STATYSTICAL EVALUATION OF THE EFFECTIVE DOSES IN THE PROCEDURES OF CARDIAC CATHETERISM

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Abstract : The purpose of this work is the analysis and statistics of the effective doses received by the professionals that perform medical procedures of cardiac catheterism in two great hospitals of São Paulo State, in Brazil. The individual doses of 103 professionals of hospital A were analysed from 1991 to 2000, and the individual doses of 176 professionals of hospital B from 1992 to 2002. The statistics and interpretation of the data were considered in terms of the profession and the individual equivalent dose accumulated in the period. The main obtained results are summarised as follows: (1) The physician's and resident physician's doses are the highest because they are the professionals that stay closer the patient and of the source of X-rays for a long period of time during the procedure. (2) The physicians monitored in the hemodinamic services of hospital A practically receive annual doses lower than 10mSv. (3) The resident physicians and the high level trainees received annual doses higher than the physicians. (4) In the hospital B, physicians received annual doses close to the annual limits.

1 INTRODUCTION

The interventional radiology carried out through hemodinamic studies had a very big growth in its application when compared with other treatment types in the last years. Faulkner et al. [1], in recent study, mention that this growth is owed, partly, to the high applied technology in those types of studies, to the substantial improvement of the X-rays image equipments, to the refinement of the project of the catheter, to the patients' treatment without need of general anesthesia and, mainly, to the situations in that the surgery is not possible being accomplished. Nakamura et al. [2] mention that one of the factors responsible to the increase of the exposure to the radiation in interventional radiology is the increasing number of patients submitted to exams of interventional radiology.

In agreement with the data registrations of the Centro Nacional de Intervenções Cardiovasculares - CENIC, during 2002 in Brazil, 374 physicians, 208 hospitals with hemodinamic services were registered, and during 2000 – 2002, 68.426 coronary interventions were performed.

The radiological risk to the medical staff in laboratories of cardiac catheterism of the hemodinamic services is of great concern in the radiological protection of a hospital. According to International Commission on Radiological Protection [3], the individual exposure in cardiac catheterism is considered higher when compared with the occupational exposure to the ionizing radiation originating from other type of radiological procedure and, the medical staff that performe this procedure type can receive doses close to the occupational limits suggested by ICRP.

During the technique of cardiac catheterism the fluoroscopy is used for placement of central catheters and temporary pacemakers. The fluoroscopy time used in the procedures can be a potential risk relatively high for the physicians and their assistants [2,4]. In agreement with National Commission Radiation Protection [5], in partly of the hemodinamic technique the cine is used to recording the images that also results in high individual exposure to the medical staff. International studies show that the physicians's doses are the highest among the other components of the staff, because these professionals stay closer to the patient and the source of X-rays for a long period of time during the procedure [6,7,8,9].

The purpose of this work is the analysis and statistics of the annual effective doses received by the professionals that perform medical procedures of cardiac catheterism in two great hospitals of Paulo Paulo State, in Brazil.

2 MATERIALS AND METHODS

For the accomplishment of this study were analyzed the 279 professionals' individual doses that are part of the hemodinamic services of two hospitals of the São Paulo State, Brazil. In the first hospital, designated in this study as hospital A, the 103 professionals' individual doses were analyzed in the period from 1991 to 2000. The professionals that had the analyzed doses were physicians, resident physicians, high-level trainees, nurses and nurses' aid. In the period from 1991 to 1997, the dosimetry was performed with film badge positioned in the thorax under the lead apron, and starting from 1998 it was introduced the TLD dosimeter (CaSO4:Dy + Teflon) positioned in the area of the professional's thorax on the lead apron.

In the second hospital, designated in this study as hospital B, the 176 professionals' doses were analyzed in the period from 1992 to 2002. The professionals of the hospital B that had the analyzed doses were physician, nurses and nurses' aid. The individual monitoring was carried out with TLD dosimeter (CaSO4.Dy + Teflon) positioned in the area of the professional's thorax under the lead apron up to 1995, and starting from 1996 the dosimeter was begining to be used on the lead apron in the area of the thorax.

The annual limits of 50 mSv of the National Commission of Nuclear Energy (CNEN) established up to 1997, and starting from 1998, and the annual limit of 20 mSv of the Sanitary Surveillance Office (SVS) of Ministry of Health are represented in the dispersion graphs for better understanding of the behavior of the doses in relation to the annual limits adopted in Brazil.

3 RESULTS AND DISCUSSION

3.1 Evaluation of the medical staff individual doses of the hospital A hemodinamic service.

3.1.1 The physicians annual doses

All physicians presented annual doses lower than to 10 mSv, according to display the figure 1. In the first period from 1991 to 1997, when the annual limit was 50 mSv, the physicians received annual doses on average in the range from (0,4 ± 0,1) mSv to (1,5 ± 0,1) mSv, and the highest annual dose received by a physician in this period was 1,6 mSv corresponding to 3,2% of the recommended limit. In relation to the second period from 1998 to 2000, these professionals received annual doses on average in the range from (0,4 ± 0,2) mSv to (3,8 ± 1,5) mSv, and the highest annual dose in that period was 5,3 mSv corresponding to 26,5% of the SVS limit.

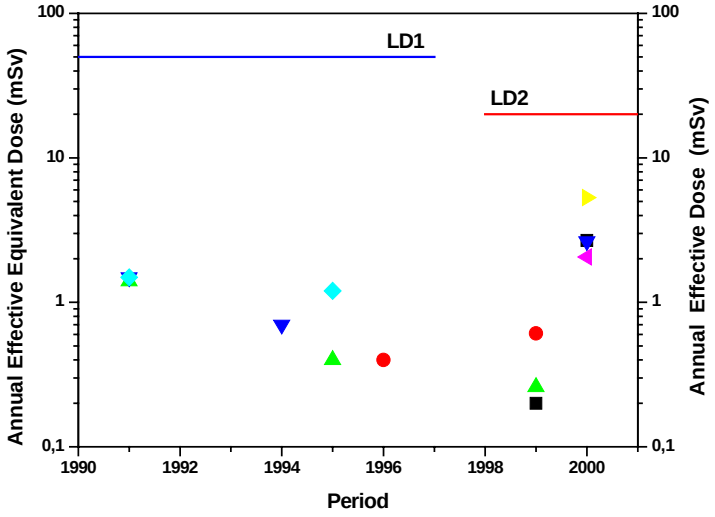

Figure 1 - Distribution of physician's annual doses of the hospital A in relation to the annual effective equivalent dose limit of CNEN (LD1) and to the annual effective dose limit of SVS (LD2), in the period from 1991 to 2000.

3.1.2 The resident physicians annual doses

The resident physician are the professionals that are in training phase, and they usually spend more time in the performance of the hemodinamic procedures than the physicians, because they can use for more fluoroscopy and the cine time, among other factors. Those professionals stay close of the exam table during the procedure, and they are also more exposed to the ionizing radiation. The resident physicians doses didn't exceed the limits in the period from 1991 to 2000, according to display the figure 2.

In the period from 1991 to 1997, when the annual limit was of 50 mSv, the resident physicians received annual doses on average in the range from (2,3 ± 1,1) mSv to (13,9 ± 11,8) mSv, and the highest annual dose received by a resident was 25,7 mSv corresponding to 51,4% of the limit recommended by CNEN. In the period from 1998 to 2000, these professionals received annual doses on average in the range from (2,1 ± 1,9) mSv to (7,8 ± 0,1) mSv, and the highest annual dose received by one of these professionals corresponding 39% of SVS limit. Comparing the figures 1 and 2, it can be seen that resident physicians' annual doses are higher than the physicians.

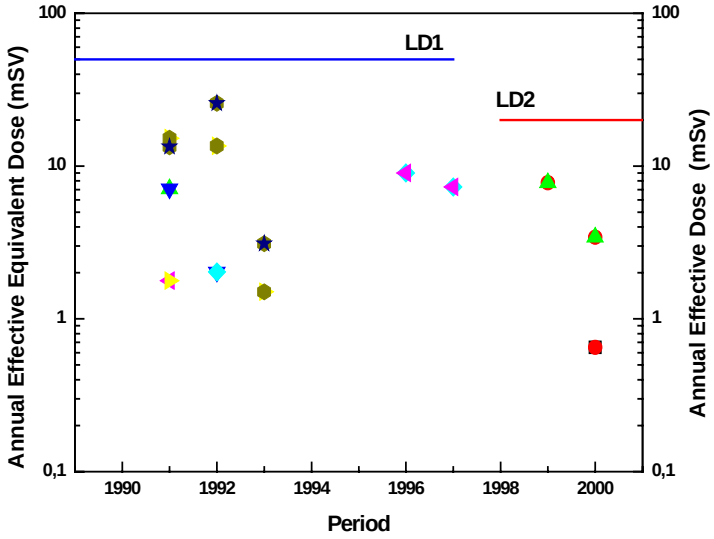

Figure 2 - Distribution of resident physicians' annual doses of the hospital A in relation to the annual effective equivalent dose limit of CNEN (LD1) and to the annual effective dose limit of SVS (LD2), in the period from 1991 to 2000.

3.1.3 The high level trainees annual doses

The high level trainees as well as the resident physicians are professional that are also in training phase and among other factors they also spend more time in the performance of the hemodinamic procedures, being more exposed to the ionizing radiation. In this case exist registrations of annual doses exceeding the limit recommended by CNEN of 50 mSv, according to display the figure 3.

The high level trainees, in the period from 1991 to 1997, received annual doses in the range from (1,4 ± 0,5) mSv to (41,8 ± 38,9) mSv, and the highest annual dose received by a trainee exceeded 68,8% of the CNEN limit. In the period from 1998 to 2000, the trainees received annual doses in the range from (1,4 ± 0,1) mSv to (7,6 ± 6,1) mSv, and the highest annual dose received by one of these professionals corresponding to 64,5% of the SVS limit.

Comparing the figures 1, 2 and 3, it can be seen that the high level trainees presented higher doses than the resident physicians and physicians. This result is in agreement with Watson et al. [10] study; that present to physician' doses during the first year of training higher than the physicians during the second year of training in laboratories of cardiac catheterism.

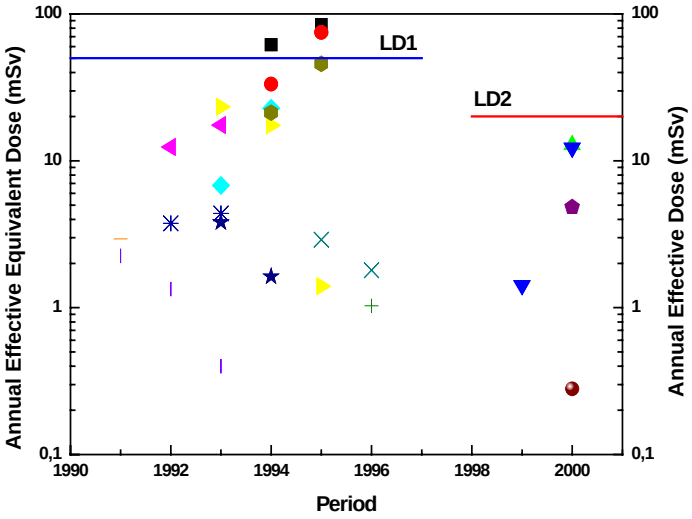

Figure 3 - Distribution of high level trainees' annual doses of the hospital A in relation to the annual effective equivalent dose limit of CNEN (LD1) and to the annual effective dose limit of SVS (LD2), in the period from 1991 to 2000.

Besides, it was verified that the hospital A works as a hospital school, in which the physicians work more in teacher's function of the resident physicians and high level trainees, and these, act as executioners of the hemodinamic procedures, which among other factors, justifies the annual doses levels be higher than the physicians.

3.1.4 The nurses' aid annual doses

The nurses' aid, among the specialized occupations of support that integrate the medical staff of the hospital A hemodinamic services, are the professionals that stay inside the laboratory of cardiac catheterism during the whole period of the procedure, but no so close of the patient as the physicians. These professionals' annual doses didn't exceed the recommended limits, according to display the figure 4.

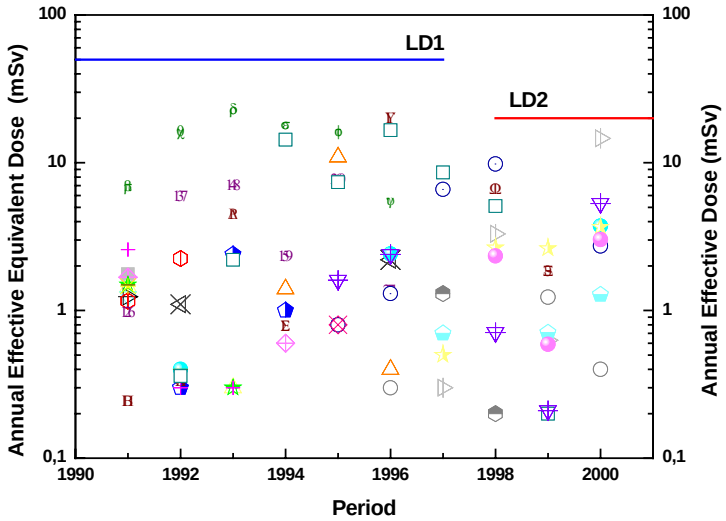

Figure 4 - Distribution of nurse's aid annual doses of the hospital A in relation to the annual effective equivalent dose limit of CNEN (LD1) and to the annual effective dose limit of SVS (LD2), in the period from 1991 to 2000.

The nurses' aid, in the period from 1991 to 1997, received annual doses in the range from (1,8 ± 1,7) mSv to (6,6 ± 6,1) mSv, and the highest annual dose received by one of these professionals corresponding to 47,2% of the CNEN limit. In the period from 1998 to 2000, they received annual doses in the range from (1,1 ± 0,9) mSv to (4,7 ± 4,3) mSv, and the highest annual dose corresponding to 73% of the SVS limit. In spite of the dose registration of 23,6 mSv during 1993 to be higher than the dose registration of 14,6 mSv during 2000, it was can be seen that with the reduction of the annual limit of 50 mSv to 20 mSv during 1998, that last dose registration is near the annual recommended limit to the period.

Comparing the figures 1, 2 and 4, it is observed that the nurses' aid annual doses are higher than the physicians' annual doses and they are not significantly different from the resident physicians' annual doses.

In this context, it is observed that these results contradict the study of Kottou et al. [9] that present dose registrations of physicians and physicians in training phase higher than the other professionals of the medical staff of the hemodinamic service.

3.1.5 The nurses annual doses

The nurses of the hospital A hemodinamic service partipate of the procedures in the laboratory of cardiac catheterism only when the physycian needs a more qualified professional to aid him. In the analyzed period, all nurses received annual doses lower than 10 mSv, according to display the figure 5.

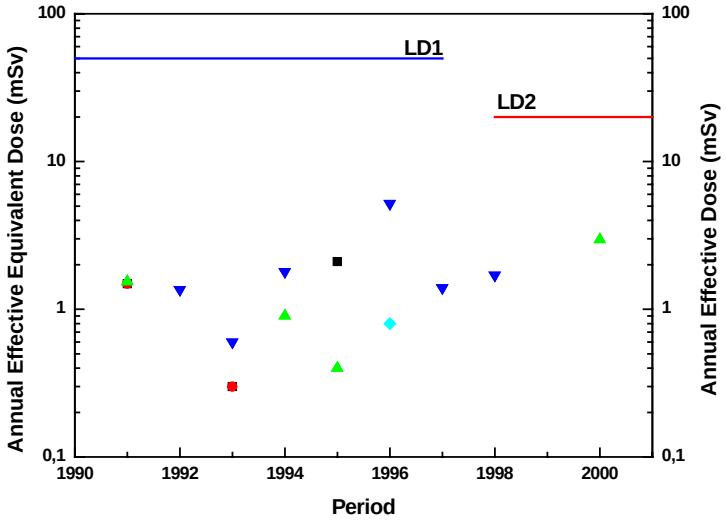

Figure 5 - Distribution of nurses' annual doses of the hospital A in relation to the annual effective equivalent dose limit of CNEN (LD1) and to the annual effective dose limit of SVS (LD2), in the period from 1991 to 2000.

The nurses, in the period from 1991 to 2000, received annual doses in the range from (0,4 ± 0,2) mSv to (3,0 ± 3,1) mSv, and the highest annual dose corresponding to 10,4% of the CNEN limit. In the period from 1998 to 2000, these professionals received annual doses in the range from (1,7 ± 0,1) mSv to (2,9 ± 0,1) mSv, and the highest annual dose corresponding to 14,5% of the of SVS limit. Comparing the figures 1 and 5, it can be seen that the nurses' annual doses had a similar behavior the physicians' annual doses in the analyzed period.

3.2 Evaluation of the medical staff individual doses of the hospital B hemodinamic service

3.2.1 The physicians annual doses

The physicians of hospital B hemodinamic service are the professionals that execute the hemodinamic procedures, staying very close to the patient and the tube of x-rays during the exam,

being more exposed to the ionizing radiation than the other specialized occupations that integrate the medical staff.

From the total 136 physicians, 78,7% received annual doses lower than 10 mSv in the period from 1992 to 2002. In the period from 1992 to 1997, when the established limit was 50mSv, 3,1% of the physicians received annual doses between 20 and 30 mSv, and 5,8% received annual doses between 10 and 20 mSv. In the period from 1998 to 2002, 9,6% of these professionals received doses between 10 and 15 mSv, and 3,7% received annual doses between 15 and 20 mSv. Only one physician received annual dose higher than the SVS limit, according to display the figure 6.

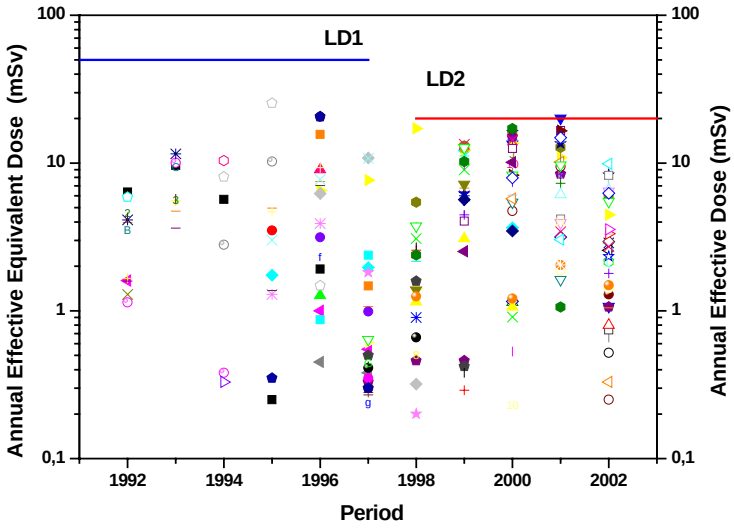

Figure 6 - Distribution of physician' annual doses of the hospital B in relation to the annual effective equivalent dose limit of CNEN (LD1) and to the annual effective dose limit of SVS (LD2), in the period from 1992 to 2002.

The physicians received annual doses on average in the range from (1,9 ± 3,1) mSv to (7,3 ± 2,8) mSv in the period from 1991 to 1997, and the highest annual dose corresponding to 50,8% of the CNEN limit. In the period from 1998 to 2000, these professionals received annual doses on average in the range from (2,6 ± 3,6) mSv to (7,9 ± 5,3) mSv, and the highest annual dose of this period exceeded 0,5% of the SVS limit.

Comparing the figures 1 and 6, it can be seen that the physicians of the hospital B received annual doses higher than the physician of the hospital A. The annual dose received by one physycian of the hospital B during 1995 was 21 times higher than the annual dose received by one physician from the hospital A in the same year. During 2000, the physician's annual dose of hospital B was 3 times smaller than the physician of hospital A.

Many factors can be attributed to these results, among then stand out: a) the different characteristics of works of the hospitals; b) the eventual participation physicians of hospital A in hemodinamic procedures; and c) the number of hemodinamic procedures performed annually by the physicians.

3.2.2 The nurses annual doses

The nurses of the hospital B hemodinamic service have the same functions that the nurses of the hospital A, that is, these professionals are usually available for service in the hemodinamic service and they only participate in the procedures in the laboratory of cardiac catheterism when requested by the physician. All nurses received doses lower than 1 mSv in the period from 1992 to 2002. Comparing the nurses' annual doses of this two hospitals, it can be seen that in the hospital A these professionals presented higher doses than the hospital B.

3.2.3 The nurses' aid annual doses

The nurses' aid of the hospital B, as well as the nurses' aid of the hospital A, participate in the hemodinamic procedure in position no so close to the patient as the physicians.

Practically 99% of the nurses' aid received doses lower than 10 mSv in the period from 1992 to 2002. Only one nurse aid received annual dose near the SVS limit, according to display the figure 7. These professionals presented annual doses higher than the nurses' aid that integrate the medical staff of the hospital A hemodinamic service.

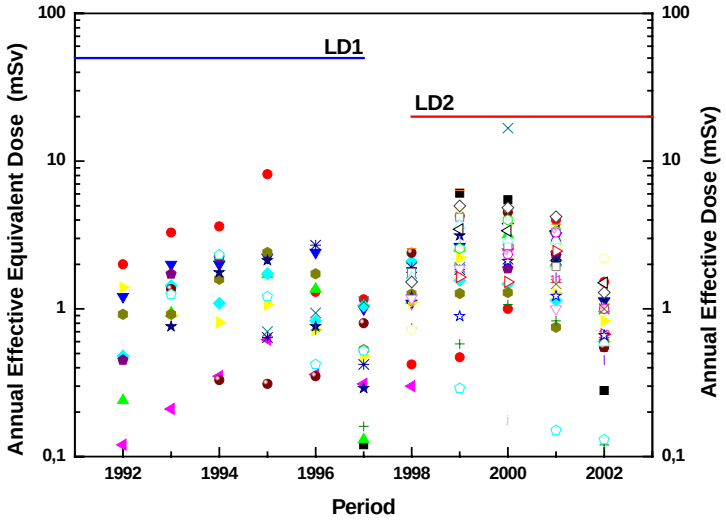

Figure 7 - Distribution of nurses' aid annual doses of the hospital B in relation to the annual effective equivalent dose limit of CNEN (LD1) and to the annual effective dose limit of SVS (LD2), in the period from 1992 to 2002.

The nurses' aid received annual doses on average in the range from (0,7 ± 0,3) mSv to (1,9 ± 2,0) mSv in the period from 1991 to 1997, and the highest annual dose corresponding to 16,4% of the CNEN limit. In the period from 1998 to 2000, these professionals received annual doses on average in the interval (0,9 ± 0,4) mSv to (3,2 ± 3,0) mSv, and the higher annual dose in this period corresponding to 83,5% of the SVS limit. Comparing the figures 6 and 7, it can be seen that only 1% of the nurses' aid presented annual doses higher than 10 mSv, while 21,3% of the physicians presents annual doses higher than that value.

It is noticed that the values of standard deviation in relation to the average of the annual doses come high and with great variation. Some factors might have influenced so that this measured of uncertainty had this type of behavior, among then stand out: the) the small number of the samples by year for the statistical calculation; and b) the great dispersion of the annual doses in the appraised periods.

International studies appear that the residents physicians' and trainees inexperience in the exercise of their functions, the lack of knowledge of the medical staff about the implications of the work with X-rays, the absence of collective protection coupled to hemodinamic equipment, the non use of equipments of individual protection, the lack of preventive maintenance of the hemodinamic equipments, the age of the equipments, the patient's size, the incorrect use of the dosimeters, the practices adopted by the physicians during the procedures, as well as the administrative practices adopted by the hospitals, are also factors that collaborate in the reception of doses very close or higher than the recommended annual limit, as well as in the dispersion of the professionals'doses values of cardiac catetherism laboratories [1,2,8,9,10,11,12,13].

4 CONCLUSION

Any attempt to compare published studies of radiation exposure levels in hemodinamic procedures should be performed with care due to the lack of standardization of the acquired data and of the variables no controled as the patient's size, the differences between hemodinamic equipments, the progresses in the technology for image and the practices adopted by the physicians during the procedures.

The study showed that the annual doses of similar occupations differ from hospital to other. It was can be seen that the physicians of the hospital A in training phase received higher doses than the other professionals of the medical staff, and the physicians of the hospital B presented higher annual doses than the physicians of the hospital A. It was observed, that with the reduction of the annual dose limit from 50mSv to 20mSv, introduced in Brazil during 1998, the professionals of the hemodinamic services of the two hospitals presented annual doses closer than the current established limit.

The implementation of preventive actions against the radiation exposure risks should not only depend on recommendations and regulations, but also, of judgements and perceptions of the radiological protection qualified personnel.

Even with the technological progress in the area of interventional radiology walking together with the radiological protection is the continuous concern of the researchers in relation to occupational exposure of the medical staff of the hemodinamic services.

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