Kamp, I. van, Velden, P. van der, Yzermans, J. Case Study: Enschede Fireworks Disaster: lessons Learned. In: R. Duarte-Davidson, T.Gaulton, S. Wyke, S. Collins (Eds). Chemical health threats: assessing and alerting, chapter 3, Londen: Royal Society of Chemitry: 2019, p. 283-289

Postprint version : 1.0

This is a Nivel certified Post Print, more info at nivel.nl

Case study: Enschede fireworks disaster: lessons learned

Irene van Kamp, Peter van der Velden, Joris Yzermans

[a] National Institute for Public Health and the Environment, Bilthoven, The Netherlands;
[b] Intervict, Tilburg University, The Netherlands;
[c] CentERdata, Tilburg, The Netherlands;
[d] Netherlands Institute for Health Services Research, Utrecht, The Netherlands

A3.1 Introduction

On the 13th of May 2000, late on Saturday afternoon, two massive explosionsoccurred at a fireworks depot in Enschede, a town in the eastern part of the Netherlands. A residential area of around 100 acres near the city centre, with around 500 houses, was destroyed, 23 people were killed and 1000 people were injured. The sudden and immense blasts frightened many residents:
"*the enormous startle after the first explosion, a window flew through the room and we fell backwards due to the pressure …. and the debris flying around my ears. I saw a piece of rock hitting the window of a car with a child in it* ".[1]

In total, 4500 rescue workers and volunteers were deployed on the first day by the various emergency services. Expert assistance on the day of the incident comprised of 680 doctors and 270 ambulance personnel, as well as 80 first-aiders and 45 general practitioners. They arrived from various surrounding areas, including Germany.[2]

A3.1.1 Background and Implementation of the Enschede Fireworks Disaster Study

The implementation of the Enschede fireworks disaster study was strongly influenced by the aftermath of an earlier disaster in the Netherlands: the Bijlmermeer plane crash in 1992 that occurred in a residential area in Amsterdam. Uncertainty about potential exposure to toxic substances due to inadequate and contradictory information in the media and lack of action by the authorities caused mistrust and fear among the residents, with health symptoms still being attributed to the disaster years later. In 1999, a parliamentary inquiry committee therefore recommended the rapid assessment of immediate health effects following a disaster.

As a result of previous difficulties, shortly after the fireworks disaster the Institute for Public Health and the Environment (RIVM) carried out measurements of concentrations of substances in the air, which were repeated over the following days after the disaster. Using health-based guidelines it was concluded that negative health effects due to exposure were highly unlikely, except for short-term irritation of the airways. Measurements of deposition showed the environmental load outside the disaster area to be non-relevant with respect to the normal background concentrations in soil.[3,4]

Learning from the troublesome aftermath of the Bijlmermeer plane crash, the Dutch Government soon decided to implement and start three activities:

- Implement an Information and Advice Centre to account for all problems that have affected residents and rescue workers.
- Integrate psychosocial aftercare for residents and workers, to address mental health needs and to facilitate treatment of mental problems and disorders following the disaster.
- Execute health monitoring, consisting of research:
  - (a) among affected residents and rescue workers themselves.
  - (b) using electronic medical records of general practitioners, pharmacists, psychologists and company doctors (including comparison groups and baseline data).

This case study is focused on health monitoring.

A3.2 Overall Design of Health Monitoring

The Health Monitoring system, commissioned by the Dutch Ministry of Health, Welfare and Sports, was prepared under enormous time pressure in the first one to two weeks after the disaster and conducted within three weeks after the event. This included gaining permission to implement a Medical Ethical Testing committee. The primary aim of this study was to collect information that would otherwise have been lost during the public's exposure to shocking and potentially traumatic events, which included the collection of blood and urine for the measurement of trace elements indicative of exposure to toxic substances related to fireworks. A second aim was to make a rapid assessment of the immediate health effects by means of a questionnaire. The purpose of this questionnaire was to communicate acknowledgement of mental and physical health problems which would contribute to a sense of social support, recognition and a “caring government”.

Initial results were reported in July 2000 and a full report was issued in April 2001. The survey was repeated after 18 months, and again four years later in the framework of the Enschede Firework Disaster Health Surveillance Project (GGVE). It was also repeated ten years later among native Dutch affected adult residents. Health monitoring using medical records of general practitioners was conducted over a six-year period, including one year pre-disaster. Results were presented to all general practitioners every three months. Several other cross-sectional studies were conducted in specific vulnerable groups.2

A3.3 Main Outcomes of the Surveys

A3.3.1 Blood and Urine Study in the First Survey Two to Three Weeks Post-event

The first survey and the collection of blood and urine samples among affected residents and rescue workers were conducted in the period between two and three weeks after the disaster.

In total, samples were collected from 4000 residents and rescue workers and analysed by inductively coupled plasma mass spectrometry (ICP–MS) for barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), antimony (Sb), strontium (Sr), titanium (Ti) and zinc (Zn). No systematic increases of blood and urine levels were found in the residential group (including children) nor in the rescue workers. Importantly, 22 people had relatively high levels of Cu, Pb, Sr, Ba or Ni. These were considered to be chance observations since there was no indication that the elevated levels were associated with exposures related to the disaster but given their clinical toxic relevance these individuals and their GP's were notified.[5]

A3.3.2 Acute Physical and Mental Health Effects after the Disaster

Thirty-five percent of the residents and rescue workers from the disaster area, 45% of passers-by and 23% of the rescue workers reported that they suffered one or more acute symptoms within the first 24 hours after the explosions. Coughing and irritation of the throat, respiratory tract, eyes and nose were often mentioned. Moreover, residents and passers-by frequently reported earaches, acute tinnitus, shortness of breath and vertigo. The rescue workers who wore facial protection or a surgical mask during the rescue activities (31%) reported significantly fewer acute symptoms.

A3.3.3 Main Outcomes of Surveys Among the Affected up to 10 Years Post-event

Over a period of 10 years several large surveys were conducted, three among rescue workers and affected ethnic minorities, and four among Dutch native affected residents. Topics covered included demographics, what people felt, saw and heard during the disaster (exposure), mental and physical health problems, substance use, mental health care utilization, social support, optimism, life-events and work-related stressors.

The main outcomes with respect to mental health are presented in Table A3.1. At four years post-disaster, mental health problems were still elevated compared with non-affected Dutch natives. About one in ten people suffering from severe symptoms two to three weeks after the disaster still suffered from these symptoms at the point of all four surveys, i.e. from chronic symptoms.[6] Ethnic minorities however showed a much higher prevalence of health problems[7] at the first three surveys (they were not included in the fourth survey due to high participation costs). During the first 4 years, about 45% of Dutch natives affected used mental health services, three times more than non-affected people. In addition, when comparing affected and non-affected people with similar mental health problems, affected residents used these services more often than non-affected residents.[2]

A different pattern was observed among rescue workers. Symptom levels were much lower than among affected residents at two to three weeks post-disaster[8] and at 18 months post-event they were similar to or even lower than those of non-affected rescue workers. The prevalence of probable post-traumatic stress disorder (PTSD) among the total group of rescue workers was very low[2,9]

New findings emerged however with respect to risk factors for post-traumatic mental health problems. Results indicated that smokers were more at risk for mental health problems or post-traumatic stress symptoms than non-smokers. In addition, results indicated that optimism was far less predictive of mental health problems among non-affected-people[2] and that 18 months post-disaster, organisational stressors were stronger and more independent predictors of mental health problems among affected residents than disaster-related stressors.[10]

[Table A.3.1]

A3.4 Main Outcomes from General Practice Health Records

Longitudinal surveillance of victims and non-victims was also conducted, using existing medical registries in general practice and aimed at exploring psychological and physical morbidity, (primary) healthcare utilisation and the identification of high risk groups among residents and rescue workers. A matched cohort study design with one year pre-disaster and five years post-disaster measurements was applied. Victims (n = 9183) and matched controls (n = 7066) were surveyed via the electronic health records of 30 family practices. As gatekeeper to secondary care (every citizen is enrolled in the practice of just one GP) the GP could provide data on health problems of victims and controls. The results indicated that forced relocation and a history of psychological problems were risk factors for post-disaster psychological problems of victims in family practice. Moreover, physical and psychological symptoms and disorders appeared to be intertwined with one another. For example, depressive symptoms and lower back pain were often seen combined in the same individuals. Rescue

workers suffered for a longer period from physical symptoms, compared with psychological problems.[11]

A3.4.1 Self-reported Symptoms and GP-reported Symptoms Immediately after the Disaster

The data from the two-wave longitudinal survey (two to three weeks and 18 months) among survivors of the disaster was combined with continuous morbidity surveillance in general practice. Differences in presented symptoms over time were analysed using logistic multilevel analysis. More than half of the respondents reported health problems they attributed to the disaster. Psychological problems were most frequently reported and in contrast to physical-attributed symptoms, presentation of these problems in general practice decreased over time.[12] Survivors who attributed symptoms to the disaster at both waves or after 18 months most often presented such symptoms to the GP.[13] Attribution of symptoms to an extreme life event such as experiencing a disaster may therefore require the special attention of caregivers.

A3.5 Lessons Learned

To date, about 80 peer-reviewed papers have been published, in which important findings were highlighted and discussed. It is beyond the scope of this case study to provide a complete overview of all lessons learned. However, we would like to end our contribution with the following 'lessons learned'.

1. Early measurement of concentrations of substances in the air and soil, as well as blood and urine tests to exclude exposure to toxic substances at levels that were potentially hazardous to health were among the important activities for preventing unnecessary worry and speculation in the media after the Enschede firework disaster.
2. In contrast to the Bijlmermeer disaster, the Enschede fireworks disaster was not accompanied by ongoing media-reports, rumors, speculation and severe worries about the possible negative effects of fireworks-related toxic materials. Although this disaster took place in another city located in another area in the Netherlands with a slightly different culture, the activities immediately after the disaster might explain this difference.
3. We found clear indications that affected residents with mental health problems used mental health services more often than non-affected people, indicating that the mental health policy after the Enschede disaster facilitated recovery
4. Physical symptoms and diagnosis were often intertwined with psychological problems and disorders. Physical symptoms often were medically unexplained (e.g. tiredness and fatigue, pain in neck and shoulders). Most of these symptoms were presented to the general practitioner.

Acknowledgements

Many persons and organizations contributed to the Enschede fireworks disaster study. We gratefully thank all respondents, family physicians, the GGD Regio Twente (the local health authority in Enschede), the steering group and all our colleagues.

References

1. E. van der Ploeg, A. M. Dorresteijn, P. G. van der Velden and R. J. Kleber, Blijvende herinneringen aan de dag van de vuurwerkramp op 13 mei 2000 in Enschede [Abiding memories to the day of the Enschede Fireworks disaster, May 13, 2000], Ministerie van VWS, Den Haag, Enschede: gemeente Enschede, 2001.
2. P . G. van der Velden, C. J. Yzermans and L. Grievink, Mental health and disasters, in The Enschede Fireworks Disaster, ed. Y. Neria, S. Galeo and F. Norris, Cambridge University Press, 2009, pp. 473–496.

3. H. J. T. H. Bloemen and F. R. Cassee, Risk Assessment for Populations during Inhalation Exposure as a Result of Catastrophes, RIVM Report 630110002/2006, 2006.
4. M. G. Mennen, J. J. G. Kliest and M. van Bruggen, Vuurwerkramp Enschede: Metingen van concentraties, verspreiding en depositie van schadelijke stoffen: rapportage van het milieuonderzoek RIVM Report 609022002, 2001.
5. R IVM Projectteam Gezondheidsonderzoek, Vuurwerkramp Enschede: Stoffen in bloed en urine; rapportage van het Gezondheidsonderzoek, RIVM rapport 630930 003, 2001.
6. P . G. van der Velden, A. Wong, H. C. Boshuizen and L. Grievink, Persistent mental health disturbances during the 10 years after a disaster: fourwave longitudinal comparative study, Psychiatry Clin. Neurosci., 2013, 67, 110–118.
7. A. D. Drogendijk, P. G. van der Velden and R. J. Kleber, Acculturation and post-disaster mental health problems among affected and non-affected immigrants: a comparative study, J. Affective Disord., 2012, 138, 485–489.
8. I. van Kamp, P. G. van der Velden, R. Stellato, J. Roorda, J. Van Loon, R. J. Kleber, B. P. R. Gersons and E. Lebret, Physical and mental health shortly after a disaster: first results from the Enschede firework disaster study, Eur. J. Public Health, 2006, 16, 253–259.
9. P . G. van der Velden, R. J. Kleber, L. Grievink and C. J. Yzermans, Confrontations with aggression and mental health problems in police officers: The role of organizational stressors, life-events and previous mental health problems, Psychol. Trauma, 2010, 2, 135–144.
10. P . G. van der Velden, M. W. G. Bosmans, S. Bogaerts and M. J. P. M. Veldhoven, Social organizational stressors and post-disaster mental health disturbances: a longitudinal study, Psychiatry Res., 2014, 219, 177–182.
11. C. J. Yzermans, G. A. Donker, J. J. Kerssens, A. J. E. Dirkzwager, R. J. H. Soeteman and P. M. H. ten Veen, Health problems of victims before and after disaster: a longitudinal study in general practice, Int. J. Epidemiol., 2005, 34, 820–826.
12. A. J. E. Dirkzwager, L. Grievink, P. G. van der Velden and C. J. Yzermans, Risk factors for psychological and physical health problems after a manmade disaster. Prospective study, Br. J. Psychiatry, 2006, 189, 144–149.
13. B. van den Berg, L. Grievink, R. K. Stellato, J. Yzermans and E. Lebret, Symptoms and related functioning in a traumatized community, Arch. Intern. Med., 2005, 165, 2402–2407.

Tables and figures

Table A3.1 Mental health problems among affected Dutch natives

	2–3 weeks post-disaster	1.5 years post-disaster	4 years post-disaster	10 years post-disaster	Chronic, over 10 years
Mental health problems	%	%	%	%	%
Severe PTSD symptoms	70.0	39.1	26.4	16.7	6.7
Severe anxiety symptoms	43.1	27.6	21.2	18.4	3.8
Severe depression symptoms	47.6	32.1	27.2	23.9	6.2
Severe sleeping problems	45.1	29.2	26.7	24.6	4.8