Association belge de Radioprotection, Vol. 35, n° 3, 2010
Belgische Vereniging voor Stralingsbescherming Vol. 35, nr 3, 2010

Thyroid measurement campaign after an accidental release of 45 GBq ^{131}I in Fleurus, Belgium

Klaas van der Meer, Anne-Laure Lebacq, Eric Boogers, Sven Boden, Greet Verstrepen, Filip Vanhavere, Jantine Schröder, Johan Camps, Carlos Rojas Palma, Lieve Sweeck, Tanja Perko, Isabelle Majkowski, Catrinel Turcanu

Abstract

On August 22, 2008, a cloud of ^{131}I was released from the Institut des Radioelements (IRE), a producer of medical isotopes located in Fleurus, Belgium. The peak of the release took place in the weekend of 23-24 August and was followed by a smaller, continuous release which lasted for several weeks.

After reports of the incident in the press, concern grew among the local population about possible health effects of this release of radioactivity.

As a consequence of this concern, the Belgian public health authorities organised a thyroid measurement campaign for the local public to reassure the public that no detectable dose was acquired in the thyroid, especially for small children and pregnant women.

The Belgian Nuclear Research Centre SCK•CEN made a very substantial contribution to the thyroid measurement campaign. It provided 4 of the 5 measurement teams, each one equipped with a high-purity germanium detector and the necessary hardware and software. The University of Liège provided another team with a NaI detector.

All detectors had been calibrated in advance and were checked regularly during the measurement campaign.

The thyroid measurement campaign took place on Monday September 1st and Tuesday, September 2nd 2008 in the village of Lambusart close to Fleurus. More than 1000 people were measured, including all children from the local schools. No thyroid contamination was detected.
This paper elaborates on the preparation of this measurement campaign and the practical execution. It draws important lessons for the preparedness for similar situations in the future, both with respect to public information and technical and organisational aspects.

Introduction

During a radiological or nuclear emergency, it is of utmost importance to maintain (or establish) public thrust in the authorities for a good implementation of countermeasures and to prevent ill-based panic.

On August 22, 2008, a cloud of ^{131}I was released from the Institut des Radioelements (IRE), a producer of medical isotopes located in Fleurus, Belgium. The peak of the release took place in the weekend of 23-24 August and was followed by a smaller, continuous release which lasted for several weeks.

After reports of the incident in the press, concern grew among the local population about possible health effects caused by this release of radioactivity.

As a consequence the Belgian public health authorities decided to organise a thyroid measurement campaign for the local public to reassure the public that no detectable dose was acquired in the thyroid. Especially small children and pregnant women, the most sensitive group, were envisaged.

The Belgian Nuclear Research Centre SCK•CEN and the University of Liège were asked to execute the technical part of the thyroid measurement campaign. SCK•CEN provided 4 out of 5 measurement teams, each one equipped with a high-purity germanium detector and the necessary hardware and software. The University of Liège provided another team with a NaI detector and associated hardware and software.

Description of the measurement campaign

Goal (technical and societal)

The technical goal of the measurements was to measure at least a ^{131}I contamination in the thyroid that would result in an effective dose of 2 mSv for a child.

Based on the assumption that the intake of ^{131}I took place via inhalation, Absorption Type F, the predicted values for activity in the thyroid per inhalated activity [ICRP 78] and the ICRP dose conversion factor for ^{131}I in the thyroid (inhalation, AMAD 1 μm, Absorption Type F [ICRP 71]) a measurement time of 1 minute was derived in order to be able to measure a 2 mSv thyroid equivalent dose for a child, equivalent to a 100 Bq activity in the thyroid 8 days after the major release.

An analysis of the measured gamma-spectra after the measurement campaign revealed that the obtained detection limits were in the range of 20-90 Bq. The observed variation is due to differences in the detectors, mainly the efficiency.
The maximum detection limit of 2 mSv is well below the Belgian intervention level of 10 mSv thyroid equivalent dose for children and pregnant women.

Based on the known release of ^{131}I, it was considered as extremely unlikely that a measurable contamination could have occurred. However, in view of the concern among the local population, it was decided by the authorities to organise this measurement campaign in order to reassure the public. The campaign focussed on children, but adults that desired to be checked were given the opportunity to be measured after the children were measured.

Used equipment

Four detectors were used:
– 1 LEGe detector with electronics and Genie2000 analysis software
– 1 MAC Ge detector with electronics and Genie2000 analysis software
– 2 Ge detectors with ISOCS efficiency calibration.

The acquisition, analysis and calculation of the detection limits was done with Genie2000 (Canberra) software. Detection limits were calculated with the Currie method. The detection limit is stated as the smallest net signal that can reliably be quantified. It can be calculated for the radionuclides not found in the spectrum, as well as for those that have been found. Under ideal laboratory conditions (low background, long measurement time), a detection limit as low as 1 Bq can be achieved, but this was not the case for this measurement campaign as explained below.

Calibration was performed with a ^{133}Ba source in a thyroid neck phantom as shown in figure 1. The measurement setup of the University of Liège was also checked with this calibration phantom for consistency of the measurement results.

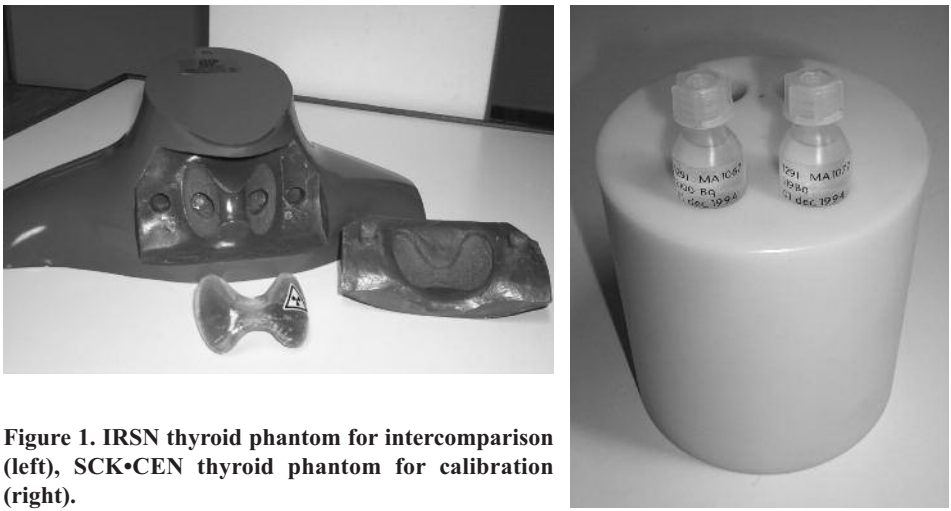

Figure 1. IRSN thyroid phantom for intercomparison (left), SCK•CEN thyroid phantom for calibration (right).

Practical execution of the measurements

The 4 detectors were placed in two changing rooms of the sports hall *'Salle Omnisport*' of the village of Lambusart, close to Fleurus. This village is located in the main wind direction of the release. The setup for the measurements consisted of placing the person with his/her thyroid gland (located just under the Adam's apple in the neck) in front of the detector at 2-5 cm distance (figure 2). A measurement was then started for 1 minute during which the person had to stay as still as possible. The measurement is based on the detection of the 364.5 keV gamma peak of ^{131}I.

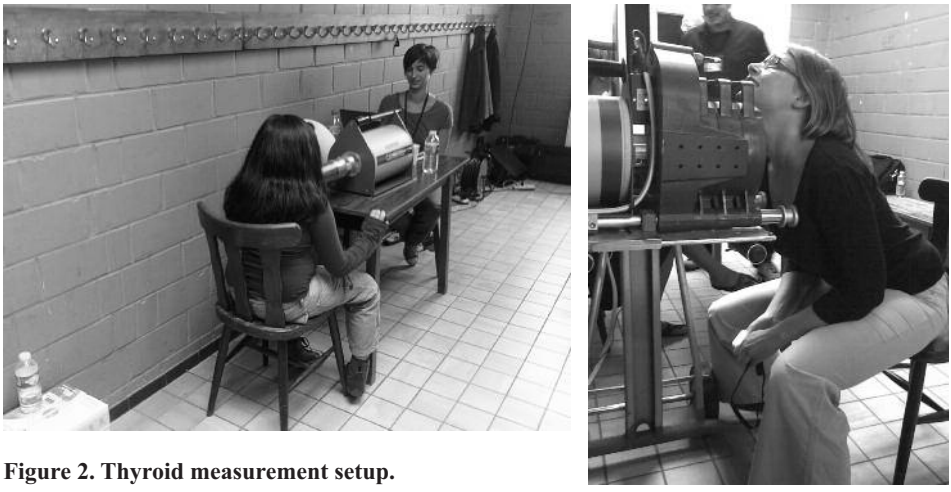

Figure 2. Thyroid measurement setup.

After the gammaspectrum is acquired, the analysis is done immediately and indicates if any activity of ^{131}I was detected in the thyroid. No activity detected means that with a confidence of 95%, the activity in the thyroid is lower than the calculated detection limit.

Measuring in an unshielded room and reducing the measurement time to 1 minute increased the detection limits considerably compared to the above-mentioned ideal laboratory conditions. The use of different detectors and the varying background activity in the environment resulted in detection limits ranging from 20 to 90 Bq for the detection of ^{131}I..

The result of the measurement was immediately communicated to the person involved and it was indicated on the result sheet with an identification number. 'SCK•CEN' was written on the results sheets of persons measured by any setup of SCK•CEN. When no activity was detected, a result of 'risque nul' (zero risk) was indicated on the result sheet of the measured person. This was done on demand of the responsible from Public Health although scientifically we could not state the activity was zero.

Target group

The authorities decided to focus first on the most vulnerable group, children and pregnant women. All children from the schools in the vicinity of Lambusart were transported to the sports hall to be measured, while also all pregnant women were requested to come to the measurement location.

After these groups had been measured, the other members of the local public could come and let themselves be measured.

SCK•CEN performed 876 recorded measurements, all with a negative result. Additionally about 200 persons were monitored with equally negative results, but without recording the results in writing. This was done at their explicit request.

Chronology

On Friday August 29th the public health authorities asked the SCK•CEN representative at the federal crisis centre whether SCK•CEN would be capable to organise a thyroid measurement campaign for the local population of Lambusart, with an estimated 3000 inhabitants. The same

date SCK•CEN wrote a note that stated that such a campaign would be possible.

On Saturday August 30th SCK•CEN received an order of the Ministry of Public Health to provide measurement teams for the thyroid measurement campaign. The same day the relevant experts were contacted to prepare this campaign.

On Sunday August 31st two available measurement chains were prepared. Soon it was realised that these two setups would not be sufficient to measure 3000 people and it was decided to include the two additional ISOCS systems to have four systems available. The complete team was assembled, consisting of 4 measurement teams with one operator and one guide, an expert in electronics, a team leader and a radiological expert for informing people.

Monday September 1st at 5:45 a.m. arrival of the team at SCK•CEN for the last preparations. Departure to Lambusart at 6:30 a.m.for arrival at Lambusart at 8:30 a.m.. Set up of equipment took 1 hour and final briefing of the teams at 9:30 a.m. Start of the measurements at 10:00 a.m. From 10:00 a.m till 01:00 p.m. measurement of limited numbers of children and pregnant women. After 13:00 all inhabitants could come and have themselves measured. Between 16:00 and 19:30 there was a peak, resulting in relatively long queues. After 20:00 the campaign was finished. Several team members had to stay for an information session for the local population from 21:00 till 23:00. After this session the public health authorities decided to extend the measurement campaign at the next day. Departure at 24:00.

Tuesday September 2nd, two measurement teams were sent instead of four. Measurement campaign was executed from 16:00 till 20:00. The team consisted of two measurement teams of two persons, a team leader, a radiological expert and a communication expert. No electronics expert was present, but a third Ge detector was present in case replacement is necessary.

Interactions with/reactions of the public

Most members of the public did not ask more information. However, when an initiative was taken to provide them with more information, the majority reacted positively and asked for more information. A considerable minority

considered the campaign as a cover-up of the authorities, but nevertheless accepted a measurement.
The minority that asked more information on its own initiative was concerned whether the measurements itself could harm them and wanted to know more about the health effects of ^{131}I. Less questions were asked about how the measurements were performed and how reliable the measurements were.
Performing measurements on small children is a trick on its own. The size of the Ge detectors was rather impressive for the youngest (0-5 years) and required distractors like laboratory gloves blown as balloons. For that group, the NaI detector of the University of Liège was less frightening since its size was much smaller, but its efficiency was also lower.
An additional disadvantage was that September 1st is the first schoolday, so most teachers were not yet acquainted with the children and had not yet established a bond of trust.
The vast majority considered SCK•CEN and the University of Liège as impartial and therefore trusted the quality and outcome of the measurements. This would not have been the case if IRE, which caused the release, would have carried out the measurements.
The vast majority of the team on the first day consisted of native Dutch-speaking people, with one exception. Although many of them spoke reasonably well French, communication with the French-speaking population led sometimes to misunderstandings, certainly when it concerned children. It was decided for the second day to compose teams with a better French-speaking ability.

Possible improvements

It has to be admitted that the existing measurement equipment just had been calibrated for thyroid measurements, rather as a coincidence. Actions are ongoing now to extend calibrations for a range of isotopes (^{131}I, ^{137}Cs, ^{60}Co, ^{235}U and ^{238}U) and contamination types (thyroid, whole body, lungs).
There was a clear demand of the general public to be informed, but the initiative should come from the experts. The public is reluctant to ask experts about their expertise, but is eager to listen and learn when something is explained. Therefore communication to the public should be part of the overall strategy, explaining first of all of the health effects of radiation and secondly of the principles of the measurement method.

To establish and maintain experience in these kind of campaigns, regular exercises should be undertaken as part of the overall emergency planning exercises. The different types of measurements (thyroid, Whole Body Counting, lungs) should be trained to understand the specific problems that occur in practice.

Conclusions

During a measurement campaign, the public needs to be informed actively, since the majority will not ask information, but is nevertheless interested when more information is provided. The information given should focus first on the health effects of radiation and secondly on the radiation measurement principles.

Very young children (age 0-5 years) should be measured in a reassuring environment. Toys, ballons and lively colours will distract their attention from the impressive measurement equipment.

Measurements should be executed by institutes that are not related with the institute responsible for the radiological problem and that are considered by the general public as independent and impartial.

Calibrations of existing measurement equipment for specific cases are time-consuming and cannot be performed in times of crisis. These calibrations should be performed for all different types well beforehand and should be checked by intercomparison exercises.

To maintain the operationality of the measurement teams, exercises should regularly be organised to test also the aspect of measuring large number of people.

In a multilingual country measurement teams should be partly composed of native speakers of the local language to provide a clear communication with them.

References

[ICRP 78] International Commission on Radiological Protection. Individual Monitoring for Internal Exposure of Workers. ICRP Publication 78, Volume 27/3-4, 1999

[ICRP 71] International Commission on Radiological Protection. Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 4 Inhalation Dose Coefficients. ICRP Publication 71, Volume 25/3, 1996