X Congreso Regional Latinoamericano IRPA de Protección y Seguridad Radiológica
"Radioprotección: Nuevos Desafíos para un Mundo en Evolución"
Buenos Aires, 12 al 17 de abril, 2015
SOCIEDAD ARGENTINA DE RADIOPROTECCIÓN

Comparison between radioactive waste management and the exposure of workers

Pena, G.P.[2], Santos, J.S.[1], Gonzalez, J.A.[1], Pássaro, B.M.[1], Videira, H.S.[1], Lopes, A.B.[1], Buchpiguel, C.A.[1], Guimarães, M.I.C.C.[1].

[1] Nuclear Medicine Service of InRad Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (NMC InRad HCFMSUP), São Paulo, Brazil,
[2] Pontifícia Universidade Católica de São Paulo (PUC-SP), São Paulo, Brazil

ABSTRACT

Depending on how the radioactive waste is managed it can become an additional source of exposure to the worker. In order to minimize this exposure the amount of radioactive waste generated by a nuclear medicine center was analyzed, quantified, qualified and compared with the doses obtained by personal dosimetry in the Nuclear Medicine Service of InRad HCFMUSP. The greatest quantity of radioactive waste produced was of Tc-99m. Approximately 90% of the solid waste was non-compactable, such as needles and others, and the remaining 10% were of compactable waste (gauze, gloves and other). Among the years there has been a significant variation in the amount of waste, which is directly connected with the quantity of exams performed. The medium dose value observed was of 0.6 mSv per month for all the workers, including radiopharmacists, nurses and physicists (dosimeters positioned in thorax) and 1.6 mSv in wrist dosimeters. We observed that months with greater amount of waste coincided with months of higher doses. However, this increase was not significant and was not proportional due to optimization in handling the waste.

1. INTRODUCTION

There is a major concern with the protection of the worker especially when the radioactive material arrives in a nuclear medicine service since it usually has high activities, but it's important to have the same caution when treating the radioactive waste or it can become an additional source of exposure to the worker. The management of radioactive waste is a set of administrative and technical activities involved in segregation, processing, packaging, transportation, storage, control and disposal of radioactive waste. The main objective of this management is to protect human health and the environment, both now and in the future from any deleterious effects caused by radioactive materials considered as having no more use [1].

Currently in Brazil, the management of radioactive waste is regulated by the norm CNEN-NN-8.01 (2014) [2]. As defined by IAEA [3], the management of radioactive waste must be subject to standards of safety. The Nuclear Medicine Service of InRad HCFMUSP follows strict standards in order to guarantee the best working conditions and the safety of the exposed worker. When analyzing the significance of the assimilation of radiopharmaceuticals in diagnostic and therapy procedures, the proper management and implementation of technical standards and radiation protection and safety in the nuclear medicine service must be a priority. However, as the number of exams and therapy using radiopharmaceuticals increases, there was not so far (in the studied clinic) an analysis of how the increase or decrease of radioactive waste relates to the doses of these workers, since handling and inadequate storage of these wastes can cause unnecessary radiation doses to the workers.

The generation of radioactive waste should be as far as possible minimized [2], which can be achieved through the adoption of appropriate operating procedures, so as to avoid contamination, to reduce exposure and in order to reduce the volume of waste to be managed. In order to minimize the exposure of the worker the amount of radioactive waste generated by a nuclear medicine center was analyzed, quantified and qualified with the additional benefit of optimizing the management of that waste.

2. METHODS

A retrospective analysis was made of the records of storage and disposal of radioactive waste from January 2010 to December 2012 in the Nuclear Medicine Service of InRad HCFMUSP. Using the data of personal dosimeters used by 12 workers (including radiopharmacists, nurses and physicists) of the above mentioned nuclear medicine service in the same interval, a comparison between the equivalent doses and the quantities of radioactive waste produced was made.

3. RESULTS

The greatest quantity of radioactive waste produced was of Tc-99m, representing 75%. In terms of mass, this corresponds to approximately 781 kg. Other nuclides used in the clinic of this study generated the following quantities of waste: 186 kg of Cr-51, 52 kg of I-131 and 20 kg of Ga-67. The higher percentage for Tc-99m is consistent with the fact that this radionuclide is the most used as a tracer in hospitals because of its versatility in diagnosing illnesses and its radiological properties. Figure 1 shows the amount of solid waste produced for each year of the studied period.

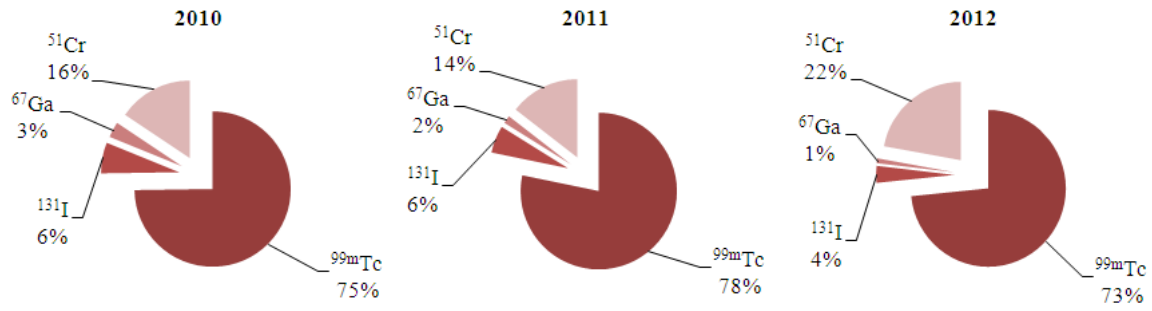

Figure 1. Percentage of the amount of waste produced solids

Depending on the workload and the characteristics of the nuclear medicine service the generation of radioactive waste can vary both quantitatively and qualitatively. We can see in

Table 1 that for the year 2011 we had a decrease in production that, among other factors, was due to renovations in the building structure that resulted in a decrease in attendance flow.

Table 1. Amount in mass (Kg) of waste produced

	Mass (kg)		
Year / Radioisotope	2010	2011	2012
Cr-51	58.29	37.31	90.67
Ga-67	12.10	4.20	4.07
I-131	23.67	14.45	14.18
Tc-99m	279.12	201.08	300.51
Sum	373.18	257.04	409.43

In the investigated period approximately 10% of the solid waste was compactable (gauze, gloves and other) and the remaining 90% were of non-compactable waste, such as needles and others, independent of radionuclide. Figure 2 shows a comparison of this data for each year of the studied period.

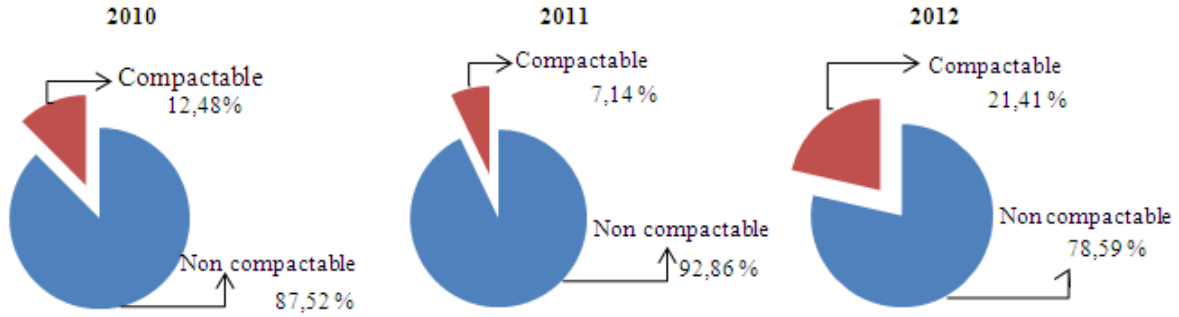

Figure 2. Percentage of the amount of waste produced solids non compctable

The non-compactable waste has mostly sharp ends which can perfurate plastic bags. As such, this kind of waste have to be disposed of in appropriate recipients for these kind of residues. After the radioactive decay, these recipients can be treated only as needlestick waste. This procedure adds a high cost to the hospital budget. One of the benefits of this study was to optimize radioactive waste and reduce this cost.
Figure 3 shows the percentage of the amount of non-compactable waste produced per year for radioisotope.

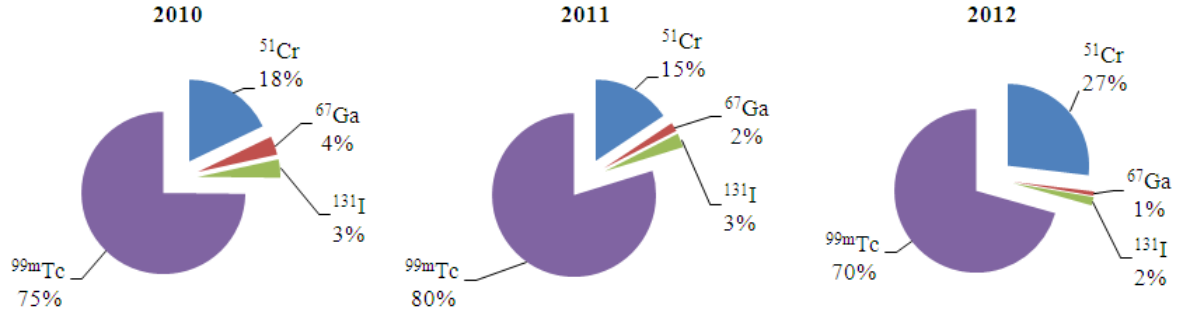

Figure 3. Percentage of the amount of non-compactable waste produced

All material involved in the preparation or administration of radiopharmaceuticals as syringes, needles, vials, gauze, inhalers and gloves may have a quantity of residual radioactivity. The amount of activity of radioactive waste stored for decay can be seen in Table 2.

Table 2. Amount in activity (mCi) of waste produced

	Activity (mCi)		
Year / Radioisotope	2010	2011	2012
Cr-51	39	24	61
Ga-67	13	5	5
I-131	89	60	57
Tc-99m	298	224	375
Sum	439	313	480

Liquid radioactive waste was not included in this study due to alterations in the handling of that waste in the given interval.

The doses obtained from personal dosimeters resulted in a range from background values to 1.4 mSv in a month (the latter was observed only once in one nurse, being the second and more common value of 0.9 mSv observed in more than one worker). Wrist dosimeters showed a range from background values to 8.5 mSv (this dose was observed only once in a radiophamarcist, being the second and more common value of 2 mSv observed in more than one worker).

The medium dose value observed was of 0.6 mSv per month for all the workers (dosimeters positioned in thorax) and 1.6 mSv in wrist dosimeters. However, it's important to emphasize that some workers are more exposed than others and that a slight increase in the doses was observed in months with more exams and consequently more radioactive waste.

4. CONCLUSIONS

The majority of procedures performed for diagnostic purposes in the Nuclear Medicine Service of InRad HCFMUSP uses radiopharmaceuticals labeled with Tc-99m. Thus, the greater quantity of radioactive waste generated of this radionuclide was expected.
There was an increase throughout the years in the number of exams performed in the service, which is directly connected with the quantity of waste. Hence, an increase in the doses and an increase in the number of radioactive waste was expected. We observed that months with greater amount of waste coincided with months of higher doses. However, this increase was not significant and was not proportional due to optimization in handling the waste. All the doses were in acceptable levels and well bellow the limits defined by CNEN [4].

4. REFERENCES

1. INTERNATIONAL ATOMIC ENERGY AGENCY, Management of waste from the use of radioactive material in medicine, industry, agriculture, research and education, Safety Standards Series No. WS-G-2.7, IAEA, Vienna (2005).
2. COMISSÃO NACIONAL DE ENERGIA NUCLEAR, Gerência de rejeitos radioativos de baixo e médio níveis de radiação, CNEN NN-8.01, Brasil (2014).
3. INTERNATIONAL ATOMIC ENERGY AGENCY, Disposal of Radioactive Waste, Safety Standards Series No. SSR-5, IAEA, Vienna (2011).
4. COMISSÃO NACIONAL DE ENERGIA NUCLEAR, Diretrizes básicas de proteção radiológica, CNEN NN-3.01, Brasil (2014).