

Simulation Modeling and Research of the Functional Capabilities of the Medical Special Task Unit in Case of an Accident at a Radiation Hazardous Facility

Andrey A. Tarasiev Ural Federal University Yekaterinburg, Russian Federation andrew4800@mail.ru	Alexey A. Sheklein Ural Federal University Yekaterinburg, Russian Federation alexbrain@bk.ru	Konstantin A. Aksyonov Ural Federal University Yekaterinburg, Russian Federation wiper99@mail.ru	Igor F. Savchenko Military-medical Academy St. Petersburg, Russian Federation	Maxim L. Chuvashov Military-medical Academy St. Petersburg, Russian Federation
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Abstract

The purpose of this work is to study the existing approaches to the evacuation of the affected accident at a radiation hazardous facility, the search for shortcomings and limitations in the existing organization of the work of the special task force. In the process of work: the stages of evacuation of the injured accident at a radiation hazardous facility were investigated, the analysis of limitations and possibilities for the operation of a special purpose medical unit was carried out. As a result of the research, an imitation model was created, modeling results were analyzed, based on the simulation results, an assessment was made of the work at each stage of the special medical unit, the required number of hospital beds at the points on the evacuation path was calculated, the analysis of alternative variants of medical- evacuation measures.

1 Introduction

Experience in eliminating emergency situations at a radiation-hazardous facility, how to organize and provide assistance primarily with the help of medical and preventive institutions, as close as possible to the locations of the location of potentially hazardous facilities. In all cases of the accident, irrespective of the size of the sanitary losses, the administration of the affected facility and the senior health officials take measures to call the medical strengthening team from the disaster medicine center. This reinforcement group organizes and carries out sorting of the affected and provision of urgent qualified medical care.

As a result, the main groups of people are selected, waiting for referral in medical institutions with the definition of priority. The primary link in the emergency medical service is the so-called rapid reaction teams.

The main task of the brigades is to provide emergency medical assistance to the affected and to hospitalize them in specialized local, regional or central medical institutions.

"Protection", which decides the decisions assigned to it through regional centers, rapid response teams and outreach autonomous, a hospital on pneumoframe modules.

2 Organization of a special medical unit

In the hearth of the lesion immediately after the emergence of the accident is the first and first medical aid to the injured medical personnel of the emergency facility and the ambulance brigades arriving in the first 1-2 hours.

The main task in this period is the withdrawal (removal) of the victims from the accident zone, the necessary sanitation, placement depending on the conditions in the medical unit or other premises and the provision of first medical assistance [1].

In case of radiation accidents, the brigades include:

- Radiologist - 2 people;
- Hematologist-laboratory assistant - 1 person;
- Physicist-dosimetrist - 2 people;
- Hygienist-hematologist - 1 person.

The process of evacuation and assistance to the victims can be broken down into the following stages:

- Collection of victims in the sorting post, sorting of victims by groups;
- Sorting platform (area) - here is sorting according to the severity of the condition of the affected;
- Department of special treatment for sanitary treatment of groups that received radiation damage;
- Surgery and intensive care units;
- Hospital department;
- Evacuation area.

The autonomous hospital is completed as follows:

In the operating room are:

- Surgeon - 2 people;
- Anesthesiologist - 1 person;
- Surgical nurse - 2 people;
- Sister-anesthetist 1 person;
- Sanitary - 1 person.

These specialists work at one surgical table. The hospital department is completed by physicians of therapeutic specialties (therapist, neurologist, dermatovenerologist, infectious disease specialist), as well as middle (nurses) and junior (nurses) personnel.

Transportation by hospital is carried out using stretchers. Evacuation from the hospital is carried out with the help of air transport.

3 Formulation of the problem

To study the internal work of the detachment, the following test data was taken, describing the work of the detachment in the event of an accident at a radiation hazardous object.

During the accident, 600 people were injured. At the same time, 134 of them diagnosed radiation sickness (RS) among them.

The structure of RS severity was as follows:

- Lightweight - 31%,
- Average - 37%,
- Heavy and extremely heavy - 16% each.

The combination of thermal explosion factors and radiation factors leads to the following groups of victims forming on the sorting post:

Gr1 – with isolated radiation lesions (radiation sickness) 20% of all received;

Gr2 – with combined radiation-mechanical lesions (radiation sickness and mechanical trauma) 20% of all received;

Gr3 – with combined radiation-thermal lesions (radiation sickness and burns, both thermal and radiation burns due to β -irradiation, as well as their combinations) 20% of all received;

Gr4 – with isolated mechanical trauma 20% of all received;

Gr5 – with somatic pathology (patients) 20% of all received.

The last 2 groups are those who have avoided radiation damage (Table 1).

Table 1. The structure of the incoming flow by category from the total

Degrees of severity	Gr1	Gr 2	Gr 3	Gr 4	Gr 5	Total by group
	20%	20%	20%	20%	20%	
Lightweight	4%	4%	5%	8%	10%	31%
Average	7%	8%	8%	6%	8%	37%
Heavy	4%	4%	3%	4%	1%	16%
Extremely heavy	5%	4%	4%	2%	1%	16%

Each of the groups has its own "trajectory" of passing functional units (Figure 1).

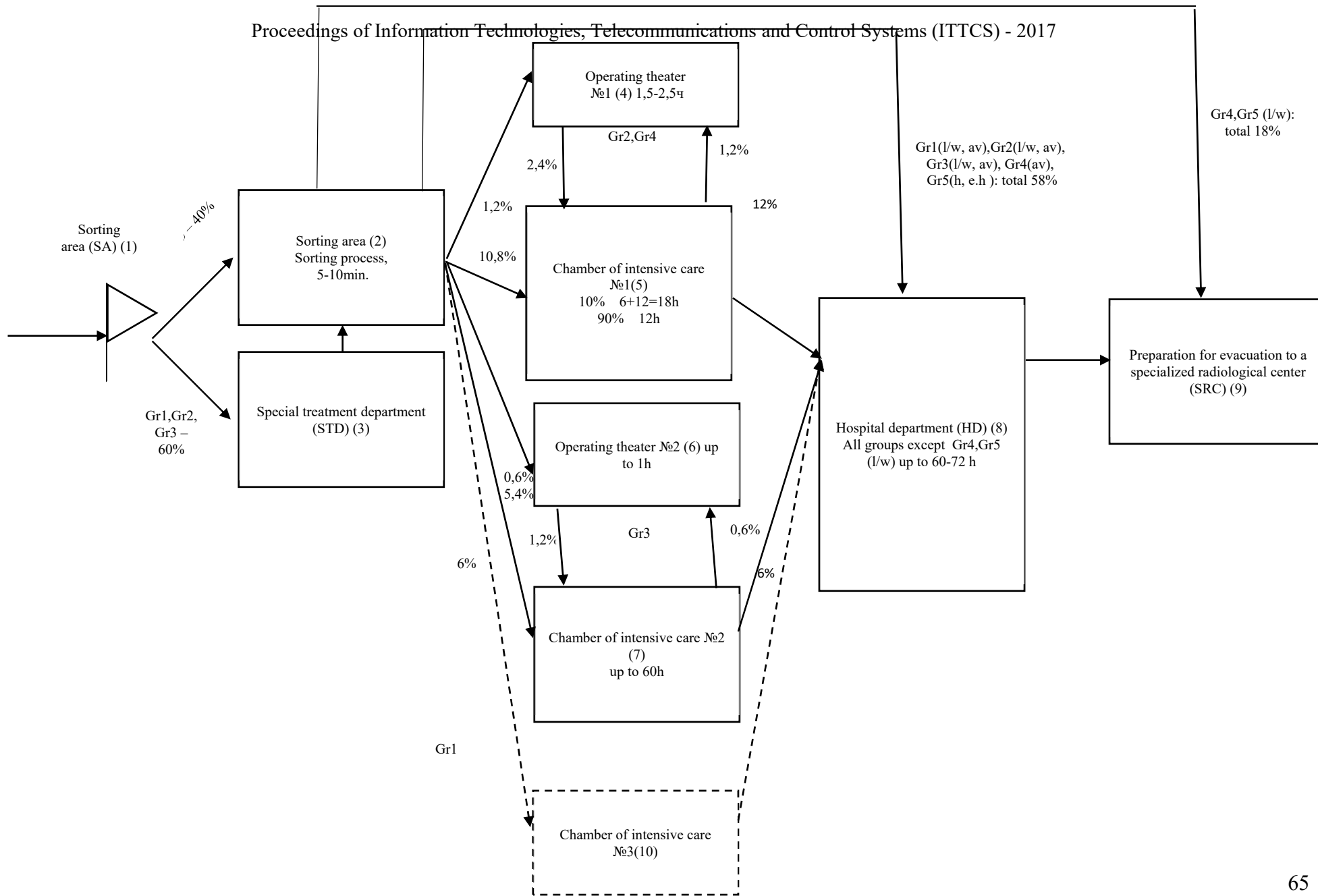


Figure 1. The trajectory of the passage

Priority in care is given to those affected with a heavier lesion. In view of the localization of the work of the detachment, all the movements between the stages are fleeting and are not taken into account in this model.

Groups 1-3 are sent in full to the sanitary treatment in the special treatment department (STD) from the sorting area (SA). The treatment time for light and moderate severity is 10 minutes, with up to 6 people being treated at the same time, and for severe and extremely severe (stretchers) - 25 minutes, while the victims are treated one at a time.

Then the groups are moved to the sorting platform. The time spent for sorting is 5-10 minutes. Persons with mild and moderate severity lesions are sent to the hospital department (HD), and then, after pre-examination and therapy, are prepared for evacuation to a specialized radiological center.

Individuals belonging to groups 2 and 4 with severe and extremely severe lesions are sent either to the operating room with a probability of 10% and / or to the intensive care unit with a 90% probability.

In total, about 20% of people need operative interventions of both groups, and half of them (10%) first pass through the intensive care unit № 1 on average for 6 hours (from 2 to 8 hours), then goes to the operating room on average for 1.5 hours (from 1 to 2.5 hours).

All the operated persons need to be in the intensive care unit number 1 on average up to 12 hours (from 6 to 24 hours). In the intensive care unit and intensive care can be at the same time up to 8 people affected.

Individuals who do not need operative interventions of both groups (severe and extremely severe Gr2, Gr4 - the remaining 80%) need to be in the intensive care unit number 1 on average up to 12 hours. After that they are sent through the hospital department for evacuation by air transport in helicopter or airborne resuscitation modules.

Persons belonging to groups 2 and 4, with mild and moderate severity of lesions, are sent from the sorting to the hospital department, where pre-examination, preparation for evacuation and further evacuation are carried out. The delay of these persons in civil defense is up to 2 days. Evacuation is carried out mainly by car sanitary transport

Persons of the third group with severe and extremely severe lesions are sent either to the operating room №2 and / or to the intensive care unit №2 separately from the second group.

The sequence of their passage is similar to the procedure for people with a severe and extremely difficult condition from the second and fourth groups. Then they are sent to the hospital department, where preparations are made for evacuation and evacuation.

Timing: for surgical interventions differ and make up to 1 hour. Resuscitative and anti-shock measures in the aggregate do not exceed 2.5 days.

The two intensive care and intensive care rooms are regular, the third ward for people of the first group with severe and extremely severe radiation lesions № 3 is additional (non-routine), deployed at the expense of the hospital department and dedicated anesthesiologists-resuscitators and appropriate separation units, or by strengthening the detachment a non-staff brigade of anesthesiology and resuscitation from the military hospital. Similarly, then they are sent to the hospital department, where preparations are made for evacuation and evacuation.

Persons belonging to the fifth group (except for the victims with mild severity) after the sorting are sent to the HD with subsequent evacuation.

There are 100 beds in the hospital department. Persons who get in here receive planned conservative (medical) treatment until the first practical possibility of evacuation - with evacuation facilities and the corresponding condition of the affected. The average length of stay must be such that the total time of stay of the struck in the detachment does not exceed three days. Otherwise, people with radiation injuries may experience early complications that need to be treated in a radiological hospital.

The presence in the hospital department of all categories of victims is 1-3 days.

The main task of the detachment during the period of three days is to provide primary medical and sanitary (medical and specialized) assistance. In other words, according to the classification of types of medical aid in time of war - to provide qualified medical care with specialized elements, since in the future these persons will require specialized, including high-tech medical assistance in stationary medical organizations of municipal, regional or federal subordination.

4 Imitation model

Simulation [5-6] and multi agent [7-8] approach are used for analysis medical unit. An imitation model of the squad's work in the simulation system BPsimMAS was created (Figure 2).

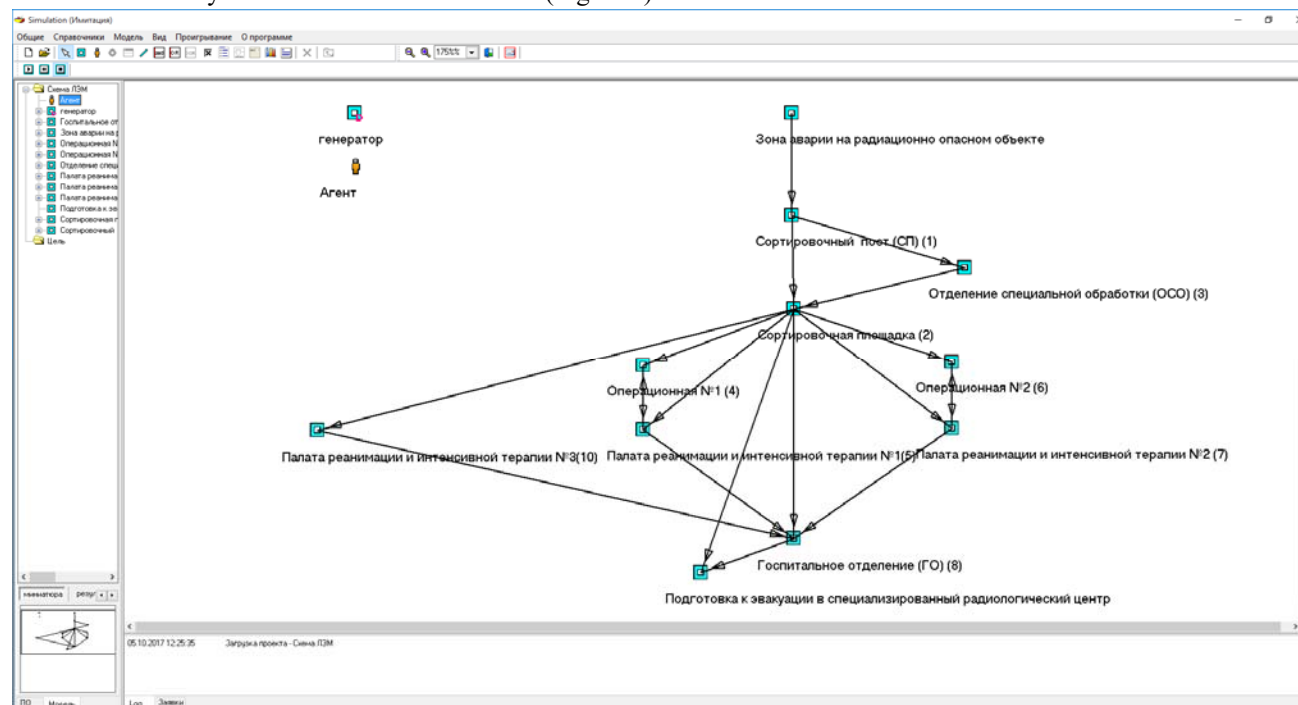


Figure 2. Simulation model of work of the detachment

The model consists of 11 processes through which the request z1 passes, describing the state of the victim at each stage. In this case, the following parameters are described at each stage:

- Group (Gr1,Gr2,Gr3,Gr4,Gr5);
- Degrees of severity (lightweight, average, heavy, extremely heavy);
- Waiting time on STD;
- Waiting time on sorting area;
- Waiting time for operation;
- Time spent in the intensive care unit;
- Time spent in the hospital department;
- Total time of the request in the system.

At the stages 1,2,5,7 and 8 there are 34 rules of the agent describing the decision-making process, responsible persons at the stages, etc. Also the resources and means used at these stages (hospital units (HU), surgeons, medical orderlies, other health workers of the detachment, etc.) are also described.

5 Conclusion

Based on the results of the simulation, the following conclusions were drawn:

As the number of arriving victims increases daily, the burden on staff at all stages increases. For example, when 50 victims arrived on the yard (2) on the first day, the minimum working time of the full number of orderlies is 4 hours and 15 minutes, and when the injured are injured on the third day, the maximum time for the nurses reaches 16 hours and 40 minutes. A similar picture is also observed in the stages 3, 7, 10.

The most critical effect is manifested in the intensive care unit №1 (5), when the maximum working time of the staff on the third day (with the arrival of 100 victims) is approaching 24 hours!

As a recommendation for solving this problem, it is necessary to increase the staff of the intensive care unit and intensive care, and to increase the number of hospital beds at least twice.

Since the finding of victims in the hospital department is planned for a period not exceeding two days, it is also necessary to increase the number of HUs by the number of victims entering the day.

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