კლინიკური შემთხვევა

TWENTY–FIVE YEARS AFTER LILO RADIOLOGICAL ACCIDENT: OVERVIEW AND FOLLOW-UP (1997-2022)

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Resume

In 1996-1997, a radiological accident occurred in the territory of the training center of the former Soviet troops in Lilo, a suburb of Tbilisi, Georgia, as a result of which 11 military personnel received acute radiation trauma. Today, this incident is known as "The Radiological Accident in Lilo". We are conducting extended monitoring and treatment of the victims of this accident. It should be noted that such long-term observation is very rare around the world, and the patients affected by the radiological accident in Lilo are still under the attention of experts of the World Health Organization and the International Atomic Energy Agency, as well as foreign colleagues (France, Germany, Russia). The paper presents the prolonged observation of two victims (1AN II and 3CG II), the complications identified during this period, and the results of their treatment.

Key words: The Lilo Radiological Accident, local radiation injury

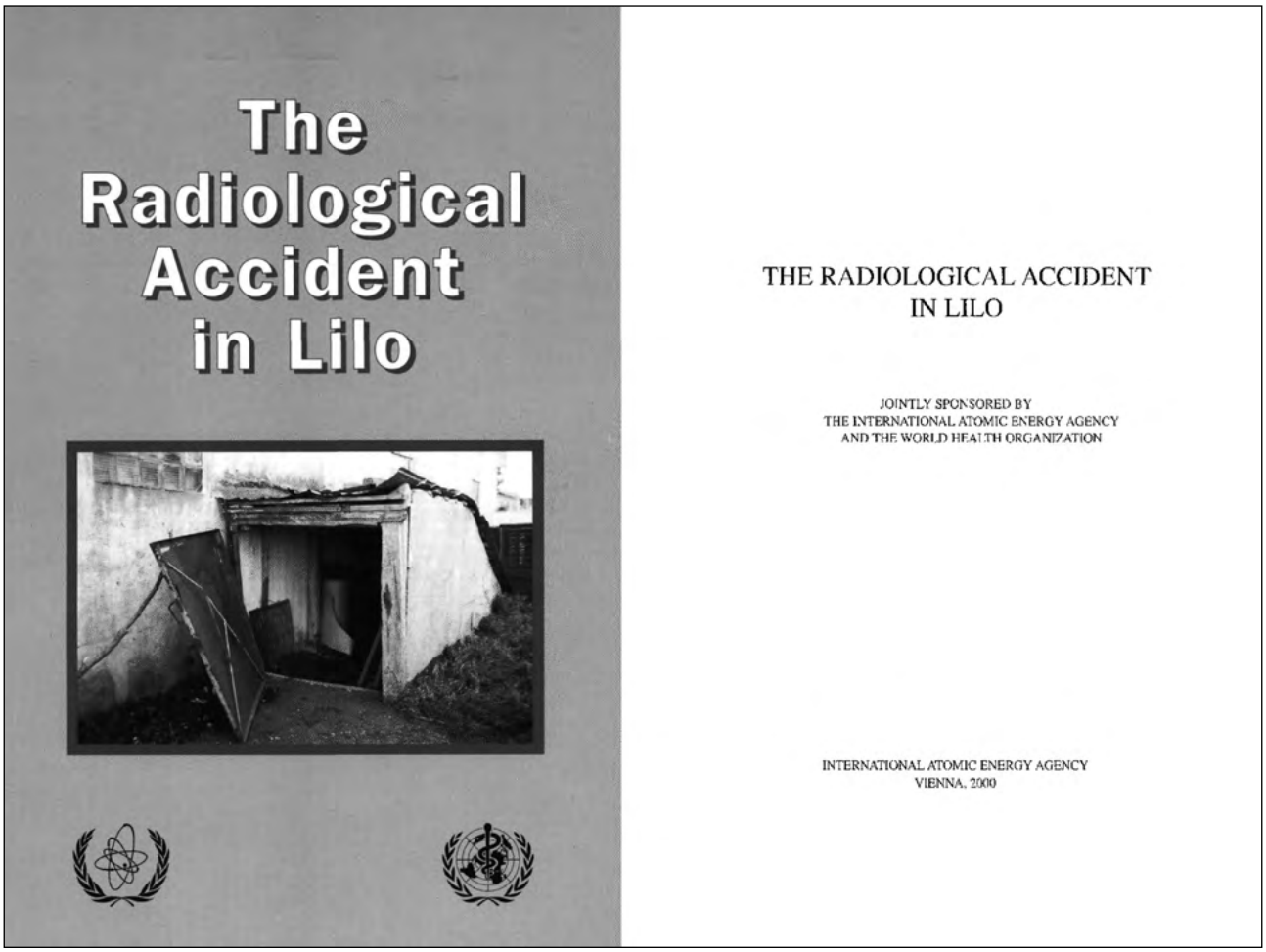

Figure 1. In 2000, Jointly sponsored by the International Atomic Energy Agency and the World Health Organization, a monograph dedicated to this accident "The Radiological Accident in Lilo" was published [1].

Figure 2. Places of Radiological Accidentsin Georgia

LOCATION OF THE ACCIDENT

The accident took place in Lilo, a small Georgian town located near Tbilisi (fig. 2). Before 1992, a training camp of the Soviet Army was installed in the town. In 1992, the camp was transferred to the Georgian Army, and then used for the training of Georgian frontier troops.

CHRONOLOGY OF THE ACCIDENTAL EXPOSURE

For unknown reasons, several radioactive sources were left in the camp by the Soviet Army, most of them apparently in their protection containers. However, no information was given to the Georgian soldiers by the Soviet Army about those sources.

The radioactive sources were subsequently found by Georgian soldiers (totally unaware of their nature) and were responsible for the severe lesions listed below.

It should be noted that the very precise circumstances of the accidental exposures were extremely difficult (and often impossible) to reconstruct, either because the soldiers did not realize at all the dangers of the small pieces of metal that they found, or because they were extremely reluctant to speak about it, with some feeling of being "guilty" of having manipulated such material. Even the patients with very severe hand lesions never recognized that they handled something resembling the sources...

The first event was noted in July 1996 (fig. 3), when a young Georgian recruit exhibited fever, together with atypical lesions of both hands, of the abdomen and of the left thigh. At that time, the precise diagnosis was almost impossible, and the patient was treated for "serum disease".

In March 1997, five other soldiers exhibited nausea, vomiting, associated with multiple skin lesions, some of them necrotic. The patients were at that time treated for a "polyform exudative erythema".

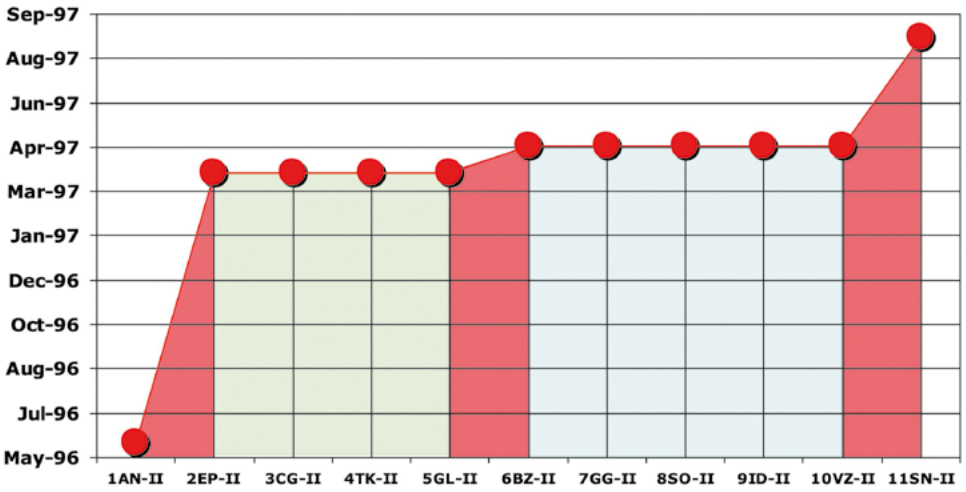

Figure 3. Periods of Radiological Injuries Manifestation in 11 Patients

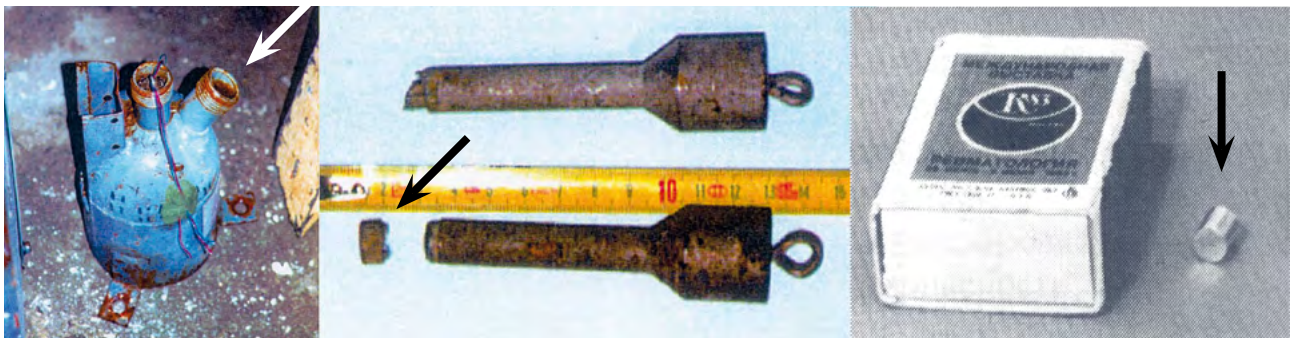

Figure 4. Radioactive Sources, September 11, 1997; a, b - container of sources; fizical size of sources. Images from Institute Curie Report (1997)

In May-June 1997, five other soldiers presented with various skin ulcerations.

Conditional Period of Soldiers' Overexposure from June 1996 - Injury Manifestation of First Patient (1AN-II) to May 1997 (End of Soldiers' Service in Lilo Training Centre) (Fig. 3).

The diagnosis of radiation injuries was only suspected in August 1997.

The first radiation hot spot, which is shown on this slide, was detected on August, 1997, near the underground shelter. On September, 1997, a Cesium source, with an activity of 164 GBq, was removed from the pocket of a soldier's winter jacket (fig. 4 - a, b, c). Since this jacket was also used as a blanket by several soldiers, this source was probably responsible for the lesions presented by most of the victims.

There were eleven victims. Mean total body doses (France and Germany) and by Electron Spin Resonance (ESR) obtained from the study of tooth enamel or of bone pieces (in case of finger amputation) in Russia. The doses are represented in the table (Table 1).

Patient	Cytogenetic (corrected)	ESR
1 AN	4.2	No data
2 EP	5.9	4.5
3 CG	1.5	1.4
4 TK	1.1	1.5
5 GL	0.2	No data
6 BZ	0.6	0.7
7 GG	1.1	1.3
8 SO	0.7	0.1
9 ID	4.1	0.4
10 VZ	0.2	No data
11 SN	0.6	0.1

Table 1. Comparison of cytogenetic analyses and Electron Spin Resonance (ESR) Individual (total body) doses in Gy

Considering the necrotic lesions, the local doses probably exceeded 25 Gy. Here are some examples of injury localization and types of local radiation injuries that developed after a Lilo Radiological Accident (see fig. 5, 6, 7, 8, 9,10, 11).

THE TYPES OF LRI INITIAL PERIOD

Initial Management of Patients in the French Armed Forces Percy Hospital, Clamart, France

Patient 3CG-II and 4TK also arrived on the 22 October, 1997 in France.

To our knowledge, these two patients were the first ones with radionecrosis who benefited from a three-step graft technique which was initially developed for the treatment of severe deep thermal burns. After complete removal of the radionecrotic tissues, the three steps were as follows:

Step 1: Porcine skin xenograft;

Step 2: Xenograft was replaced by a synthetic dermal matrix (INTEGRA);

Step 3: The matrix, colonized by the fibroblasts of the patient himself, was covered by a thin skin autograft.

With satisfactory evolution, the two patients could return to Georgia at the beginning of 1998.

Initial Management of the Patients at the Federal Armed Forces Hospital, Ulm, Germany

The seven other patients (5 to 11) arrived in Germany on the 29 October, 1997.

They all benefited from more or less sophisticated surgical procedures adapted to their lesions.

With satisfactory evolution after surgery, all patients but one could return to Georgia after about two months of hospitalization (end of 1997).

For one patient (Patient 6BZ), the German specialists had to face difficult problems, with radiation-induced synovitis of the right knee and associated complications. Four surgical interventions were necessary for this patient between October 1997 and April 1998.

He could only be released in June, 1998 and returned to Georgia.

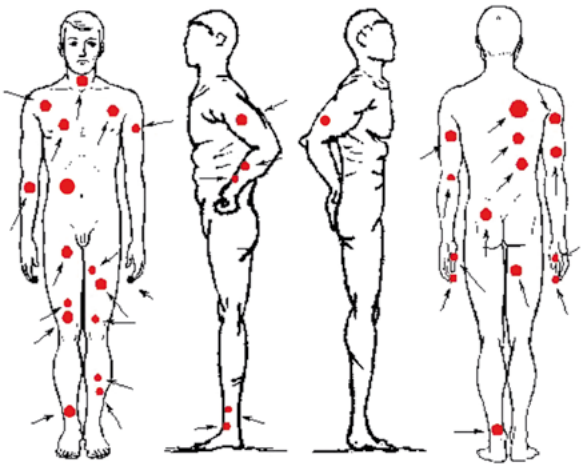

Figure 5. Examples of Localization of LRI. Patient 2EP-II, 35 LRI

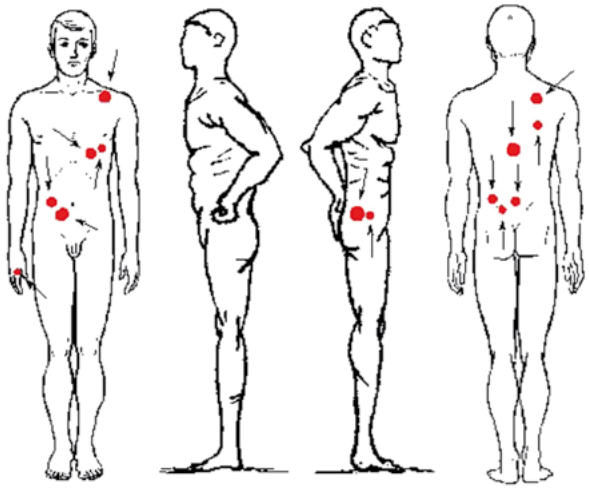

Figure 6. Examples of Localization of LRI. Patient 9ID-II, 15 LRI

Figure 7. Types of LRI. Patient 1AN-II

Figure 8. Types of LRI. Patient 3CG-II

Figure 9. Types of LRI. Patient 5GL-II

Figure 10. Types of LRI. Patient 4TK-II

Figure 11. Types of LRI. Patient 6BZ-II

Management of Patients in Obninsk, Russia

In 1998-1999 five patients benefited from surgical treatment in Obninsk, Russia. With satisfactory results after surgery.

FOLLOW-UP

Patient 1AN-II follow-up

I would like to inform you that there was no contact with this patient for a long time.

In August, 2017 the patient complained of pain in the left femoral area and existence of purulent fistula to me (fig.12).

As it appeared in 1998 was performed osteosynthesis by using of intramedullary stem due to pathological fracture. Exactly this stem and fixation screws were the cause

of the present osteomyelitis. Preliminary examinations were made, flora was estimated and antibacterial therapy was started (fig 13).

In February, 2018 surgery was performed: extraction of intramedullar construction. Sanation and drainage of osteomyelitis ("New Hospitals", Tbilisi, Georgia). The result was positive (fig. 14).

This foto shows the condition of hand injuries (fig. 15).

In the right femoral and the left shoulder areas the patient was noted to have relatively new areas of radial fibrosis (fig 16, 17).

Patient 3CG-II-II follow-up

LRI was localized in the middle third on the front lateral surface of the right femur and on the right hand.

Management of Patients in the French Armed Forces Percy Hospital, Clamart, France.

Patient 3CG-II. The patient had to be rehospitalized in Tbilisi (Georgia) in September 1998, for amputation of fingers DI and DIII of the right hand.

Progressive flexion deformity, atrophy and radiation fibrosis of the distal phalanges of the right palm's II finger. Fibrosis with teleangiectasis, dysfunction, painfulness and

Figure 12. Patient 1AN-II. Left femoral area and existence of purulent fistula

Figure 13. Patient 1AN-II. The stem and fixation screws were the cause of osteomyelitis

Figure 14. Patient 1AN-II. Extraction of intramedullar construction. Sanation and drainage of osteomyelitis. The result was positive

Figure 15. Patient 1AN-II. condition of hand injuries

Figure 16. Patient 1AN-II. In the right femoral area, the patient was noted to have a relatively new area of radial fibrosis

Figure 17. Patient 1AN-II. In the left shoulder area, the patient was noted to have a relatively new area of radial fibrosis

edema (periodically) are expressed on the medial surface of right palm's IV finger and on the medial and lateral sites of the left III-IV fingers' palmar surfaces (fig. 18 a, b, c, d, f, g).

In 2007 his right palm's II finger was amputated (fig. 18 e).

In 2001 hepatitis C was diagnosed. He has been periodically treated in the hospital of infectious disease, Tbilisi.

In 2015, the general and skin conditions are not satisfactory. The patient complains of weakness, nausea, dyspepsia and depression. Asthenospermia was diagnosed.

Here I represent condition of patient's injured areas in 2000, 2008, 2012, 2015, 2016, 2017, 2018, 2019, 2022 (fig. 19-30).

On the fourteenth of March 2016, the Assistance Mission Team evaluated the patient.

1. Clinical observation:

a. Patient 3CG-II-II, 39 years old, has no functional impairment to walk and no spontaneous pain;

b. The current size of the lesion has reduced compared with the size as presented in Picture 1, the healing is uncompleted after local ointments treatment applied in the last four months. A new spot lesion appeared at the proximal part of the lesion;

c. The inflammatory area is limited around these two lesions;

d. At the medical examination: the palpation of the right thigh, around the lesion, induces pain; the soft tissues covering the femoral bone are thin;

e. The rest of the thigh is normal at the examination;

f. There is an evident psychological impact after the Lilo (1997) radiological accident and the patient displays

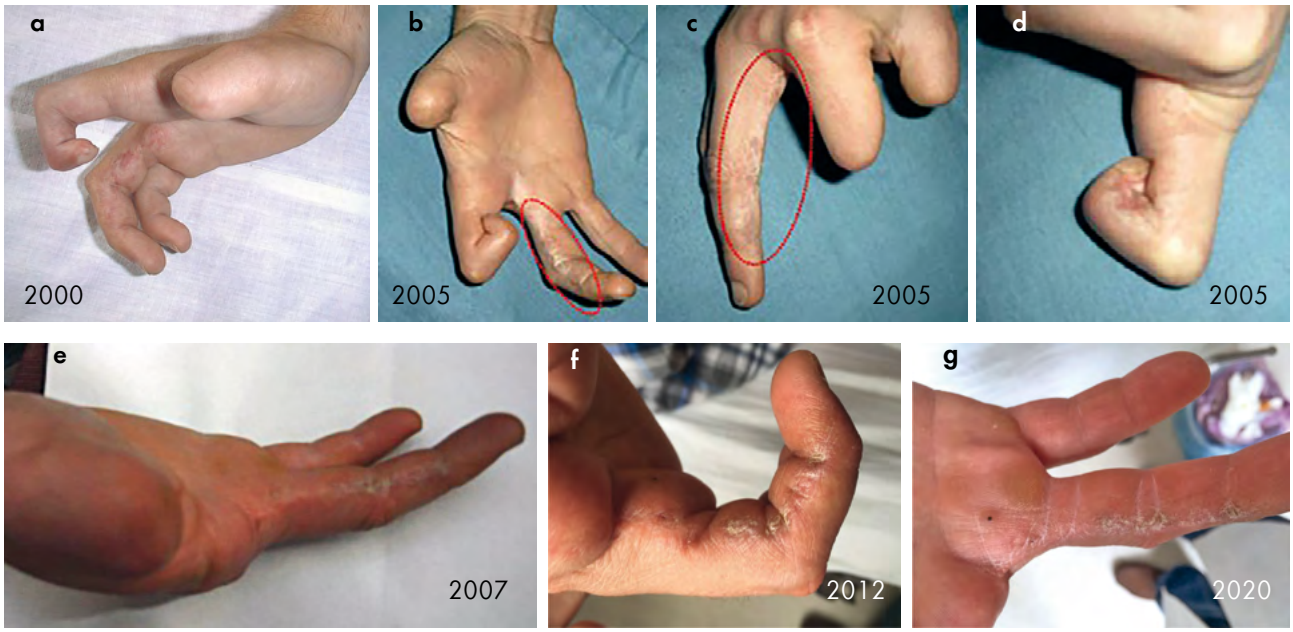

Figure 18. Types of LRI. Patient 3CG-II - dynamics of hand cluster local radiation injuries by years.

Figure 19. Patient 3CG-II. Initial lesion - 27.10.1997

Figure 20. Patient 3CG-II. Artificial Dermis - 05.11.1997

Figure 21. Patient 3CG-II. Meshed Skin Autograft - 21.11.1997

Figure 22. Patient 3CG-II. Final Aspect – 1998, Jul

Figure 23. Patient 3CG-II. LRI condition as of March, 2000

Figure 24. Patient 3CG-II. LRI condition as of March, 2008

Figure 25. Patient 3CG-II. LRI condition as of May, 2012

Figure 26. Patient 3CG-II. LRI condition as of February, 2015

Figure 27. Patient 3CG-II.
LRI condition as of May, 2016

Figure 28. Patient 3CG-II.
LRI condition as of March, 2018

Figure 29. Patient 3CG-II.
LRI condition as of February, 2019

Figure 30. Patient 3CG-II. Artificial Dermis - 05.11.1997

depression tendency. The patient is unemployed for several years. Additionally, he presents the following comorbidities: hepatitis C which was cured several years ago after interferon treatment and a strong tobacco addiction (1 or 2 boxes of cigarettes per day since more than 20 years).

2. Imaging observation: The Magnetic Resonance Imaging (MRI), dated 11 November 2015, showed an inflammatory process in the soft tissues contiguous with the right femoral bone.

3. Anatomo-pathological observation: performed 3 biopsies of the lesion, 4 months ago, which confirmed the absence of malignancy processes.

November, 2017, the ulcer area reduced, though appeared a new small area, inflammation degree reduced around.

In connection with the ongoing processes in the area of local radiation injury, in May 2019, the patient underwent a surgical operation in France - excision of the ulcerated defect within healthy tissues and covering the defect with a rotational flap on the vascular pedicle. The postoperative period is satisfactory. The surgical wound healed by primary intention.

ntroducing the state of the affected area as of March 2022 (fig. 30).

LESSONS TO BE DRAWN

After the initial treatment in France and Germany, the eleven patients could reasonably be considered cured, or at least consolidated. Subsequent careful follow-up did not confirm, unfortunately, this optimistic prognosis.

Overall, seven patients, among eleven, had to be re-hospitalized (sometimes several times) for complementary treatment(s). This was linked either to the recurrence of radionecrosis in a previously treated area, or to the emergence, or reopening, of radionecrotic lesions in areas not previously treated in France and Germany (most often at the level of primary lesions which initially spontaneously healed).

Consequently, the main lessons to be drawn from this accident are:

Satisfactory initial surgery did not prevent in all cases some secondary (often localized) radionecrotic ulcerations to occur several months, or even years, later.

Skin lesions which spontaneously healed and appeared stable at the initial examination can deteriorate, with secondary reopening, a long time (months-years) thereafter.

Moreover, a number of sequelae were responsible for a severe impairment of the quality of life of these patients; functional sequelae (finger amputations...) for some of them, cosmetic sequelae for almost all patients, oligo or azoospermia in all cases, and various understandable psychosomatic symptoms and nervous breakdowns.

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25 წელი ლილოს რადიოლოგიური ინციდენტიდან: მიმოხილვა და გახანგრძლივებული დაკვირვების შედეგები

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რეზიუმე 1996-1997 წლებში საქართველოში, თბილისის გარეუბანში - ლილოში, ყოფილი საბჭოთა ჯარების სასწავლო ცენტრის ტერიტორიაზე განვითარდა რადიოლოგიური ინციდენტი, რომლის შედეგად აცმწვავე სხივური ტრავმა მიიღო 11 სამხედრო მოსამსახურემ. დღეს ეს ინციდენტი ცნობილია, როგორც "ლილოს რადიოლოგიური ინციდენტი". ჩვენ ვახორციელებთ ამ ინციდენტის დროს დაზარალებულთა გახანგრძლივებულ მონიტორინგს და მკურნალობას. აღსანიშნავია, რომ მსგავსი გახანგრძლივებული დაკვირვება ძალზე დიდი იშვიათობაა მთელს მსოფლიოში და ლილოს რადიოლოგიური ინციდენტის დროს დაზარალებული პაციენტები დღემდე იმყოფებიან ჯანდაცვის მსოფლიო ორგანიზაციის და ატომური ენერგიის საერთაშორისო სააგენტოს ექსპერტების, უცხოელი კოლეგების (საფრანგეთი, გერმანია, რუსეთი) ყურადღების ქვეშ. ნაშრომში წარმოდგენილია ორი დაზარალებულის (1AN II და 3CG II) გახანგრძლივებული დაკვირვება, ამ პერიოდში გამოვლენილი გართულებები და მათი მკურნალობის შედეგები.

საკვანძო სიტყვები: ლილოს რადიოლოგიური ინციდენტი, ლოკალური სხივური დაზიანება