between the stakeholders involved has been identified by French experts in post-accident management. These experts stress that the absence of a single management doctrine can lead to a lack of coherence in the post-accident response actions and to a loss of available and useful information and resources to orientate decisions and actions. Clarifying a doctrine for the organization of the post-accident phase by delineating the responsibilities of every stakeholder, taking into account their interests and concerns and implementing the tools in a coherent way, would enable the creation of a global, coherent, sensible and relevant management strategy.

In order to deal with this situation, two different committees (CODIRPA (2006) and OrgActOuPOST (2008)) have been recently created with the goal of producing an appropriate post-accident management doctrine in the context of nuclear accidents and chemical-industrial accidents respectively.

Bearing in mind that the delayed effects of a disaster can constitute real environmental and public health problems, the French post-accident management experts also highlighted the necessity of an appropriate **assessment of the health impact** during all phases of the disaster in order to help to orient management actions (ex. clean-up measures, mental health screening…), to assess their efficiency and to try to prevent future negative health consequences. In this context, **health risk assessment** and **epidemiology can be a helpful tool** to assess the health burden by pointing out the main health problems, warning of unexpected ones, identifying at-risk populations and improving awareness of risk factors.

In parallel to these committees, the French Institute for Public Health Surveillance (Institut de Veille Sanitaire, InVS) has recently launched a specific program of preparedness for industrial and natural disasters (Peraic) within the Environmental Health Department. The program aims at producing appropriate epidemiological tools adapted to each kind of accident and at facilitating the organization of a network of actors in the post-accident management scenario. In order to achieve these goals, the InVS is exchanging experiences with other European public health institutes involved in epidemiological response to disasters (the Health Protection Agency – HPA - in the United Kingdom and the National Institute for Public Health and Environment – RIVM - in the Netherlands).

2. Objective

Based on the comparison of responses to three disasters in three different countries, the objective of this report is to identify **the main epidemiological issues in the aftermath of the accident.**

This work aims to serve as basis for future exchanges between the European public health institutes in order to improve the epidemiological response to a disaster

3. Methods

3.1. Choice of the material

All three countries, the Netherlands, France and the UK have been hit by natural and man-made disasters in the recent past. In France, the AZF factory explosion in Toulouse was chosen on the base of the quantity of epidemiological articles published and the impact it had on the French population. Eight years after, the explosion is still present in the mind of the French population. The recent Enschede fireworks disaster in 2000 could be mentioned as the Dutch example for the same reasons. And as for the United-Kingdom, the 2005 terrorist attacks in London were selected since they had a large impact on the population and led to a very organized response. These three events on which information and literature are available became material for comparison.

3.2. Bibliographic review

The scientific literature published from 2000 (year of the first accident considered) and onwards was searched. This period was chosen to reflect the most recent methods used in France, UK and the Netherlands for measuring exposures and health effects after a disaster in environmental epidemiology studies. Studies were identified mainly by using PubMed-Medline databases, Google and Google scholar. Hand-search was a second method used to explore the available books and paper documents of the InVS and the French administration. Articles were limited to studies in humans and to reports published in English or French. Systematic searches of the scientific literature were conducted using the following key words: epidemiologic studies, chemical disaster, physical and mental health effects, Enschede fireworks disaster, AZF explosion, London bombings. Articles were considered for inclusion if epidemiological methods of studies were clearly explained or if containing clear description of the accident and how public health authorities were engaged.

After the selection, articles were read in order to describe the respective events and the corresponding management and epidemiological answers from national and local authorities. The epidemiological responses were compared. This comparison helped to identify the main elements of an epidemiological answer in the framework of public health action. It also helped to discuss the main issues associated to each of these elements.

3.3. Exchange with other institutes

This comparison allowed the identification of some issues that served for material of exchange and discussion between institutes: health risk assessment, bio monitoring, community involvement, “surveillance systems”, cohort and cross-sectional surveys including

population registration and health reference levels, good comparison and feedback to the stakeholders. To fulfill the discussion with respective current experiences, direct exchange of knowledge and opinions through email, telephone and videoconference with the RIVM in the Netherlands and the HPA in the UK were scheduled.

4. Results

4.1.Description of the respective epidemiological responses:
A) AZF factory explosion in Toulouse

In September 2001, an explosion occurred at the AZF petrochemical factory in Toulouse inside a warehouse containing 300-400 tons of ammonium nitrate. The human effects of the explosion were up to 30 deaths, more than 3000 people injured and about 5000 people treated for stress [2]. The AZF explosion was and still is the worst industrial disaster in France in recent history.

Rescue actors such as fire-fighters, policeman and ambulance services (Samu) were the first to intervene under the supervision of the prefect of the “department” (administrative unity of a geographical division in 100 parts of the French territory), trying to confine the area. The InVs was contacted shortly after the explosion and the direction of the institute went to the field in order to make an early evaluation of the threat and to provide correct and clear information for appropriate health management [3].

An initial literature review was done to identify major environmental exposure effects and physical and psychological traumas. Additionally, due to the characteristics and the scope of the accident, the InVS together with the Drass (Regional direction of health and social affairs) via the Cire Midi-Pyrénées (Regional unit of the InVS), decided to create a project to assess the health burden of the disaster. Its objectives were firstly to analyse the health risks and health effects of the environment in the short and long terms, secondly to identify specific health problems requiring special attention and thirdly to study the direct and indirect long-term effects on the health of the entire population of Toulouse [4].

This work was organised and followed by 3 committees:

A scientific committee with academics and experts from the InVS to define the goals and design of the studies needed, supervise the analysis, make recommendations to health authorities and provide information to the population on a “scientific” point of view.

An executive program committee in charge of the program and the data analysis.

An institutional committee lead by the prefect and composed of local and regional authorities, health authorities, unions, victims, experts and population representatives, with the aim of facilitating the organisation of the studies and the exchanges between epidemiologists, the population and the media [3].

Ongoing results were presented regularly to the institutional committee. Authors have highlighted the fact that this committee provided the opportunity for debate on the consequences of the catastrophe and therefore avoided the appearance of possible rumours and fears of other health effects. Furthermore, the institutional committee enabled the implication of the local stakeholders during the entire process. One example is the participation of victims' associations in the design of the questionnaires used in the population study [3].

The health burden assessment followed different methodological axes:

For the **short-term consequences**, a Health Risk Assessment (HRA) linked to toxic releases to the environment was launched together with a surveillance system for the detection of health consequences of the explosions [5].

For the health risk assessment, data on emitted pollutants was obtained from the factory and the fire brigade. The possible toxic effects were assessed by searching on toxic databases. Exposure to pollutants by the population was estimated by mathematical modelling taking into account meteorological conditions for air and soil depositions and assumptions on food consumption. Subsequent sample analysis was conducted by a network of official institutions of regular air and water monitoring. As a result of all this work, the initial results of the risk assessment indicated that no important toxicity risk apart from eye and respiratory irritation should be expected [3;5]. Posterior surveillance systems based on visits to general practitioners and other specialists validated the results obtained by the HRA.

At that time no operating syndromic surveillance system was in place in France. In order to detect the specific health problems related to the explosion, different databases were used and created for the specific surveillance of the population of Toulouse. Data on known possible effects were collected by a sentinel network of general practitioners, paediatricians, ophthalmologists and ENT (Ear, Nose, Throat) doctors in Toulouse. A register of pregnancy terminations was regularly checked. The anti-poison centre was used for the detection of unusual or unexpected toxic cases. An analysis of the medical consumption of the population

through the databases of different health insurances (Union Regional des Caisses d'Assurance Maladie) was implemented, focusing on the detection of newly prescribed psychotropic treatments. And finally, the regional emergencies observatory was used to monitor the use of emergency departments [6].

These sources of information enabled the identification of the major problems during the initial weeks after the disaster as well as proposals for special measures to deal with them. The 2 major issues ascertained, apart from the eye and respiratory temporary irritations were a high incidence of ear injuries and mental health problems. An increase in ischemic diseases was also highlighted, but given the fact that heart diseases are multifactorial in nature it was not possible to establish a direct cause effect relation with the explosion [5].

As a result of the surveillance system, screening for hearing loss was conducted in schools and recommended for the general population. Increasing mental health services in the area of the disaster was also recommended.

In could be said that the procedures to detect the problems in the short term were quite successful. However, the emergency aid only lasted for about 6 weeks, even though healthcare needs were still high after that period, particularly for mental health [3]. Furthermore, even if medical support was made available their impact was not assessed. Assessing the use of health care by the population in need could be more difficult than expected. It could not be ascertained whether all the population needing help was using them. Numerous studies show that after a disaster, health is not necessarily the priority of the affected population, especially if dealing with family difficulties or housing and work problems. Collective feedback of the epidemiological studies five years after the accident revealed that a non-quantified but apparently non-negligible fraction of the involved population had not yet made insurances declarations despite being obvious physical or material victims [3].

As for the **mid- and long-term consequences**, three series of surveys among three population groups (general population, workers and children) were completed in order to evaluate the health impact independently from the access to health care systems. Surveys included questions on personal characteristics, exposure to the explosion, material consequences, social consequences, physical impact and psychological symptoms (focusing on post-traumatic stress and depression) [6].

Although the surveys were planned to start within less than six weeks after the explosion, several problems, such as restricted budget and logistics, lack of census data of population, administrative delays, etc. made it impossible.

The first survey was distributed among school children. Two cross-sectional studies were performed nine and 16 months after the explosion, with 78% and 74% participation rate respectively (surveys were filled-in during class time). From these studies it could be seen that a majority of students lived near the explosion site and their homes were damaged too. Most of them declared having suffered physical injuries and the questionnaires revealed that the explosion had a major impact on the mental health of a great percentage of the pupils [7].

Another cross-sectional study was performed among working adults who were less than three kilometers from the centre of the explosion and also rescue workers. More than 5,000 questionnaires were sent one year after the explosion, but the response rate was very low (34%). To detect possible toxic health effects, mental health problems and socio-professional problems, a cohort study in a subgroup of the participants of this cross-sectional study was carried out. Three thousand and six workers agreed to be followed up for five years at the health screening centre of the local health insurance system. The prevalence of immediate psychological symptoms reported was high, but the low response rate made the representativeness difficult. The composition of both the cross-sectional and cohort studies was analysed and differences in social and demographic variables were found. Blue-collar workers and self-employed workers were over-represented in the cohort. Moreover, healthcare utilization in the aftermath of the disaster was more frequent in cohort members and therefore it was possible that initial health status was a selection factor in the cohort population [2].

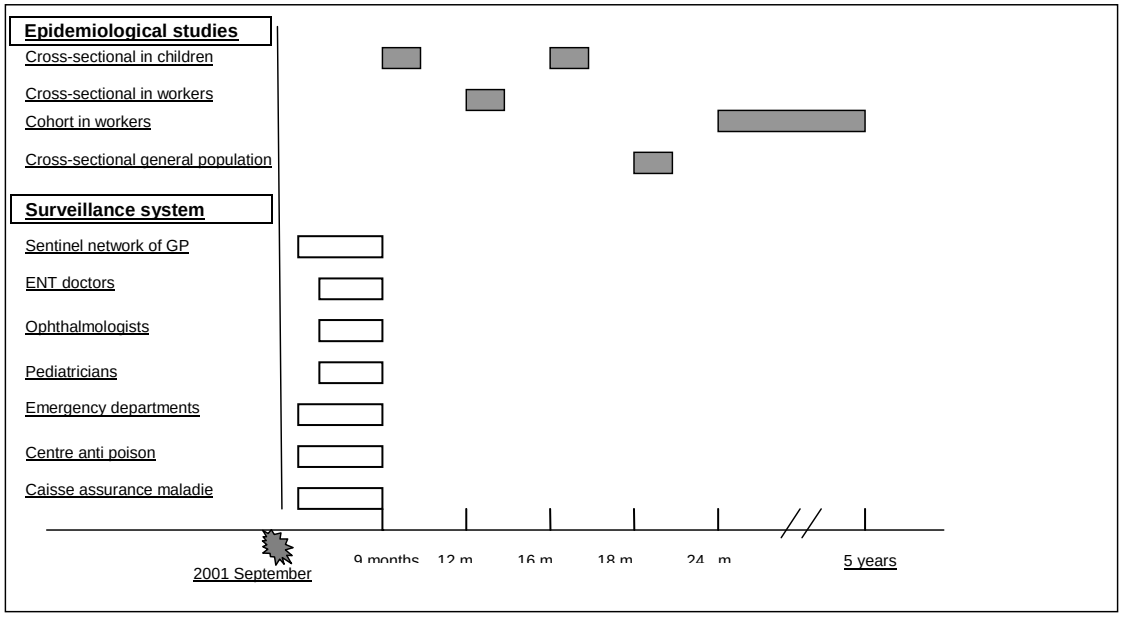
A final cross-sectional survey was distributed among the general population of adults over age 18 in Toulouse. This survey was conducted 18 month after the explosion through a face-to-face interviews, and its response rate was 60% [3]. The study showed that the population of the nearby area was the most seriously affected by the explosion, both physically and psychologically. Moreover it stressed the fact that this population was in a lower socio-economic status than the rest of the city: one in four persons had no superior education, one in two was a blue-collar employee and more than one in ten were unemployed. Additionally, the study highlighted a large share of people born abroad in this area [8].

The results of all these surveys, even if late, were coherent with the preliminary evaluations based on health information systems and were the only tool capable of providing quantitative estimations of the real psychological impact [4].

The AZF explosion forced the InVS to carry out its first health impact evaluation of a large scale accident. The institute proved to have an initial reactivity with good influence in the health management for environmental effects enabling a good relation between the Cire (Regional Unit of the InVS) and the Ddass (Division Direction of Health and Social Affaires). However, it had to deal with difficulties in collaboration during the emergency phase with the fire-fighters and the factory team, who were supposed to deliver the first information on pollutant contamination. This lack of communication in the short term resulted in a gap of information about pollutants in the explosion cloud that could never be remedied [4].

The other difficulty that the scientific committee had to deal with was the reliable detection of excess psychological and hearing problems due to the lack of reference level before the accident. Despite epidemiological information about high levels of mental health disorders and the necessity for support, six weeks after the disaster, emergency aid was no longer available. Likewise, establishing the reality of resulting hearing losses was challenging due to controversies among ENTs and this affected the process of convincing health providers and decision makers to launch screenings for hearing problems [4].

Fig 1: Chronology of events after the AZF explosion



On the whole, it could be said that all the studies and investigations after the AZF disaster highlighted three public health issues:

The importance of an appropriate epidemiological approach for the guidance of decision making regarding the mid- and long-term health effects of the population.

The importance of a good collaboration and coordination between the different institutions and stakeholders of the crisis management [9].

The complementation of various tools (HRA, ecological studies, surveillance systems, cross-sectional studies) to have a comprehensive view of the health impact of the catastrophe.

B) Enschede firework disaster

In May 2000, a series of three fireworks explosions occurred near the city centre of Enschede. As a consequence, nearly 500 houses were destroyed, 22 people were killed, about 1000 inhabitants were injured and material loss reached more than €500 million.

The government wanted to avoid the distrust on public authorities that appeared after the airplane crash in Amsterdam in 1992, where no epidemiologic studies were done until six years after the crash. To do so, they decided to create the Enschede Firework Disaster Health Monitoring Project (GCVE), following the Parliamentary committee recommendation of 1999 to rapidly assess the immediate health effects after a disaster. This project was an epidemiology-based tool to assess the immediate health effects as well as the long term effects after the explosions [10].

Another part of the government program was the creation of an Information and Advice Centre (IAC), set up to monitor the well-being of the victims, to provide them with information and, where necessary, assistance. It was established two days after the explosion under municipal responsibility and all adult residents living in the disaster area were registered. A specialized mental health-care unit within the centre was later founded to treat disaster-related disorders using evidence-based treatments. In the future, information on the utilization of this service and the kind of assistance delivered should give information on the extent to which these methods have been able to limit the long-term consequences [11;12].

The Enschede health study could be described as a scientific research project with a social purpose. Regarding the scientific perspective, the aim of the project was to gain knowledge concerning disaster-related health problems and their clinical evolution.

1.- In order to ensure the scientific quality, all examinations and surveys were conducted by accredited national scientific committees.

2.- Furthermore, an independent scientific advisory board was set up to offer advice on the studies at any time.

3.- As for the social relevance, a Social Review Group was attached to the study to make sure that the research covered the questions addressed by the affected population. They were contacted at the start of new activities and participated in the outline of reports. This social review group was formed by local residents directly affected by the accident and rescue workers.

Finally, overseeing the entire project there was a steering group formed by the project leaders of the different health studies and monitoring projects. Its role was to implement and coordinate the activities as well as to communicate the research results to the participants and healthcare providers [13].

The epidemiological project combined two research approaches:

1. An *indirect approach* (ecological and surveillance data) through an ongoing surveillance programme. The main data used was the IAC database together with data provided by reports of health care professionals from the insurance database of all general practitioners. GPs, mental health services, occupational health and safety services and the youth health care services department contributed to the monitoring strategy [13;14].

2. A *direct approach* though the establishment of interview-based cohort studies and a bio-monitoring system of blood and urine samples. The first health questionnaire of the cohort was distributed three weeks after the explosion and two posterior follow-up surveys among a cohort of victims were launched 18 months and then four years later. For the two last follow-up studies, four districts of the city of Tilburg were selected as control groups. They were comparable in terms of general health status and from socio-demographic point of view. In addition, comparison groups of police, fire-fighters and ambulance personnel from other parts of the Netherlands, who were not involved in the disaster, were identified. They were approached by their employers to participate in the second wave of the study [15]. Furthermore, surveys into more specific aspects were conducted among subsamples of the cohort population and different cross-sectional studies completed the assessment of the long-term effects [13].

The main purpose of the first health survey (three weeks after the accident) was to collect information of the short term consequences and possible risk factors by means of a questionnaire about the exposure to shocking and traumatic events that would otherwise have been lost.

The aim of the collection of blood and urine samples was the measurement of trace elements indicative of exposure to toxic firework-related substances (cadmium, strontium, lead, etc) [10]. The bio-monitoring procedure was not conceived as a medical follow-up of individuals. Nevertheless, due to medical-ethical considerations, if clinical toxicology results were relatively high compared with reference data evaluated, additional monitoring of the specific individuals was recommended, even in the case where the high values were suspected to be unrelated to the fireworks explosion [16].

The general conclusion from the blood and urine results was that no alarm should be raised about concentration of toxic substances in the bodies of the exposed persons. These results validated the various environmental measurements conducted immediately after the disaster. By contrast the first questionnaire revealed that the study population, divided in three subgroups (residents, passers-by and rescue workers), presented various physical and mental health problems three weeks after the accident when the first study was conducted. Most health problems decreased from first to the second and third surveys among affected residents. However, 18 months after the explosion, even if health problems had started to decrease, residents still had two or three times more health problems than the respondents in the control group [17]. Residents and passers-by who had been more exposed were the ones who presented the most serious health effects [13].

Apart from direct injuries from the blast, the most common physical symptoms described in the first questionnaires and the follow-up ones were headache, fatigue and pain in the stomach, chest, joints and muscles. These types of symptoms are commonly described as Medically Unexplained Physical Symptoms (MUPS) or psychosomatic symptoms [18]. As for mental health problems, severe sleeping problems, feelings of depression and anxiety as well as self-reported symptoms of Post-Traumatic Stress Disorder (PTSD) were identified [17].

Despite quick intervention efforts to better highlight the immediate effects and to be able to implement the appropriate support systems as quickly as possible, time pressure played a negative role and was the basic limitation of the study. First, the commitment of healthcare providers and policy makers was poorly organized at the first stage of the project. Consequently, investigators could only formulate the research questions and the corresponding questionnaire based on earlier epidemiological experiences. This changed in the later stage of the study; both policy makers and healthcare providers participated in the production of the survey questionnaires in order to obtain profitable answers from the follow-up studies. Second, no simultaneous measurement in a control population comparable in

terms of demographics was done in the first stage, three weeks after the event. Again this drawback was solved in the posterior follow-up studies by selecting a control group in Tilburg. Furthermore, at the time of the first survey there was no proper definition of the heterogeneous group of survivors. There was neither a full registration of residents nor of rescue workers, not to mention passers-by [13]. Once the official disaster area was established, every affected resident was invited to participate in the study. However the participation rate of the survey three weeks after the disaster was quite low, only about 30%, which may suggest biased study results.

A specific surveillance system based on GP records was useful to try to estimate whether cohort participants were representative of the entire pools of affected residents and allowed the identification of the influence of some effect modifiers. In the Netherlands, every individual is assigned a GP who acts as a gatekeeper for access to medical specialists. The analysis of the Electronic Medical Records (EMRs) that GPs produce systematically was used in Enschede after the fireworks incident as a surveillance system, as part of the governments' health program specially designed for the survivors of the explosion. Among the 73 GPs of Enschede, 44 agreed to participate (73%). Patients were informed about the participation of their GPs, and none refused to participate in the study.

The monitoring system implemented had the strong advantage of being sensitive to variations between the pre- and post-disaster periods and it allowed monitoring of the medical visits and the diagnoses for exposed and non-exposed individuals. Health problems presented to the GPs in the period of one year and four months before the explosion were compared with those presented during the 2,5 years after the explosion for both the study population and the control group [19].

The comparison of cohort survey results and medical records showed that there was a? selective participation in the survey. There was a lower participation rate for men, young adults and singles. In addition, results suggested that survivors with more post-disaster distress were more likely to participate in the survey. However, selective participation did not affect prevalence estimates. Multiple imputations were used to fill in missing data of the survey with only minor changes observed in the prevalence estimates of health problems [17]. Furthermore the combination of survey results and data from EMR highlighted the importance of early attention needed for survivors with pre-disaster psychological problems or forced to relocate or exposed to many stressors when trying to prevent long term health consequences after a disaster [20].

The cross-analysis between the two epidemiological follow-up studies also showed that the use of EMRs alone can pose a problem in the generalisation of the results by not allowing a good characterisation of socio-demographic, health and personality characteristics of the exposed population

Figure 2: Enschede, Chronology of Events [13]

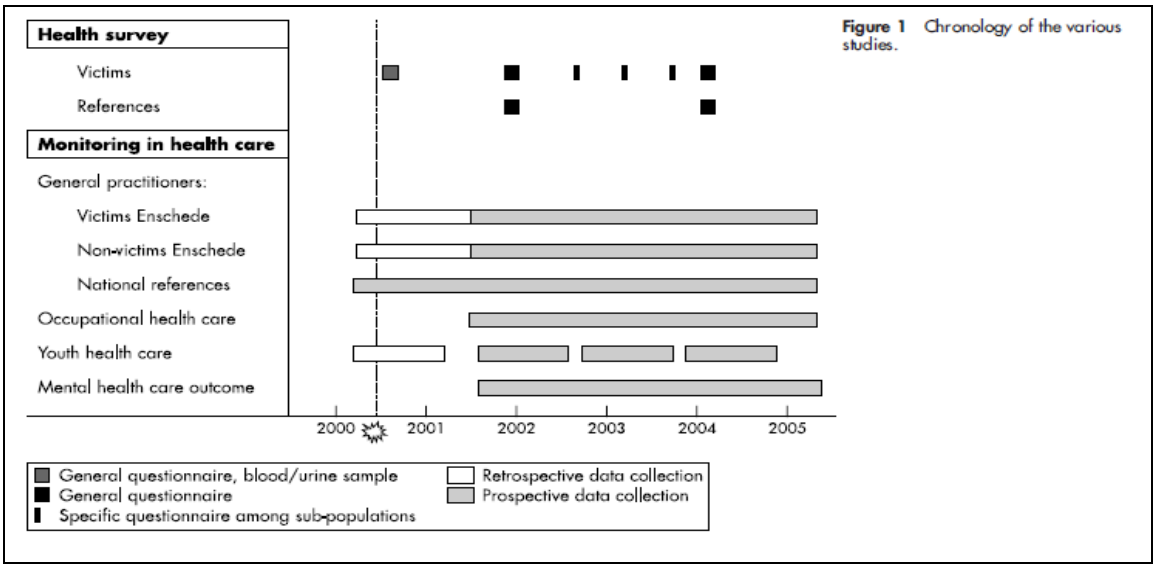


Figure 1 Chronology of the various studies.

All in all it could be said that the Enschede firework study, highlighted some important issues for epidemiology after an industrial disaster:

The importance of a good and complete registration of the involved population in order to assess the impact of the event

The usefulness of cross-checking information between the different data sources in order to assess the representativeness of the population answering to the questionnaires and improving the characterisation of the event, being helpful for management strategies

The advantages and difficulties of a bio monitoring study in emergency

The importance of a good and timely **information system,** essential for the effectiveness of the disaster management.

As a direct consequence of the Enschede fireworks disaster, the Ministry of Health, Welfare and Sports (VWS) of the Netherlands, identifying the importance of a well-planned and

structured framework of action in case of accident, decided to found the Centre for Health Impact Assessment of Disasters (CGOR) within the RIVM, as an integral disaster aftercare policy to contribute to the restoration to pre-disaster states at both the individual and societal level. The objectives of the CGOR are first, to contribute to expert, independent and transparent decision making about the usefulness, necessity and design of a disaster Health Impact Assessment (HIA); second, to create the necessary conditions to rapidly and decisively design, initiate and perform a disaster HIA; and finally, to strengthen the capabilities of local public health and medical emergency response organizations, carrying out HIAs following disasters, crises and incidents [21].

C) London Bombings

On July 7th 2005, explosive devices detonated at approximately 8:50 am on three trains on the London Underground transport network. The explosions resulted in 52 fatalities and approximately 700 people being hospitalised with a range of injuries [22].

The emergency services rapidly declared the situation as “Major Incident” and consequently the Gold-Silver-Bronze command structure was triggered. This structure is used by emergency services of the United Kingdom to establish a hierarchical framework for the command and control of major incidents and disasters [23].

- *Gold*: each organisation involved in the incident (police, ambulance, fire, local authority, etc) appoints a “strategic manager” (Gold) to have responsibility for the completion of their own strategic objectives. All the different ‘Golds’ gather together in a Strategic Coordinating Group (SCG) to determine and agree upon the overall strategic aims.
- *Silver:* the senior members of the organisation at the scene, in charge of all the resources of the organisation. They decide how to use these resources to achieve the strategic aims of the Gold commanders, and they determine the tactics used.
- *Bronze*: each service deploys Bronze managers to the actual scene to implement and carry out the tactics determined by the Silver command [24].

The **first phase** of the emergency response on July 7th began with members of the London Underground staff and the emergency services arriving and assisting passengers within minutes. At 9:15am, the London Underground Network Operation Centre declared a network emergency and began to evacuate the entire London Underground network. At 10:00 am

meetings of the Cabinet Office Briefing Rooms and the Strategic Coordinating Group took place [25].

In the **second phase** of the response to the bombings, an Environment Group was set up outside the SCG to share information from environmental and occupational hygiene sampling and to evaluate the response to the incident. This group consisted of personnel from organisations such as London Underground and Transport for London, the Chemical Hazards and Poisons Division of the Health Protection Agency, and health and safety personnel from the Metropolitan Police Service.

Hazard identification was undertaken by the emergency services on the London Underground network. This identification consisted of visual-photographic inspections of the train carriages and airborne asbestos fibre monitoring at the different affected underground stations. The risk associated with the potential release of hazardous materials from train carriages was declared to be negligible. Fortunately the contained stock of hazardous materials of the underground trains was found intact after the blasts and environmental monitoring showed that there was no risk of asbestos airborne fibres in the environment.

Occupational hygiene and wider environmental sampling and analysis were undertaken by the HPA operational (Bronze) group to support both occupational and public health risk assessments. Furthermore to confirm the absence of risk and reassure the population, a consultant medical toxicologist from the Chemical Hazards and Poison Division (CHaPD) of the HPA undertook clinical assessment of the victims of the blast with consultant colleagues of different London hospitals. Close liaison between the NHS and the HPA made this individual assessment possible, as casualty information and treatment locations were provided to the CHaPD by the NHS [22;23].

Another step in this second phase was the establishment of a Family Assistance Centre (FAC), later renamed the 7th July Assistance Centre. At the request of the SCG, the London Resilience Team convened a meeting on July 8 with relevant partners such as the Chief Executive of Westminster Council, Westminster Emergency Planning Staff, and the British Red Cross. The group identified different venues and finally the Westminster City Council and the Metropolitan Police Service led the construction of a facility which was opened by the Culture Secretary on Saturday, July 9. The centre provided immediate support for those affected by the bombings, and continued to be a focal point for long-term support and

counselling as well as a conduit for information about related events such as memorial occasions and trials of those accused of involvement in the bombings [26].

On July 8, the NHS mental health trust chief executives met to consider the **third phase** of the response. Two weeks later a Psychological Steering Group was formed by the trust, other NHS bodies and the London Development Centre for Mental Health, with representation from specialist psychological trauma centres, health commissioners, primary care physicians, the emergency services, first response agencies, the HPA and survivor groups. The steering group considered proposals for the mental health response, formulated primarily by the London psychological trauma centres. Proposals followed the NICE guidelines published previously in the same year 2005 for the management of PTSD. The guidelines recommended that the first-line treatment for PTSD should be one or two psychological interventions. They focussed on identifying and screening all trauma-exposed individuals to detect persistent symptoms of psychopathology, and then providing them with evidence-based treatment. The Steering Group estimated that there were likely to be 4000 directly affected individuals and that, on the basis of the existing literature, around one third of these would be in need of specialist help [25].

In September 2005, a systematic screen and treat programme called the **"NHS Trauma Response Programme"** was launched. It consisted on a central screening team in charge of contacting and screening survivors of the bombings, and, where appropriate, assessing and referring them to specialist psychological trauma services for evidence-base treatment [25]. Lists of names of those affected were sought from hospitals that had treated them, from the London Bombings Charitable Relief Fund, and from the health registry set up by the Health Protection Agency. The HPA used the NHS and the HPA web pages for the call of affected people to be included in the health register along with a mass media campaign [22;27].

The programme obtained contact information and sent screening materials to 910 adults. Of those 910 adults, 65.5% returned at least one screening questionnaire and of these, 56.7% screened positive at some stage. A majority of those receiving a more detailed clinical assessment (76%) were judged to require psychological treatment and most were referred (248 within the Programme and 30 outside the Programme). Of those treated within the Programme, 189 completed a course of therapy [25].

Apart from the assessment of the psychological distress on direct victims and first responders, a **telephone cohort study** was set up to evaluate the psychological and behavioural reactions to the bombings on the general population. The survey was conducted by using a random digit dialling method for all London telephone numbers. To ensure that the sample interviewed was representative of the London's population, the survey used proportional quota sampling, a standard method for opinion polls that creates quotas for participants depending on a range of demographic characteristics. Quotas were set on sex, age, working status, residential location, housing tenure and ethnicity based upon the most recent London census data [28].

The survey started 11 days after the attacks and the assessment was based on stress levels and travel intentions in London's population. The survey was completed one day before a second, failed wave of attacks took place on July 21 [29].

The response rate of the epidemiological study was quite low. From 11072 people contacted, only 1010 (10%) of the eligible persons completed the interview. Nevertheless, the survey sample was considered representative of the London population. Previous calculations showed that a weighted sample of 1000 would provide a 95% confidence of -3% to 3% of the data [28].

The analysis of the data showed that 31% of Londoners reported substantial stress and 32% reported an intention to travel less. Nevertheless, the low response rate could have lead to biased data resulting in a misinterpretation (overestimation or underestimation) of the prevalence of distress. Other significant associations of the study were high stress levels with having feared for one's life, being a woman, being of a low socioeconomic status and being Muslim. On the contrary, being white, having previous experience with terrorism and having been able to contact friends and family easily after the incident seamed to be associated with reduced stress. On the whole Rubin *et al.* concluded that ruling out the population directly affected by the attacks, there was no evidence of a widespread need and desire for professional counselling [28;29].

Seven months after the first cross-sectional survey, a **follow-up survey** of reactions to the bombings was launched to assess the medium-term effects on the general population in London and to identify risk factors for persistent effects. From the 1,010 people that completed the first telephone survey, 815 gave consent for follow-up and from those, 574 (70.4%) were successfully interviewed. Results showed that the proportion of Londoners reporting substantial stress decreased from 31% to 11% and so did the perceived threat to self. However the prevalence for various threat variables remained relatively high. All the

same, perceived safety on transports had improved, but a high number of people continued to alter their travel behaviours in response to the bombings. All together it could be said that the follow-up survey documented that the terrorist attacks had a long-term impact on the perceptions and behaviours of Londoners. However, differential attrition must be taken into consideration when interpreting results and therefore even if the first sample was considered representative of the London population, the possibility of biased results for the follow-up survey cannot be rejected. Further and larger studies would be necessary to confirm the results [30].

The answer to bomb attacks in London was more focused on a quick screening of the population in order to deliver social and psychological support rather than on a descriptive assessment of the burden of the disaster on the base of epidemiological studies. Nevertheless this example stresses clearly:

1. The difficulty to register the involved population without any preparation before the event.

2. The limits due to non-respondents to assess the impact of the event.

4.1. Comparison points

Despite the different management of all three disaster scenarios, similar methods to reach a complete assessment of the health burden of the disaster on the population can be identified:

A) Health Risk Assessment

The first action undertaken by the Public health Institutes of all three countries was a **HRA** based on environmental and toxicological measures launched immediately after the explosions **to evaluate the risk due to any potential acute danger** and orientate management actions.

The HPA and the InVS opted to rely on data collected by emergency actors to obtain information on the released substances. After the London bombings, hazard profiling was conducted firstly by the Metropolitan Police Service and the London Underground network and then communicated to the HPA [23]. Similarly in France, after the AZF accident, the company owning the factory and the fire department were the ones who were supposed to provide the information to the InVS on the emitted substances [3]. In both case examples, the assessment was completed with further environmental samples later obtained by other

official institutions, and results indicated that no potential health effects caused by the exposure during or after the explosion were expected.

In the Netherlands, a similar conclusion was reached with the results of their HRA. Nevertheless, two particularities of the Dutch case can be highlighted. First, the organization in charge of the collection of data for the performance of the exposure and risk assessment was the Environmental Emergency Response Organization (MOD) within the Environmental Safety Division (MEV) of the RIVM [31]. The second particular feature was the inclusion of a bio-monitoring system where firework-related substances were searched in blood and urine samples of rescue workers and the exposed population [32].

B) Community involvement

In order to obtain a complete vision of the public health implications of the disaster, similar structures for the implication and communication of local stakeholders in the core of the post-accident management were created.

First, **Steering committees were created where decision makers and experts discussed with local stakeholders the identification of the public health issues of the disaster.**

In London, the participation of local stakeholders started in the emergency phase since local organizations had a gold representative who participated in the Strategic Co-ordination Groups. Moreover survivor groups were also able to participate in the post-emergency phase through the psychological steering group created by the NHS mental health trust to consider mental health responses. In France and the Netherlands the committees were created directly in the post-accident phase. In Toulouse, it was called “Institutional committee” and the participation of local stakeholders (local authorities, unions and victims) was maintained through the whole epidemiological process since not only did they work on the identification of public health issues and facilitated the organisation of studies but they were also a key point in the exchanges of results between epidemiologists, the population and the media. Finally, in Enschede, the steering committee was called “Social Review Group” and in it, affected populations were contacted at the start of new activities to make sure that these activities were relevant to respond to their needs and also at the end, to participate in the outline of reports.

Apart from the steering committees, another way to involve the communities in the Netherlands and the UK was the establishment of a **facility to assist the affected population** and their loved ones **and to deliver information**. The London centre was first

named “Family assistance centre” and later renamed “7th July assistance centre” due to a multiagency investigation that found that the word “family” had been unhelpful and misleading, preventing some individuals from attending [26]. In Enschede the installation was given the name of “Information Advice Centre” [12]. Both structures contained a special unit for psychological and psychiatric support to treat disaster-related disorders.

C) Epidemiological response

Subsequent to the identification of public health issues, scientific staff worked on the identification of data sources and methodologies to answer to them. In all examples different methods with different purposes were used to reach a complete assessment of the health burden of the disaster. By and large it could be said that that two sets of tools were used: on the one hand surveillance systems based on ecological data and monitoring and alert systems and on the other hands ad-hoc epidemiological studies (cohorts or repetitive cross-sectional studies) based on direct individual interviews.

- *Health surveillance:*

In the three countries the adaptation of existing data and the activation of new sources were put in place **in order to serve as alert systems as well as tools to assess the impact of the event.** Despite most of them were created after the disaster and were temporary they were named surveillance systems by the authors.

In France, it allowed an assessment of the initial impact by the monitoring of emergency services (Orumip), general practitioners, psychiatrists, gynaecologists and an anti-poison centre. The UK used its existing syndromic surveillance system (NHS-direct) to alert on the mental health impact of the London attacks as well as for the identification of populations for screening. In the Netherlands, in contrast to the other examples, the surveillance system was established after the start of the epidemiological studies. Nonetheless, as it was based on complete individual electronic medical records. The Dutch epidemiologists took profit of the EMR and obtained retrospectively pre-explosion data for each of the individuals studied and therefore a direct pre and post-event comparison was possible. The special characteristics of the Dutch surveillance system also permitted a cross-validation of the cohort results and the identification of socio-economic risk factors.

- *Ad hoc cohort and cross-sectional studies:*

On the base of issues highlighted by the steering committee or alerts from the surveillance systems, **specific epidemiological studies based on individual interviews were**

launched in the three case examples. Their objectives were to assess the health impact of the event, and for some studies to gain better knowledge of the relationship between risk-factors and the health impact of the accident, in order to help orient actions for mid- and long-term care of the affected populations.

The InVS and the RIVM used classical epidemiological strategies for their analysis (cross-sectional and cohorts studies). Except for the first study in Enschede, all the studies had selected control groups. The English response had two different approaches, on the one hand the telephone survey with descriptive objective and on the other hand the NHS survey targeted as an outreach screen and treat programme. However, from an epidemiological point of view the method they used could be described as two sets of single cohort studies, since no control group was included [33;34].

The three institutes planned to start their interviews as soon as possible after the event and the English and the Dutch succeeded in doing so. The English telephone study was the fastest to be implemented (11 days after the attacks) and the RIVM managed to launch its first questionnaire three weeks after accident. French studies didn't start until nine months after the disaster. Nevertheless the health of the population of Toulouse was being monitored since the beginning with the surveillance system established.

The identification of the population to study was a real challenge in all three countries. However in all three situations epidemiologists found a way to contact affected population and launch health studies.

Workers were contacted through their employers after the AZF and the Enschede explosions. And in both countries in order to contact the *residents* of the area, municipal databases where searched and invitation for the participation in the study were sent to the registered homes. However, the explosion blast destroyed partly or completely a large proportion of houses, especially in Enschede, and therefore it was not clear whether the residents were reached and informed of the project. This made it impossible to accurately determine the degree of non-response and the subsequent bias.

In France, because lots of schools were seriously affected by the explosion, the InVS decided to launch a specific cross-sectional study for the assessment of the impact of the disaster among *school children*. Participants for this study were easily identified because directors delivered the list of registered students to the institute and participation rate was high because surveys were completed during class time.

The most difficult population to find if no register is established after the disaster, are the *visitors or passers-by*. In order to contact this population, announcements for the respective surveys were made by the local media of all three countries. In London, given the situation of the attacks being in the metro, the majority of affected people could be considered as passers-by which constituted a great challenge. The NHS Trauma Response to the London Bombings Programme wanted to contact all the people affected by the bombings and therefore lists of affected people were sought from hospitals that had treated them, the NHS Direct, the London Bombings Charitable Relief Fund, the police, etc

Another big challenge was the non-response rates. The response rate of questionnaires set by mail to the Enschede residents was only 30%, similar to the one of the workers in Toulouse (34%). The face to face interviews had better turn out; the NHS trauma response program obtained a 65,5% response rate and interviews among the resident population in Toulouse 60%. The highest participation rates were those obtained from the questionnaires distributed to school children (78%) because surveys were completed during class time. In all scenarios, rates diminished with successive follow-up studies.

These low participation rates rose the big issue of biased results. Nevertheless, despite the potential bias, results were informative and gave clear insight of the higher prevalence of psychological symptoms, indicators of stress, mental health problems as well as physical symptoms that can be linked to psychosomatic phenomena. These symptoms are linked to the intensity of the exposure to the traumatic event as well as to some risk factors: immigrate status, low socio-economic level, psychiatric anamnesis, etc. Follow-up studies showed that these symptoms were progressively decreasing but remained higher than among control populations.

Finally the identification of a control group of non-exposed population to compare the results of the questionnaires distributed among victims was quite challenging too. Control groups were chosen for the comparison of the results of the cross-sectional and longitudinal study in Toulouse and Enschede. After the AZF explosion, the cohort of workers in the area within a three-kilometer radius around the explosion site were compared with workers in the rest of the Toulouse metropolitan area, from which companies were randomly selected [2]. As for the cross-sectional study among school children, the comparison group was formed by students from other areas in Toulouse not affected by the explosion [7].

In the Netherlands, for the first wave of the longitudinal study in Enschede, given time constraints, no control group was arranged, but for the second and third wave, a sample from the city of Tilburg, in another part of the Netherlands, was chosen as a comparison group

because both cities had comparable histories. On the basis of age and gender composition, educational level and country of origin of the population, four districts in Tilsburg were chosen as control groups. Furthermore comparison groups of police, firefighters, and ambulance personnel from other parts of the Netherlands not involved in the explosions were identified [15]

5. Discussion

The results show that in spite of management differences, in all three cases similar steps were followed to assess the health burden of the disaster. The comparison has allowed the definition of a common framework of action:

During and just after the emergency phase, the first issue is to evaluate the acute health risks due to any toxic substance released. A **HRA** has to be launched to identify possible toxic disaster-related material and to analyse its' potential risks, to define the population or groups at risk and to provide exposure estimates for posterior epidemiological studies.

The second issue is to rapidly assess the field situation as well as the challenges faced by the local stakeholders. For this a good exchange of information and a strong relationship with local stakeholders or affected population are crucial. This can be obtained by direct visits to the affected area by the public health authorities (InVS at AZF), by establishing a strong information flux with the population (Assistance Centre of the London bombings, IAC at Enshede) and by creating specific organisations to establish a direct exchange between deciders, local stakeholders, population representatives and public health experts (**Steering committees** of all three scenarios) These committees allow **local stakeholders** to participate in the choice of the studies, the methodology and the communication strategy.

In parallel the use and adaptation of existing data in order to have **health surveillance systems** is of great importance. These systems are targeted on identification and alert about specific pathologies, or population at risk or medical support needs, as well as on the health impact assessment.

Finally, the assessment of the situation through HRA and Health surveillance systems and the interaction with local stakeholders orientates the **epidemiological** questions and methods to answer them in order to deal with mid- and long-term consequences. Cohorts and repetitive cross-sectional studies are launched to complete the assessment of the health

burden of the disaster to help decision makers to focus on the main problems of the community and to evaluate disaster management interventions.

5.1. Health Risk Assessment

HRA constitutes an essential tool for a first analysis of the public health impact of a disaster. However only limited time is available during and directly after a chemical incident to obtain certain necessary samples and this can constitute a great challenge. As mentioned in the results, France and the UK relied on the emergency actors (police, fire-fighters, etc.) to deal with the collection of samples. However, French public health experts had strong difficulties to collect the data from them, some couldn't or had great difficulties to deliver them and others didn't accept the exchange. The organisational process of UK had previewed such a situation and created an Environment group so that data could be immediately shared between the stakeholders of the environmental and health assessment.

A good contact with emergency staff is also important in a system where the withdrawal of samples is performed by the staff of the public health institutes, like the Dutch system. In this case, the communication must assure a good understanding and enable a situation where both task forces work together without getting in the way of one another.

The three examples stress the importance of an upstream preparation for an organisation allowing timely discussions between various users of the emergency environmental measurements. Respective interests and limits have to be understood by each other, and optimal measurement principles must be defined in advance. Furthermore a good preparation with exercises where epidemiologists will have had direct contact with the emergency actors seems to be required for feasible and appropriate measurements, relevant for the health risk assessment. The existence of a persistent environment group (London Bombings) can assure the link between first emergency measures and further post-accidental ones.

5.2. Biomonitoring

In the Netherlands, the aim of the biomonitoring programme of blood and urine samples was to validate the HRA results and above all, decrease uncertainty about exposure to toxic substances and reassure the population about their health risks.

Despite the added value, this biomonitoring system had disadvantages as well. It required time, staff and money to extract, analyze and stock all the samples. Since it was the first time that a study of such characteristics was launched in the Netherlands, many technical and logistical problems arose. In order to avoid such problems in the future, the Ministry of Health entrusted the RIVM the production of protocols of guidelines for possible future research including the preparation of fact-shits of different toxics [16].

One of the difficulties stressed by the Dutch experience was the lack of relevant references. There is increasing evidence of man-made chemicals detected in human bodies and other animals [35;36]. Due to the lack of the populations' reference levels, the biological results had to be compared to tolerable toxic levels described in the literature and it was impossible to know if the distribution of the results were more important in the exposed population after the event.

In France, there is a specific biomonitoring program in the environmental health department of the InVS. The program is aimed at evaluating the exposure of the French population to different pollutants at a national level. In the UK, one of the priorities for the HPA currently is to develop a Human Biomonitoring Programme for England and Wales. To do so they count with the "Reference Range Study", which aims to establish 'background' exposure data in the UK population for key environmental chemicals using in the first instance blood samples, and which is based in the Medical Toxicology research Centre in Newcastle University. Furthermore there is also the Work of the "Laboratory Review and Liaison Group" (LRLG), which is a group of leading experts in the field of biological monitoring and chemical analysis that will be published in the near future [37].

In the future, in the event of a disaster, the results of such programs could be useful in establishing reliable baseline measures for comparison. The comparison of the distribution of the results of a bio-measurement campaign on a sample of exposed population could have a great utility in quickly eliminating suspicions of exposure to certain toxic substances, as well as to discard false assumptions of excess exposure to other substances.

5.3. Community involvement

Due to time pressure and the chaotic environment after a disaster, a real implication between decision-makers, local stakeholders and the public can be difficult. Nevertheless, in the three case studies, the implication of representatives of the population in the management process went past the simple information scheme and efforts were made to try to develop discussions to be able to develop response systems where their major worries and concerns were

targeted. This high degree of implication, while quite hard to manage, had many advantages. Different papers highlight its importance for an adequate post-accident management [3;13;26;38]. Local stakeholders are the ones to have a better knowledge of what has happened and are able to favour a good rhythm of work.

Steering groups with good interactions between experts and local and supra-local actors should be always scheduled in order to take into account their information needs, provide them with adequate information on specific concerns they might have and make them part of the decision making process. The importance of the participation of epidemiologists in theses steering groups of discussion must be stressed too. On the one hand they can answer theoretical questions related to populations' health after a disaster and secondly while participating in the discussion they can gain insight on which health problems are worth quantifying by epidemiological studies. The populations' comprehension of the study and their opinion on its relevance will have major consequences on the participation rate for example, and therefore on the validity and reliability of the study.

Furthermore, involving the exposed population in the production process of the studies can also be important from a psychological perspective. Enable the involvement of the local stakeholders can favour a better evolution of their possible differed psychological effects, as by being involved they feel listened, they can highlight their major worries and therefore appropriate measures can be launched to handle their different problems: economic, logistic, health problems, etc.

5.4. Epidemiological response

A) Health Surveillance

For all the events the respective institutes gathered available information data, adapted the existing surveillance systems or even created specific networks with potential data providers in order to monitor the health impact of the event. The objectives were to provide an alert on certain pathologies or to detect at risk populations.

Data coming from medical networks allowed detecting hearing problems in the aftermath of the AZF explosion in France. During the 2005 London bombings, the NHS syndromic surveillance system was used to obtain details of individuals known to have been directly affected by the bombings and to send them the Trauma Screening Questionnaire of the NHS Trauma Response Program [34]. The use of the National Health Insurance Body database recording all medical consumption (visits to GPs, specialists, drug purchases, etc.) that are

reimbursed allowed the detection of new psychotrop prescriptions as an indicator of the mental health impact t of the event at AZF

Surveillance systems can also be used to confirm the results of the risk assessment. This was the case in France where the low degree of risk related to toxicological substances in the explosion plume was monitored and confirmed by the lack of appearance of medical syndromes.

They can furthermore be used to estimate the magnitude of the health problems and to identify groups at increased risk for adverse health outcomes and therefore be a method to ascertain the epidemiological research needed and validate the results of ad-hoc surveys.

Finally they can also be used to establish priorities for decision makers and to evaluate the impact and effectiveness of relief efforts and other interventions. Based on the results of the analysis of the different data-sources in Toulouse, the public health officers could identify the two main health impacts at mid-term after the AZF accident: mental health and hearing loss and could claim for adapted medical support.

The interesting thing is that most of the surveillance system used, were in fact, a simple ad hoc adaptation of existing data sources for the event. Nonetheless, the use of the whole information given by different sources to create a database networks for the specific surveillance of the population of Toulouse, for example, allowed an understanding of medical consumption and the impact that the disaster had on hospitals.

Taking into account the usefulness of such surveillance systems the three countries are currently analysing the adaptation of their systems in the aftermath of disasters.

Operated jointly by the UK Health Protection Agency (HPA) and the National Health Service (NHS), the UK's surveillance system examines symptoms reported to NHS Direct (a national telephone health helpline) [40]. The initial purpose of this syndromic surveillance system was to augment other surveillance systems in detecting outbreaks of influenza but in December 2001, the surveillance of 10 syndromes began, and the purpose of the system was expanded to provide an early warning for potential deliberate release of harmful biologic and chemical agents [41]. This system could have been used in case of doubts about potential environmental hazards as a consequence of the bombing.

By the end of 2003, the dramatic consequences of the heat wave (thousands of deaths) lead the InVS to build a non-specific surveillance system (Sursaud). This system is no longer

focused on different pathologies and identified syndromes but rather on health structures capable of providing daily information on the health status of the population. It is based on three basic sources of information: data from emergency departments around the country (OSCOUR®), data from an independent network of home visit emergency doctors (SOS Médecins) and mortality data registered by the National Institute of Statistics and Economic Studies (Insee). It provides the alert on the specific impact of an event, facilitating the identification of the effect. It is currently used by the InVS to test the feasibility of identifying specific scenarios of industrial or natural disaster events linked to their impacts. If feasible, this would facilitate the reinforcement of prevention or medical support strategies.

Despite its potential epidemiological utility, data from EMRs is not used in the Netherlands as a general surveillance system. The main surveillance system in the Netherlands is a Continuous Morbidity Registration (CMR) coming from a selection of GPs in order to follow nation-wide disease trends [39]. The covering of this GP sample is not dense enough to be sufficient in the event of a local disaster. To monitor a concrete population affected by a local disaster, the RIVM has a special agreement with the Netherlands Institute for Health Services Research (NIVEL), the organisation that maintains the database of all EMRs. In the event of a disaster, the database can immediately be used, and local GPs will be asked to use the ICD10 coding as soon as possible. However, their participation is not compulsory, only the EMRs of participating GPs will be extracted and analysed, respecting privacy rules and laws.

All in all it could be said that surveillance systems can constitute an essential element for the assessment of post-disaster situations. However they should be considered as a part of a comprehensive epidemiological response and not an isolated entity. They rarely can establish accountability between the disaster and a particular health event and therefore the search for causation is generally based on the results of complementary epidemiological studies.

B) Cohort and cross-sectional studies:

In order to answer to specific health issues and obtain knowledge on risk factors and the health burden of the disaster, epidemiological studies have to be carried out. The three events led to descriptive cross-sectional and cohort studies and in all three countries epidemiologists were confronted to important difficulties and limits such as the identification of affected population and controls, good health reference values and good comprehension and feedback to the stakeholders about these epidemiological studies:.

- Health Registration

In all three situations, epidemiologists found a way to contact affected population and launch health studies but they had strong difficulties to check the representativeness of the selected and answering population.

In Enschede, even if municipal databases where searched the explosion blast destroyed partly or completely a large proportion of houses and therefore it was not clear whether the residents were reached and informed of the project. Five years after AZF a shared feedback of the epidemiological results between all the local stakeholders revealed the existence of a non-assessable proportion of the exposed victims who had never registered for insurance compensations neither attended epidemiological studies. Nonetheless the testimonies of some of these non-respondents stressed that some of them had been seriously exposed to the AZF consequences (personal communication from the population advisor).

Experiences show that the lack of mechanism in the emergency planning to establish a comprehensive database of those who are affected by a disaster beforehand has proven to be a major limitation in the post-accident management, as well as a limitation for a successful epidemiological follow-up. If a pre-established protocol for a health register had existed, the selection of a representative population would have been easier.

Health registers initiatives must be launched immediately after the accident or as soon as possible in order to be able to contact all the population before it is dispersed or memory alters their reports [42,43]. Moreover, in addition to facilitating epidemiological studies, the information obtained from the register can be useful for contacting the population and offering them direct medical, psychological, social or other types of support if necessary, as well as facilitating reimbursement management, for example. Considering this and the difficulty to identify in emergency situations “representative and relevant part of the population to be observed” a census initiative must attempt to enrol all people who were exposed or potentially exposed to the accident, residents, workers, students, etc. It must include fatalities, material or physical victims and people who were involved in rescue actions or support to victims.

The three experiences highlight some relevant ways and moments to identify of the population involved: Contact of key persons of a community (workers, school children), municipal or GP databases for the residents and for all kind of exposed people, including passers-by, welcoming and information centres, radio messages, special phone numbers and websites, other support services.

The phone interviews between institutes show that each country is working on preparation of census organisation in case of accident.

In the UK, currently, a Health Register Group has been created within the HPA with experts of different divisions of the HPA, outside academics and other experts. The objective of the group is to develop a protocol for rapid epidemiological response to CBRN events, to be used by the HPA in conjunction with the NHS and other agencies. First efforts have focused on the identification of attributes of an incident that are most discriminating as criteria for deciding whether to establish a health register and consequently development of a proposal of a protocol for an HPA Rapid Response Register. The idea is that the register would primarily collect contact information of potentially exposed individuals that could be used for follow-up after the event. As for who should be registered, a draft protocol to be discussed by the Health Register Group highlighted the importance of including all the emergency personnel, other occupational groups, school attendees if schools were affected, local residents and passers-by. As for how to enable the register, the protocol suggests a close communication between HPA Centres and Local Health Protection Units (HPUs), who are well placed to communicate with Accident and Emergency (A&E) departments and primary care providers in local areas. Apart from the use of A&E departments to contact affected population, other sources mentioned are interaction with employers and calls in the media.

In the Netherlands, RIVM is proposing census factsheets collecting the main principles and recommendations to be delivered to regional authorities who in the case of an accident would be in charge of the situation.

In France, a protocol for the register of the exposed population to a radiological accident has recently been proposed by the expert committee in charge of the building of the post-radiological accident doctrine [42]. The difficulty of carrying out such a register in the chaotic environment that is generated after a disaster was acknowledged, and without attempting an absolutely complete census, the working group identified several particular situations favourable for a good register with names and contact details. Some examples are the first shelter gathering after the initial evacuation; within the assistance centre; during the first health evaluations, etc.

5.5. Health Reference Values

Apart from identifying the study population, one of the bases of epidemiology is the identification of references or control groups to assess the impact of an event or an

exposure. Existing or rapidly measurable baselines are highly important for allowing comparison of the results obtained in a study of a post-disaster scenario.

Regarding the populations' health status, the best method to gain reliable insight into the effects of the disaster would be comparing non-retrospective pre-event health data with prospective post-disaster health data of the same population [15].The EMR produced by the Dutch GPs enabled the comparison of the health status of patients from one year before the explosion and therefore to have, retrospectively, a baseline status of the populations' health.

Furthermore, the same data source allowed the matching of exposed population with a control population comparable in age, gender and socioeconomic status [12;15]. It was the best situation among the three compared examples. The comparison of two references for the EMRs was very useful and allowed the identification of the problem of generalizing the results based upon population risk factors.

In France, the National Health Insurance (Caisse nationale de l'Assurance maladie et des travailleurs salariés - CnamTS) manages at national level all the different Social Security Agencies (CPAM, Cram, SSTC, Urcam, etc.) and owns a database recording all medical consumption (visits to GPs, specialists, drug purchases, etc.) that are reimbursed. The access to the database is very difficult given its enormous dimensions and is highly restricted through privacy laws. However its existence makes the theoretical possibility of obtaining pre-event data plausible. In the aftermath of the AZF explosion, this database was used for the detection of new psychotropic treatment prescriptions [5]. However, this was analysed based upon general trends and not individual consumption.

When a before and after method is not possible because no pre-event data is available, a good alternative is comparing the health of victims with a comparable group of non-exposed population. However, this method is difficult to be implemented in emergency. The present comparison didn't allow best examples for this selection of control groups in emergency. This issue should be explored by the three institutes in the framework of future exchanges.

5.6. Information to population and stakeholders

Finally, once the surveillance systems are put in place and the epidemiological studies are set up, it is important to assure the transmission of results not only to decision-makers, but also to all the affected population, the public health community and emergency planners too. The need for information and the implication of different segments of society after a disaster is an important public health issue to be addressed. The production of reliable, transparent,

relevant and timely information should be ensured with respect to the causes and effects of the disaster as well as the efficiency of the interventions [43]. The information message has to be precise and relevant for each stakeholder. On the one hand, the exposed populations need information on the nature and amount of expected health impact and on where and when can they receive assistance. On the other hand, decision makers can use this information when evaluating the needs of the population and in addition they need information regarding the degree of relevance of the management systems they decide to implement to manage the consequences of the accident.

In order to fulfil all these information challenges, a combination of different methods was used in the three case examples. Media messages were used to deliver information for the general public, and **centres for information** with care services for adapted individual attention were set up in two of the three studied incidents.

These information centres constitute a place of choice to collect risk perceptions and health concerns of the population in order to adapt further health risk assessments, health messages or epidemiological issues. Regarding epidemiology, they can be very helpful for the identification of the population to be studied and the establishment of a census, since they welcome a large part of the exposed population. Furthermore, they are also a privileged place to disseminate information coming from surveillance systems and epidemiological studies to whom?.

In France, after the explosion of the AZF factory, no information and advice centre was established, while? done in the Netherlands (IAC) and in the UK (7th of July Assistance Centre). At the time, no such thing had been considered. Recently however, a similar concept was proposed a steering group for the reflection on the structuring of the post-accident phase in event of a nuclear disaster (Codirpa). The group working on the health follow-up of the population proposed to set up a reception and information centre (CAI: Centre d'accueil et d'information) [44]. The proposal mentioned that the centre should include a telephone helpline service and enough staff to proceed to the registry of the population, to provide information and to offer psychological or medical aid if necessary.

6. Conclusion

Different approaches are necessary to address the public health consequences of a disaster. As necessary and important as emergency services are, they are not sufficient to cope with all the aftermath of a large scale accident. Cancer, birth defects, mental health effects and

secondary effects due to the disruption of the economy are clear examples of delayed societal implications of a catastrophe out of the scope of emergency services.

With adequate information, many of these late effects can be anticipated or controlled through secondary prevention or social measures, for example. In this context, epidemiology can be a very useful tool to provide relevant, transparent and timely data for the management of this late health and social burden.

Nevertheless, in order to produce appropriate and timely information public health experts should be part of the decision making process to advocate for the relevance and need of health studies and obtain permission and funding for these studies to be set up at an appropriate time. Furthermore to be able to deal with an emergency situation in a reflex and efficient way, health questionnaires should be prepared beforehand and register protocols should be produced. Another important element for a quick assessment of the health effects of a disaster is to count with reference levels of the community's health status for comparison. The study of the three accidents have shown that there are different methods to obtain such control levels; periodic health assessments at a municipality level, development of a bio monitoring programme for the quantification of toxic levels in body fluids, the computerization of databases that record health care consumption, etc. Furthermore guidelines on the criteria to select control population and knowledge of the available emergency data could be helpful to speed up the process.

The comparison of the response of the three countries has stressed the fact that in order to guarantee a complete analysis of the health situation, a combination of methods (HRA, surveillance and surveys) must be used and that results must constantly be analysed and divulged to decision-makers and the public. It has also pointed out that in order to obtain a complete analysis of the situation, responsive to the affected population needs, victims as well as other local stakeholders should participate in the management process and have a good interaction with epidemiologists in charge of the studies to be launched. This interaction of local stakeholders, decision makers and epidemiologists is the only way to guarantee a relevant epidemiology.

Last but not least this project has highlighted the usefulness of studying and analysing previous experiences. Bearing in mind that fortunately important disasters are scarce at a country level, lessons can be learned not only from previous national disasters but also from international events. Furthermore developing collaborations between public health institutes across European countries can help to gain expertise by facilitate the production of

homogeneous and comparable results facilitating the enhancement of knowledge on how to address public-health challenges.

Bibliography

[1] Direction de la défense et la sécurité civile. GUIDE ORSEC DEPARTEMENTAL. Méthode Général. 2010.

[2] Cohidon C, Diene E, Carton M, Fatras JY, Goldberg M, Imbernon E. Mental health of workers in Toulouse 2 years after the industrial AZF disaster: first results of a longitudinal follow-up of 3,000 people. Soc Psychiatry Psychiatr Epidemiol 2009;44(9):784-91.

[3] Lang T, Schwoebel V, Diene E, Bauvin E, Garrigue E, Lapierre-Duval K, et al. Assessing post-disaster consequences for health at the population level: experience from the AZF factory explosion in Toulouse. J Epidemiol Community Health 2007;61(2):103-7.

[4] Valérie Schowoebel. L'explosion de l'usine AZF. Retour sur la gestion de l'évènement par l'InVS et la Cire. Formation aux astreintes [DSE]. Saint-Maurice, InVS. 2006.

[5] InVS. Les conséquences sanitaires de l'explosion de l'usine "AZF" à Toulouse, le 21 septembre 2001. Saint-Maurice. InVS 2003

[6] InVS. Explosion de l'Usine AZF: Dispositif de suivi épidémiologique des consequences sur la santé. Dossier préparé pour le Comité de Suivi Institutionnel. Saint Maurice, InVS.2002

[7] Guinard A., Godeau E., Schowoebel V. Conséquences sanitaires de l'explosion survenue à l'usine "AZF" le 21 septembre 2001. Rapport final sur les consequences sanitaires chez les enfants toulousains. Cire Midi-Pyrénées, Institute de veille sanitaire. 2006.

[8] Rivière S, Lapierre-Duval K, Albessard A, Gardette V, Guinard A, Schwoebel V. Conséquences sanitaires de l'explosion survenue à l'usine «AZF», le 21 septembre 2001. Rapport final sur les conséquences sanitaires dans la population toulousaine. Saint-Maurice, InVS. 2006.

[9] Verger P, Ruijten M, Russell D, Saunders P, Lang T. Better planning for health impact assessment of disasters. Eur J Public Health 2007;17(1):3.

[10] Van Kamp I, van d, V, Stellato RK, Roorda J, van LJ, Kleber RJ, et al. Physical and mental health shortly after a disaster: first results from the Enschede firework disaster study. Eur J Public Health 2006;16(3):253-9.

[11] Gersons BP, Huijsman-Rubingh RR, Olff M. [Psychosocial care following the firework disaster in Enschede; the lessons from the Bijlmer airline disaster]. Ned Tijdschr Geneeskd 2004;148(29):1426-30.

[12] Grievink L, van d, V, Yzermans CJ, Roorda J, Stellato RK. The importance of estimating selection bias on prevalence estimates shortly after a disaster. Ann Epidemiol 2006;16(10):782-8.

[13] Roorda J, van Stiphout WA, Huijsman-Rubingh RR. Post-disaster health effects: strategies for investigation and data collection. Experiences from the Enschede firework disaster. J Epidemiol Community Health 2004;58(12):982-7.

[14] Yzermans CJ. The Netherlands: Health Impact Assessment of Disaster. Expert Panel on Public Health Registries, Proceedings. 21-24. New York City Department of Health and Mental Hygiene Agency for Toxic Substances and Disease Registry, *World Trade Center Health Registry*.2004

[15] Van der Velden P, Yzermans CJ, Grievink L. Enschede Fireworks Disaster. Mental Health and Disasters - Edited by Yuval Neria, Sandro Galea and Fran H.Norris , Cambridge University Press.2009; 473-96.

[16] RIVM Project team. Firework disaster Enschede: Components in blood and urine (Dutch report no. 630930 003). Bilthoven, The Netherlands: Institute for Public Health and Environment (RIVM). 2001.

[17] Grievink L, van d, V, Stellato RK, Dusseldorp A, Gersons BP, Kleber RJ, et al. A longitudinal comparative study of the physical and mental health problems of affected residents of the firework disaster Enschede, The Netherlands. Public Health 2007;121(5):367-74.

[18] Van den BB, Grievink L, Yzermans J, Lebret E. Medically unexplained physical symptoms in the aftermath of disasters. Epidemiol Rev 2005;27:92-106.

[19] Yzermans CJ, Donker GA, Kerssens JJ, Dirkzwager AJ, Soeteman RJ, ten Veen PM. Health problems of victims before and after disaster: a longitudinal study in general practice. Int J Epidemiol 2005;34(4):820-6.

[20] Dirkzwager AJ, Grievink L, van d, V, Yzermans CJ. Risk factors for psychological and physical health problems after a man-made disaster. Prospective study. Br J Psychiatry 2006;189:144-9.

[21] Center for Health Impact Assessment of Disasters (CGOR). RIVM [updated 2006 Oct. 4; Available from: URL: http://www.rivm.nl/gor/Images/CGOR_English_tcm40-31388.pdf

[22] Wilson James, Murray Virginia. Environmental sampling and analysis on the London Underground in response to the 7th of July 2005 bombings: lessons identified for major incedent management. Chemical Hazards and Poisons Division, editor. Chemical Hazards and Poisons Report [7], 19-20. HPA, London. 2006.

[23] Wilson J, Murray V, Kettle JN. The July 2005 London bombings: environmental monitoring, health risk assessment and lessons identified for major incident response. Occup Environ Med 2009;66(10):642-3.

[24] Rowe Anthony. Emergency Planning. Management and Co-ordination of Major Incidents. Chemical Hazards and Poisons Division, editor. Chemical Hazards and Poisons Report [7], 23-26. HPA, London. 2006.

[25] Brewin CR, Fuchkan N, Huntley Z. Evaluation of the NHS Trauma Response to the London Bomings. Final Report to the Department of Health. Clinical, Educational and Health Psychology, University Collage London.2009

[26] London Regional Resilience Forum. London Regional Resilience Report on Events of 7 July 2005. Looking Back, Moving Forward: The Multi-Agency Debrief. London, UK. 2010.

[27] HPA. Continuing Public Health Response to the London Bombings of 7 Jul 2005. Protecting People. Preventing Harm. Preparing for Threats. Health Protection Agency, London. 2010.

[28] Rubin GJ, Brewin CR, Greenberg N, Simpson J, Wessely S. Psychological and behavioural reactions to the bombings in London on 7 July 2005: cross sectional survey of a representative sample of Londoners. BMJ 2005;331(7517):606.

[29] Rubin G James, Wessely Simon. Incident Response: London Bombings. Psychological Reactions to the 7th July London Bombings. Chemical Hazard and Poisons Division, editor. Chemical Hazards and Poisons Report [7], 16-18. HPA, London. 2006.

[30] Rubin GJ, Brewin CR, Greenberg N, Hughes JH, Simpson J, Wessely S. Enduring consequences of terrorism: 7-month follow-up survey of reactions to the bombings in London on 7 July 2005. Br J Psychiatry 2007;190:350-6.

[31] Bloemen H.J.Th, Cassee F.R. Risk assessment for populations during inhalation exposure as a result of catastrophes. RIVM report 630110002 / 2006. Bilthoven, RIVM. 2006.

[32] Bongers S, Janssen NA, Reiss B, Grievink L, Lebret E, Kromhout H. Challenges of exposure assessment for health studies in the aftermath of chemical incidents and disasters. J Expo Sci Environ Epidemiol 2008;18(4):341-59.

[33] Brewin CR, Scragg P, Robertson M, Thompson M, d'Ardenne P, Ehlers A. Promoting mental health following the London bombings: a screen and treat approach. J Trauma Stress 2008;21(1):3-8.

[34] Brewin CR, Fuchkan N, Huntley Z, Robertson M, Thompson M, Scragg P, et al. Outreach and screening following the 2005 London bombings: usage and outcomes. Psychol Med 2010;1-9.

[35] Barr DB, Olsson AO, Wong LY, Udunka S, Baker SE, Whitehead RD, et al. Urinary concentrations of metabolites of pyrethroid insecticides in the general u.s. Population: national health and nutrition examination survey 1999-2002. Environ Health Perspect 2010;118(6):742-8.

[36] Duty SM, Silva MJ, Barr DB, Brock JW, Ryan L, Chen Z, *et al.* Phthalate exposure and human semen parameters. Epidemiology 2003;14(3):269-77.

[37] Chemical Hazard and Poisons Division. Human Biomonitoring. HPA [updated 2010; Available from: URL: http://www.hpa.org.uk/ProductsServices/ChemicalsPoisons/ChemicalRiskAssessment/HumanBiomonitoring/

[38] Procesus-Participation du publique et consultations. Santé Canada [updated 2007 Oct. 18; Available from: URL: http://www.hc-sc.gc.ca/ahc-asc/public-consult/res-centre/process-fra.php

[39] NIVEL. Continuous Morbidity Registration at Dutch Sentinel Stations 2003. Dutch Sentinel Practice Network 2003. NIVEL, Postbus 1568, 3500 BN UTRECHT. 2004.

[40] Smith GE, Cooper D L, Loveridge P, Albessard A, Chinemana F, Gererd E, *et al.* A national syndromic surveillance system for England and Wales using calls to a telephone helpline. Eurosurveillance 11[12]. 2010.

[41] Doroshenko A, Cooper D, Smith G, Gererd E, Chinemana F, Verlander N, *et al.* Evaluation of Syndromic Surveillance Based on National Health Service Direct Derived Data --- England and Wales. MMWR 54 (Supplement), 117-122. Washington DC, CDC. 2005.

[42] Pirard P., Schmitt M., Fite J., Bernier M.O. Le rencensement, un acte indispensable en situation post-accidentelle, une organisation importante à prévoir. Reflexions du GT4 du CODIRPA. Contrôle 180, 35-40. 2008. Paris, ASN.

[43] Verger P, Aulagnier M, Schwoebel V, Lang T. Démarches épidémiologiques après une catastrophe. 2005. Paris, La documentation française.

[44] Comité directeur pour la gestion de la phase post-accidentelled'un accident nucléaire ou d'une situation radiologique (CODIRPA). Réponse aux enjeux sanitaires après un accident radiologique.Groupe de travail n°4. ASN [updated 2 007 Nov. 5; (2)Available from: URL: www.asn.fr

Comparison of three European countries (United Kingdom, the Netherlands and France) in terms of epidemiological response and preparedness for a disaster

Practicum Dissertation

Disasters constitute a major public health challenge as they can have direct and indirect consequences on the health of the populations and consequently impact health systems. After a disaster, governmental and relief organizations must identify the priorities needed for orientating actions in order to limit the health consequences at short- and long-term Health risk assessment and epidemiology can be useful tools to obtain information for such a task. Through case studies of three European countries (France, the Netherlands and the United Kingdom), this study describes and compares how these countries have applied epidemiological methods in post-disaster management. The methodology was primarily based on a literature review and direct exchanges through email, telephone and videoconference. The results show that even with management differences, in all three examples similar structures and methods were put into place and that epidemiology teams had to deal with similar key point issues, such as the importance of obtaining adequate and timely environmental samples, how to best take into account the populations points of view and needs, the difficulty of finding and enrolling a significant proportion of the population in the studies, how and where to find reference levels for comparison, etc. The identification of these specific challenges has enabled the French Institute for Public Health Surveillance (InVS) to strengthen its existing ties with the Dutch Institute for Public Health and Environment (RIVM) and the Health Protection Agency (HPA) in the UK. Future meetings are planned to continue this exchange process and develop future collaborations to improve the health impact assessment after a disaster in France and the other countries.

Key words: comparison, disaster, epidemiology, AZF, London bombings, Enschede

Comparaison des trois pays européens (Royaume-Uni, les Pays-Bas et la France) en termes de réponse épidémiologique et de préparation pour une catastrophe

Rapport de Master

Les catastrophes environnementales constituent un défi majeur de santé publique. A la suite d'événements catastrophiques d'origine anthropique ou naturelle, les administrations et les services sanitaires doivent identifier les priorités pour agir efficacement et, ainsi, limiter les conséquences sur la population à court et à long terme. Pour y parvenir, l'évaluation des risques et l'épidémiologie sont des outils essentiels. A travers l'analyse de trois catastrophes, cette étude compare comment l'intégration de ces outils dans la gestion du post-accident en France, aux Pays-Bas et au Royaume-Uni. Pour ce faire, une revue de littérature a été réalisée et des échanges directs d'information par email, téléphone et vidéoconférence ont eu lieu entre l'Institut de veille sanitaire (InVS), la Health Protection Agency (HPA) et l'Institut national de santé publique et environnement des Pays-Bas (RIVM). Les résultats montrent que même avec des systèmes de gestion différents, des structures et des méthodes similaires ont été utilisées dans les trois pays. Les épidémiologistes ont été confrontés à des enjeux similaires tels que l'obtention rapide de mesures environnementales adéquates, l'implication des populations, l'identification et l'enregistrement des populations exposées, leur participation dans des études épidémiologiques, l'identification de niveaux de référence sanitaire. L'identification de ces enjeux a permis à l'InVS de fortifier ses relations existantes avec le RIVM (Pays-Bas) et la HPA (Royaume-Uni). De futures réunions ont été planifiées pour continuer cet échange et développer de futurs projets de collaboration pour améliorer l'évaluation de l'impact sanitaire d'une catastrophe en France et dans les autres pays européens.

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