Radiological accident "The Citadel" Medical aspects

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Abstract. The work exposes the medical actions carried out in the mitigation of the consequences of the accident and its main results.

In a facility of storage of radioactive waste in Caracas, Venezuela, it was happened a radiological accident. This event caused radioactive contamination of the environment, as well as the irradiation and radioactive contamination of at least 10 people involved in the fact, in its majority children. Cuban institutions participated in response to the accident. Among the decisions adopted by the team of combined work Cuban-Venezolan, we find the one of transferring affected people to Cuba, for their dosimetric and medical evaluation. Being designed a work strategy to develop the investigations to people affected by the radiological accident, in correspondence with the circumstances, magnitude and consequences of the accident.

The obtained main results are: 100% presented affectations in its health, not associate directly to the accident, although the accident influenced in its psychological state. In 3 of studied people they were detected radioactive contamination with Cesium -137 with dose among 2.01 X 10-4 Sv up to 2.78 X 10-4 Sv.

This accident demonstrated the necessity to have technical capacities to face these events and the importance of the international solidarity.

KEYWORDS: radiological emergency, radiological accidents.

1. Introduction

The use, transportation and storage of radioactive sources require of technical and organizational measures for to guarantee their security and to reduce their waterings. However in occasions they happen radiological accidental situations, associated to human errors, technical flaws or for interaction of both factors. These fortuitous events produce noxious effects on the environment and the human health. The mentioned reasons advise to have technical capacities to face them and to mitigate their consequences. (1)

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In September 2005 was happened a radiological accident, in a temporary facility of storage of radioactive waste, located in the well-known facilities as "The Citadel", belonging to the Parish Santa Rosalía 1 of the Municipality Libetador, in the Metropolitan District of Caracas, Republic Bolivarian of Venezuela.

The accident happens for the violation of the security of the facilities used for storage of radioactive sources in disuse of Cesium 137 This situation favored the theft, plows and manipulation of the radioactive sources of Cesium – 137This event caused radioactive contamination of the environment, as well as the irradiation and radioactive contamination of at least 10 people involved in the fact, in its majority children.

The firs response to mitigates the radiological accident were executed by the Venezuelan authorities and later on they had the support of Cuban institutions, in response to requested co-operation of Venezuelan authorities, for complementation of their technical capacities to respond to the radiological accident.

In correspondence with the application of the Venezuelan authorities, the Cuban authorities send 2 physicians with the purpose of valuing the existent situation. After the evaluation of the magnitude of the consequences on the health and identification the necessities of medical care for the affected people. The team work Cuban - Venezuelan opts to transfer the affected people to Cuba, for supplement their medical evaluation with technologies non available in Venezuela.(2)

This accident demonstrated the necessity to have technical capacities to face these events and the importance of the international solidarity.

2. Material and method

In the strategy of people's study affected by the radiological accident, one had in consideration the circumstance, magnitude and consequences of this event. The invetigación included medical, dosimetric and psychological - social aspects, in to such way that executed the following purposes:

- To detect pathologies on those affected for their diagnosis and treatment.
- To identify medical and nutritional affections, with possible influence on the vulnerability of the accident victims to the effects of the ionizing radiation's.
- To characterise psychological and socially to those affected for the adoption of measures of psychological support.
- To quantify the magnitude from the exposure to ionizing radiation's of those affected.
- General valuation the state of health and psychological - social characterization. of people affected by the accident.

The general evaluation of the health status and the psychological- social characterization included all the people affected by the accident, including children and adults.

All the people affected by the accident belongs to the masculine sex and its ages are observed in the Table 1.

Table 1: People affected distribution according to groups of ages.

10 – 14 ages		25 – 29 ages	
No	%	No	%
5	83	1	17

Medical studies were carried out on the people affected by the accident to evaluate their general health condition as well as the behaviour of biological indicators most sensitive to the action of ionizing radiations

Affected people were evaluated with to medical protocol that included the following elements:

- Medical interrogation.
- Medical completes exam of the different organs and systems.
- Valuation of the nutritional status.
- Exams of clinical laboratory constituted by hematology, biochemistry and other studies.
- Psychological valuation by means of interviews and psychological test.
- Stomatological therapeutical.

In dependence of the clinical discoveries, the results of the carried out exams or for necessities of the own investigation, other studies and the evaluation were incorporated by other medical specialties.

2.1 Quantification of the exposure to ionizing radiations people's affected by the accident

The investigation included the estimate of the magnitude and distribution from the exposure to ionizing radiations in people affected by the accident, to appreciate the radiological risk and the consequences of the accident. Crucial matters considering the existent uncertainties for the circumstance and scenario of the accident.

The studies were the determination of internal contamination, for technical of corporal direct mensurations in this people and of mensurations of samples of their urine excretions. With the intention to measure activity incorporate and to calculate dose exposure.

While on the other hand with the competition of the biological dosimetríc was evaluated dose also in the accident victims.

The tests carried out in question were the following ones:

- Determination of Cesium – 137 in urine samples, for spectrometric of high resolution.
- Determination of Cesium - 137 in the human body, for spectrometric with whole body counter.
- Analysis mediating citogenetic studies the determination of frequency of chromosome aberrations on peripheral blood lymphocytes.

3. Results and discussion

3.1 General state of people's health affected by the accident

In the table 2 shows the most frequent diseases, from higher to lower frequency.

Table 2: Health status the people affected by the accident.

DISEASES	CHILDREN		ADULTS.		**BOTH**	
	No	%	No	%	No	%
Parasitic	5	100	1	100	6	100
Digestive	5	100	1	100	6	100
Endocrine- metabolic	4	80	1	100	5	83
Allergic and inmunity disorders	4	80	1	100	5	83
Neurological or sense organs	4	80	----		4	67
Bone,muscle and articulations	2	40	-----		2	33
Nutritional	1	20	-----		1	17
Congenital anormaliesl	1	20	-----		1	17

The obtained main results were that 100% of those affected presented parasitism and digestive pathology, while the Endocrine- metabolic and allergic illnesses represented the 83 % respectively. None of these pathologies has direct relationship with the effects of the ionizing radiations of the accident, but they constitute problems of health to solve. (2)

3.2 People's psychological state affected by the accident

The psychological valuation of people affected by radiological accidents is of supreme interest to know the influence of its performances in the causes of the accident, to explain some of the accidental sequels and to offer the psychological support, always necessary in the boarding of these cases.

All the accident victims presented psychological diverse affections, in those that the dysfunctions prevailed in the conduct and affective spheres, results waited by the origin and social behaviour of the same ones, as well as for the derived concerns of the consequences of the radiological accident. The psychological status the people affected by the accident are reflected in the following table. (2)

Table 3: Psychological status the people affected by the accident.

DISEASES	CHILDREN		ADULTS.		**BOTH**	
	No	%	No	%	No	%
Unexpected reactions	3	60	------		3	50
Anxiety	2	40	------		2	33
Emocional lability	------		1	100	1	17

These elements were developed by the psychological and social suffering damages, as consequence of the natural disaster in that you/they were involved, previous to the radiological catastrophe that affected them. To all these people they were offered professional support and they in techniques for the handling of their problems in the family environment.

3.3 Children's nutritional status

The studies of the growth and development are essential in the evaluation of the health and nutritional status in populations, especially in children, if it come from to humble and excluded sectors, where these indicators acquire a special connotation. . (2)

The table 4 shows the behaviours of the weight and height in children affected by accident.

Table 4: Weight and height indicators in children affected by accident.

Percentil	**Relation** weight **(Kg)- ages**		**Relation** height **(cm)- ages**		**Relation** weight **(Kg)-** height **(cm)**	
	No	%	No	%	No	%
10 – 25	-----		2	40	2	40
25 – 50	2	40	1	20	----	
50 – 75	2	40	2	40	----	
75 – 90	1	20	-----		2	40
90 – 97	-----		-----		1	20

During the carried out study diverse nutritional affectations were detected, associated to illnesses, lifestyles and genetic factors.

3.4 Quantification of the exposure to ionizing radiations people's affected by the accident

During the determination of Cesium - 137 in urine samples, it was detected in an adult person affected by accident, concentration of Cesium -137 activity , bigger than it limits of detection, with values that they oscillated between 4.90±0.4 and 6.60±0.7 Bq / kg, show the following table. (2,3,4)

Table 5: Determination of Cesium – 137 in urine samples.

Mensurations	**Concentration Cs-137activity smaller that it limits of detection (Bq/Kg)**		**Concentration Cs-137activity bigger that it limits of detection (Bq/Kg)**	
	Samples	Activity	Samples	Activity
I	5	< 1.0	1	6.30±0.7
II	-----	------	1	5.60±0.7
III	5	< 1.0	1	4.90±0.4
IV	------	------	1	6.60±0.7

In the person that presented mensurations of concentration of activity of the Cesium -137, bigger than the one it limits of detection, the activity of Cs-137 was calculated excreted in urine of 24 hours, show the table 6. . (2)

Table 6: Determination of Cesium – 137 in urine samples excreted in 24 hours.

Mensurations	**Concentration Cs-137activity** excreted in urine **(Bq/day)**	
	Samples	**Activity**
I	1	8.19±0.9
II	1	8.40±0.7
III	1	10.30±0.8
IV	1	5.70±0.6

The determination of Cesium - 137 in those affected by the accident, by means of techniques of corporal direct mensuration of the whole body, it constituted a tool of vital importance in the detection of possible radioactive contamination internal.

Table 7: Determination of Cesium - 137 in the whole body.

Mensurations	**Cs-137activity smaller that it limits of detection (Bq)**	**Cs-137activity bigger that it limits of detection (Bq)**
	No. people	No. people
I	3	3
II	------	1
III	3	3
IV	------	1
V	------	1
VI	-----	1

The mensurations detected superior activities to the activity minimum detectable in 3 people like one, observes in the following table.

Table 8: Determination of Cesium - 137 in the whole body.

People	**Limits of detection Cs-137activity (Bq)**	**Activity ranges measure Cs-137activity (Bq)**
Children 1	53.79	64.83 - 156.16
Children 2	59.74	76.94 - 111.05
Adult	67.43	2101.75 - 2376.79

In the children, the certain values were not significant, contrary to that happened with the adult that presented high values.

The doses for internal contamination were estimated in those affected by the accident, with mensurations of activity bigger to the activity minimum detectable. In this cases was calculated to Committed Effective Dose.(2,3,4)

The interviews with the accident victims and Venezuelan officials allowed the available ratification of informations in some cases and in other the acquisition of novel data on the circumstances of the radiological accident.

The contributed testimonies, they allowed the evaluation of possible routes and ways of incorporation of the radioactive substances in affected people, essential elements for the estimate of their doses for radioactive internal contamination.

When being valued the possible scenarios that could produce the contamination radioactive intern of the accident victims you considers the dispersion of the radioactive substances in the environmental environment that affected people penetrated to the place of the accident in having reiterated occasions and that they consumed foods without fulfilling hygienic measures.(2,3)

The previous informations allowed to define as possible roads and ways of contamination the following ones:

- Acute inhalation multiple or continuous of radioactive substances way.
- Acute ingestion multiple or continuous of radioactive substances.
- Inhalation combination with ingestion of radioactive substances.

The dose estimacción for acute inhalation varies among 2.01 X 10-4 to 2.78 X 10-4 Sv. In the chronic inhalation the dose is among 1.73 X 10-4 and 2.00 X 10-4 Sv. For the incorporation for acute and and chronicle ingestion the dose values were lightly lower**,** show the tables 9 and 10.(2)

Table 9: Estimate of Committed Effective Dose for acute incorporation of Cesium – 137.

People	**Dose for mensuration in vivo (Sv)**		**Dose for mensuration in vitro (Sv)**	
	Inhalation	Ingestion	Inhalation	Ingestion
Children 1	7.00 E -05- 1.52 E -04	6.85 E 03- 1.45 E 04	-	-
Children 2	6.00 E -05- 1.28 E -04	5.75 E 03 - 1.21 E 04	-	-
Adult	2.01E -04 - 2.78 E -04	1.83 E -04 - 2.59 E -04	1.56 E -04-2.17 E -04	1.46 E -04 - 2.02 E -04

Table 10: Estimate of Effective Committed Dose for chronic incorporation of Cesium – 137.

People	**Dose for mensuration in vivo (Sv)**				**Dose for mensuration in vitro (Sv)**			
	Inhalation (minimum)	Ingestion (minimum)	Inhalation (maximum)	Ingestion (maximum)	Inhalation (minimum)	Ingestion (minimum)	Inhalation (maximum)	Ingestion (maximum)
Children 1	7.55 E -05	7.05 E -05	1.03 E -04	9.75 E -05	-	-	-	-
Children 2	6.15 E -05	5.90 E -05	1.02 E -04	8.10 E -05	-	-	-	-
Adult	1.73 E -04	1.90.E- 04	2.00 E - 04	2.20 E - 04	2.07 E -04	1.63.E -04	2.30 E -04	1.90 E -04

The estimates of the doses for citogenetic studies were carried out in 2 people, show the table 11

Table 11: Estimaciones of dose for cytogenetic studies

Personas	**Number of metaphases examined**	**Limits of detection (Gy).**	**Dose (Gy).**
Children	500	0,10	< 0.1
Adult	1000	0,10	< 0.1

4. Conclusion

The doses estimated in people affected by the accident confirm radioactive contamination and local irradiation The obtained main results are: 100% presented affectations in its health, not associate directly to the accident, although the accident influenced in its psychological state, Although the biggest expectation in the children's life affected by the accident is them between 3 and 7 more sensitive times to the exposure to ionizing radiations, being bigger the risk of damages in the health circumstances

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