

## EVALUATION OF THE GENETICALLY SIGNIFICANT DOSE DUE TO DIAGNOSTIC RADIOLOGY PROCEDURES IN FRANCE

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### INTRODUCTION

As in many other developed countries, medical radiology in France is the second source of population exposure to ionizing radiation, following the natural background contribution. Furthermore the doses received by patients from routine x-ray examinations in France has not been assessed on anything approaching a national scale for the past 25 years.

The last evaluation of the mean individual gonadal dose had in fact been performed by Reboul and al. in 1957 in Bordeaux /1/. Since then, considerable changes in both, the practice of medical radiology and the technology in use in France, have occurred, and the necessity of an updated Genetically Significant Dose (GSD) evaluation became evident.

Thus the CEPN (Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire) decided to perform in 1982 a new national survey of radiological activity to establish the annual GSD from medical x-ray procedures in France.

### THE SURVEY OF THE RADIODIAGNOSTIC ACTIVITY

Information on the frequency of diagnostic x-ray examinations was obtained by questionnaires sent to 157 public hospitals and 280 private clinics and surgeries spread throughout the country. These medical centers were selected using a stratified random sampling method.

The questionnaires asked for detailed informations concerning every x-ray examinations carried out at these medical centers (Hospitals, clinics, surgeries) during a specified week, such as the sex and age of the patients, the number of films used, the size of films, the fluoroscopic screening time, the tube voltage and the mAs used, the type of projection...

The response rate to the questionnaire was rather high : the average value is 70 % for both public and private medical centers. Eventually, 13 000 examinations were recorded for the whole country during the survey week.

The total annual number of x-ray examinations was estimated by multiplying the weekly values of radiological activity by seasonal and other extrapolations coefficients : this procedure of assessment leads to a figure of 45,3 million x-ray examinations in France in 1982. This corresponds to 836 examinations per thousand of inhabitants (excluding mass chest screening, dental examinations, scanning procedures).

As it can be seen from the table 1 below, this rate is rather high when comparing with some earlier surveys in other industrialised countries.

Country	Year	Examinations per thousand
Japon	1979	1 013
West Germany	1978	864
France	1982	836
U.S.A.	1980	742
Sweden	1977	494
Great Britain	1977	408

Table 1 : Frequency of x-ray examinations per thousand head of inhabitants for industrialised countries /2/.

### THE GONADAL DOSE MEASUREMENTS

Aiming at the assessment of the gonadal dose associated with every x-ray examination, a set of dosimetric measurements have been performed, using thermoluminescent dosimeters (lithium borate chips), on an anthropomorphic RANDO phantom. These measurements took into account the following parameters :

- the size of each film used for a given x-ray examination,
- the projection related to each film,
- the anatomical focus point of x-ray beam,
- the fluoroscopic screening time.

The collective gonadal dose equivalent associated with 45,3 million examinations in France in 1982 reaches 28,600 man-Sievert : this means an individual mean gonadal dose equivalent of 0.53 mSv per inhabitant /3/.

When comparing this last value with that evaluated by Reboul in 1957, we observe an increase of 64 %.

Computed mean gonadal doses, averaged over all age groups and sex, are shown for each type of examination in figure 1 below.

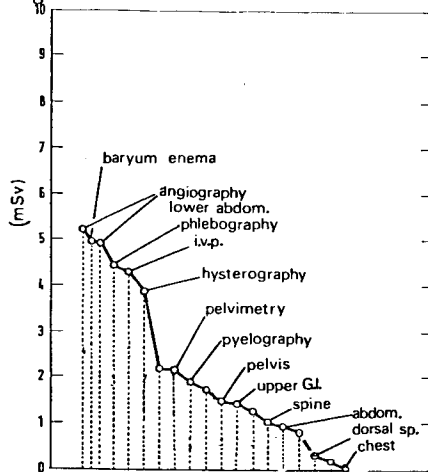


Fig. 1 : Mean individual gonadal doses per examination

As might be expected, the angiography of lower abdomen, the hystero-graphy and the IVP appear to be the most important examinations in terms of gonadal exposure ; furthermore for these examinations it seems quite difficult to use gonadal shielding.

### THE GSD

The previous results concerning the frequency and gonadal dose for each examination types have been combined with child expectancy of the patients to obtain the GSD. The total GSD to the population of France from all diagnostic examinations is estimated to be  $290 \mu\text{Sv}$  (290 m-rem).

Considering the French GSD value, it appears clearly that it is a mean value in comparison with other industrialised countries (see Fig. 2).

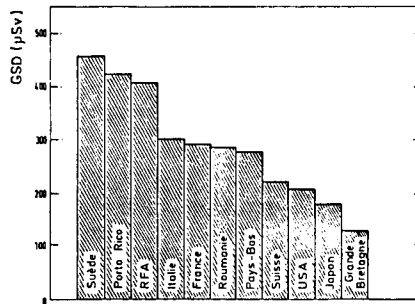


Fig. 2 : Genetically significant doses in different countries

The following figure shows to which extent the various types of examination contribute to the total GSD.

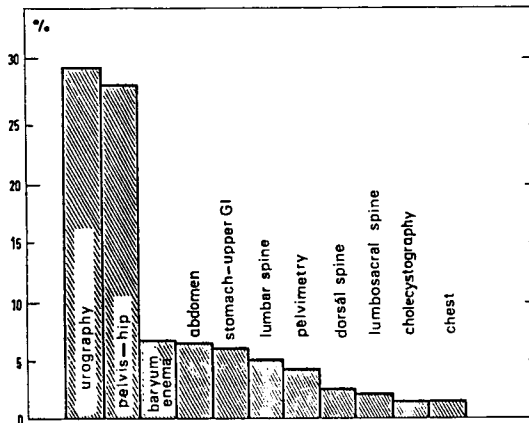


Fig. 3 : Relative contribution to GSD of different x-ray examinations (France 1982)

One can note that IVP and pelvis examination account for more than 50 % of the total GSD. The last figure 4 shows the break-down of the total GSD for each age group by sex.

It is important to stress that more than 50 % of the GSD is due to the exposure of the less than 30 years old female population ; otherwise the irradiation of the less than 1 year old children represents 16 % of the total GSD.

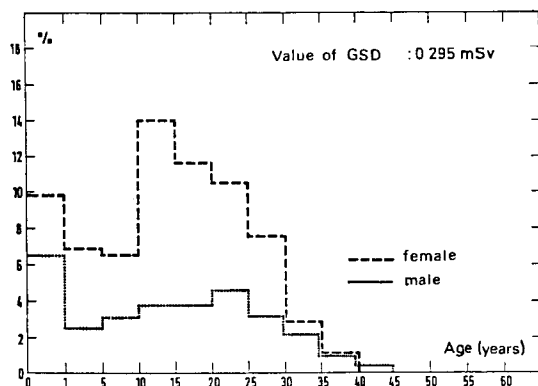


Fig. 4 : Contribution to GSD different age groups

While the GSD from diagnostic radiology amounts to only 14 % of that from natural background, it is however the largest man-made contribution to the collective GSD received by the population of France : the contribution of the other types of sources (radiotherapy and nuclear medicine, fallout, occupational exposure) does not exceed more than 3 % of the total GSD.

It is possible to make a very approximate estimate of the number of cases of serious hereditary ill health that will result from this level of population gonadal exposure. ICRP publication 26 /4/ recommends a value of  $10^{-2} \text{ Sv}^{-1}$  for the probability of serious defects appearing in the first two generations following irradiations of either parents with an additional equal probability for all succeeding generations. Applying the ICRP risk factor to a GSD of 290  $\mu\text{Sv}$  and the number of children born in France per year, the estimate is of 120 cases of serious hereditary ill health appearing in the population each year at genetic equilibrium if the current annual GSD is maintained.

#### REFERENCES

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- /2/ UNSCEAR, "Ionizing radiation sources and biological effects", 1982.
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- /4/ ICRP, "Recommendations of the International Commission on Radiological Protection", ICRP, Publication n° 26, Oxford, Pergamon Press, 1978.