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RADIATION 5

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COMMONWEALTH OF PUERTO RICO

NUCLEAR CENTER

DEPARTMENT OF HEALTH

SECOND R=PORT

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EVALUATION OF HEALTH HAZARDS DUE
TO UNINTENTIONAL IRRADIATION OF THE
GONADS DURING ROUTINE ABDOMINAL
X-RAY EXAMINATION OF MALE AND FE-
MALE PATIENTS IN PUERTO RICO.

REPORT NUMBER 2 - SOUTHERN REGION

MICHABL GILEADI, MS. ? RESEARCH ASSOCIATE

PUERTO RICO NUCLEAR CENTER

JUNE 1970

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?It has been demonstrated that gonad doses canbe reduced very decidedly with
{improved techniques by a factor of \$0 to 100 percent?

Report ofthe United Nations,
General Assembly, New York, 1958,

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ACKNOWLEDGEMENTS,

[The author wishes to express his appreciation forthe assistance in the preparation of
this second report to:

Dr Angel A. Colo Obie. Assistant Secretary for Environmental Health and Consumer
Protection. fo his warm attitude and encouragerrent inthis projec

Mr Modesto Reyes-Reyes, Environmental Health Supervisor, Southern Health District of Puerto Rico, for his devoted and valuable cooperation in collecting certain data

Dr Ramberto Pérez Ribier, Radiologist; Mrs, Zolla Rosario Iglesias, Chief X-ray Technician; and the Administrative Staff of the Ponce District Hospital for their assistance in allowing the author to use their equipment for dose measurement,

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Genetically Significant Dose Feces

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seme problem inthe Southern Region of Pate Rese ius

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Rico forthe frst time.

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resents potential hazard to all ature ofootog

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{future generations long offer the death of the iudiated pcre

the agar at® of Keeping the unintentional gonadal doses as es compatible

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cedures are the most signifiant of exposures rom man made cao

wer ereyih reent port iat, using eighty thee Xray unity 217.799 examina

pouures for ebtoreas ine Southern Region of Puerto Rican 1968, Tae ea seer

es Tor oaa tena <aminations wer 161,86 andthe namberoy reset

thor exper ncaa Om a population of \$89.50, the number nf iene

Msc xponires reached 265 698: These gre dasa the gnocchi

dom ed near or? Frequent in priate office than in publ inition, where

we Seldom find unlicensed X-ray operators

{In order to keep unintentional irradiation to

parade the educction of Kray technicians Aan

?This upgrading should lake place through ali

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ne ofthe interesting renuts ofthe present report points tothe fact that although the

ren aexaminations per 100 patients i higher in the Southers Reption than the

cum ole [aur for the Western Region 1967-68 (40.6 vs. 34.1) the per capita gonadal
Sor dibern eegin in 1968 ts oer than the corresponding figure in the Western
doen 968 6 vn 56-4), This pomnts fo technically sounder redolegiest practices
Begin on sion da Trost in art to the generally higher Industri and technical
level ofthe! feographie reat

Tia certainty hoped that inthe future close collaboration between the Department of
1 eine petaa Rico Nuclear Center wil be of erat benefit tothe future population
Heth a since the Departmen of Health recognizes the important role of radiation
Oe forthe wellbeing ofthe population ofthe lend present and future generations
rotection fo Ov id project wes approved to survey Puerto Rico's dental units Tas
Include etjone in cooperation oth the Schoo! of Dentistry andthe Univer of
Tor a otis hoped that it results will complete the survey of the isand?s diagnostic
Reray unit

CC Ge Wor

Emesto Colén Yordén, M. D.

?Secretary of Health

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SUNIMARY

Per capita annual gonad doses, 28 well se genetically significant doses associated with a
?selected group of abdominal and thoraciealX-eay dignentic in the Southern Region of
Puerto Rico during 1968, hive heen determined nnd are reported herewith, Sitar indih
tors referring tothe Westeen Region of Puerto Rico have heen updated in order to make
comparisons more meaningful. Some of the most important resus of the survey ate aE
marized below and compared with avilable 1967 dats

REGION AND YEAR OF REFERENCE

SR965 W.R.-1968 W.R.1967

Pop. 498,500 | Pop. 420.200 | Pop. 438.400

?Mon gonadal dow per

abdominal Xray 443.6 mnd 424.8 mad 422.8 mrad

diagnostic examination

?Mean gonadal dowe por

thoracieal Keay 1.08 mest Litmnd .

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Keay tamination offspring offspring -

* Values that were not evaluated in the 1967 survey,

?These results indicate that, generally speaking, the genetic hazard due to thoracal examinations is negligible as compared to the hazard caused by abdominal Xray diagnostics

: ?The results point to the imperative need for accurate colimation and shielding to reduce the gonadal dose to the minimum compatible with reliable diagnosis

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Further relevant data and results are enumerated below

[REGION AND YEAR OF REFERENCE

Pop. 498,500 | Pop. 420,200

?Number of diagnostic Xray units

(excluding dental Xray units) per 100

48,586 55.68

?Total number of fluoroscopic

diagnostic examinations 108,576 97,258

(number of fluoroscopic exam

into interventional radiotherapy 181,188

Total number of fluoroscopic

Population per ray unit 387

Number of Xray examinations

per 100 patients per year

Per capita annual gonadal dose (mSv) 436 964

While in the previous report the dose evaluation was based on phantom measurements only, dose determination in the Southern Region, 1968, included both measurements using phantom, and measurements in vivo. This provides a more realistic evaluation than one based on phantom measurements only.

GSD evaluations are to the author's knowledge the first ones made in Puerto Rico.

The expected number of future offspring per parent by age and sex groups has been evaluated specially for this purpose, using data provided by the Division of Vital Statistics of the Department of Health, P

The status of X-ray technicians (operators) in Puerto Rico and its relevance to the amount of radiation unintentionally received by the patients is discussed in the appendix.

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score,

The scope of the present report has been extended

partial report

?The genetically significant dose is an important criterion since
titative parameter indicative of radiation hazards. The dose in wh
?urement is further significant improvement

To obtain more meaningful value of Ue genetically significant dose
doses associated with thoracic examinations have been

?To implement the scope of work described above a was never

1). Collect the relevant statistical data, including the number and
types and their characteristic parameters the number of
?X-ray examinations performed by each unit during period time
?of examination, age and sex of patient. geographic location etc.

2) Measure the unintentional irradiation dose associated with

?Xray examination considered. taking into account the differences in the use of the
{of different Xray units. different collimation and/or filtration as well as differ-
ences in the technique of positioning

'3) Establish correlation of dose data measured in situ on the one hand and on a Rana

?Phantom on the other. Several population studies of Xray tubes were used in this

?Procedure in order to assess the relevance of hazard coefficients. etc.

4. Evaluate from the measured data

?2 the average annual per capita gonadal dose,

>. the genetically significant dose using demographic data

Government of Puerto Rico

lobo ts the

In order to execute each of the above mentioned operations, appropriate: procedures were developed and followed.

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COLLECTION AND ANALYSIS OF STATISTICAL DATA

Southern Region, Puerto Rico-1968

Statistical data was collected and analyzed in the Southern Region of Puerto Rico in a similar manner as in the Western Region, following the Planning Board System

Figure 1S shows the municipalities of the Southern Region and their respective populations.

Personal addresses of all medical facilities were taken from the Medical Directory of Puerto Rico 1968.

Where required data were collected by sending a detailed questionnaire and cover letter to the respective facility and private medical office in the Southern Region that operated

?or more diagnostic Xray unite

Jee en mbroved spe questionnaires are part of this report. The new ques:

Honnaies facilitate automatic data processing, as planned for future saree.

pine Presence of the Health Department among the sponsoring agencies, andthe active
apport of the Project by the Deputy Secretary of Health, improved the response of tee
rwvate medical offices significantly. Longedistance telephone cals nd parser sags ere
?nevertheless necessary to complete the required date,

Same of the difficulties encountered in data collection stemmed from the fact that the
Fouthem Region of Puerto Rico is larger in area, and more mountainous thar the ase
Fee A COPY ofthe sample questionnaire along with a copy ofthe cover letter sented
?by the Subsecretary of Health i included in this soporn,

Unlike the procedure followed in the previous report, diagnostic chest X-rays were in
luded inthe present survey in order to make the average gonadal done, as wel we tre
?enetically significant dose values, more meaningful,

Those ete of Undersecretary of Health Sr. Carlos Nater, and a sample questionnaire,
?are shown an the following pages.

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DEPARTAMENTO DE SALUD

SAN JUAN. PUERTO RICO, 00908

2h de junto de 1970

? 1 Médicos de Hospitales PSblicos y Privados,

Médicos on Práctica Privada y Radiblogos

de Cartos 2, Mater, HD. EX

Subsecretario de Sélid

Asunto + ?Encuesta sobre radiación y evaluacisn de 1a seeadiacsén

de 10s génados durante los exinencs de rutina de Rayos K

fen los hombres y las cujeres de Puerto Rico,

EL Departanento de Salud, conjuntamente con el Centro Nuclear de

la Universidad de Puerto Rico, perteneesente a is ContaiGn de Energtá Atéaica

de los Estados Unidos, est realizando un estudio pinseioso de codas Las

facilidades de Fayor Ken Puerto Aico wedlante una encvasta y una evaluactén

de los posibles peligros no intencionados que pudieran tener los diferentes equipos de Rayos X existentes en la Isla,

Esta encuesta está encabezada por el Sr. Michael Gileadi, M.S., Científico Asociado del Centro Nuclear de Puerto Rico, y sus asistentes, quienes le visitarán próximamente para explicarles cómo se conducirá dicha investigación.

En las Regiones Oeste y Sur de Puerto Rico se hizo un estudio preliminar que fue de gran provecho para todas las instituciones públicas y privadas, ya que se pudo identificar y corregir a tiempo pequeños defectos en los equipos que ofrecen algún peligro de radiación no intencionada-

A mismo tiempo se pudo determinar con gran certeza qué medidas tomar para evitar radiación innecesaria a los miembros de la población,

Esperamos que se le ofrezca al señor Gileadi la mayor cooperación y toda la información necesaria para que esta investigación continúe &

Anstructiva tenga el sejour de ios éritos.

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XcRAY_RADIATON SURVEY ~ 1968 _? QUESTIONNAIRE ? No.1

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XRAY RADIATION SURVEY~1968 - QUESTIONNAIRE- 2

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X-RAY RADATION SURVEY

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QUESTIONNAIRE = 3

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XRAY RADIATION SURVEY 1968 QUESTIONNAIRE 4

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SOUTHERN REGION,

PUERTO RICO?1968

?The Southern Region includes the southern coast of the Island, with sixteen municipal ties and population of 493,500 (1968).

Ponce, the most important city of the Region, preceded only by San Juan, is a dynamic city with a promising economic, cultural and political future. Heavy industry is being developed in his area, There is a private university, three schools of nursing and the Soutbera ?Tabslating and Technology College which offers an X-ray Technicians Course.

Ponce has « medical center with a district hospital, two private hospitals, two clinics and thtee ant-tbercaloss facilities (Hospital Anti-Tubercafoss, Pubic Health Unit and the

T. B. Center), There are five munieipal hospitals in the area, en Health Centers and two private hospitals,

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Geographical Distribution of Medical Facilities Equipped with X-Ray Units

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Figure 4?s

VARIATION OF POPULATION AND NUNBER OF X-RAY DIAGNOSTIC
UNITS IN PUBLIC AND PRIVATE MEDICAL INSTITUTIONS,

SOUTHERN REGION PUERTO RICO~ 1940

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Figure 5-5

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FIGURE 6-8

PERCENT DISTRIBUTION OF RADIOGRAPHIC EXAMINATIONS

?BY BODY AREA IN PUBLIC AND PRIVATE MEDICAL INSTITUTIONS

SOUTHERN REGION PLERTO RICO ? 1968,

THORACIC

48.5%

(105, 576)

Lower ABOMINAL,

21.7%

2s 22) (47,440)

(22,148)

The percent distribution of the 217,73 radiographic examinations by body area in the Southern Region is shown in Figure 68

About half of all X-ray examinations performed in this region were related to the thorax, abdominal X-ray examinations represented about 22% of the total X-ray examinations. The percentage of lower extremity examinations (25,292)

7

---Page Break---

Figure 7-5

PERCENT DISTRIBUTION OF DIAGNOSTIC XRAY EXAMINATIONS
IN HOSPITALS AND OUTPATIENT CLINICS BY TYPE OF FACILITY.

SOUTHERN REGION OF PUERTO RICO-1968,

wosprTacs

33.19%

| mae68)

PRIVATE OFFICES

21.48%

(46,606)

HEALTH CENTERS

PUBLIC HEALTH UNITS

FONDO DEL SEGURO

33.58%

(73,129)

Figure 78 shows that rate of X-ray examination per 100 population in the hierarchy

In Ponce. It shows the most sophisticated X-ray machinery (and the highest economic and social standards) are

The data showed that in the Este Raion, those who live in the cities have more

medical X-ray examinations per 100 population per year than those who live in the

These differences are related to economic and social factors, which influence medical

care. The number of X-ray examinations per 100 population per year is higher in the

rate of X-ray examinations than those of the lower educational and income level

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DOSE MEASUREMENTS

"Medical radiation equipment is the most important electron product

with regard to population exposure? ;

In addition imparted to the gonads? For any reason? constitute a potential health hazard not only to the individual, but also to (or her) future offspring via the radiated genetic material, that may enable the genetic code transmitted from parent to offspring and may cause changes mutations? which are seldom seen?

In order to express the health hazard associated with each individual, a systematic procedure on a quantitative basis, three types of characteristic indicators are generally used:

- (4) The mean gonadal dose per examination of a certain type,
- (5) The per capita per annum gonadal dose as referred to a suitably defined population,
- (6) The genetically significant dose.

Reliable and accurate dosimetric measurements are indispensable for the evaluation of these indicators, for this reason no effort was spared to make the dose measurements as

accurate and reproducible as possible. The majority of the dosimetric measurements were carried out in the District Hospital of Ponce using a Picker 200 MA X-ray unit with a PX:1DA tube as irradiation source. This unit has a filtration equivalent to 5 mm of aluminum and a half value layer of 4 mm of aluminum, corresponding to an effective energy of 87 KEV at 16 KVP, a tube voltage typically used in abdominal X-ray diagnosis. The units are equipped with a variable collimator. Figures 1 DS and 2 D'S contain the data and demonstrate the method used to determine the half value layer of two different sources.

The instrumentation used for dose measurements included the following:

(a) Victoreen Model 227, bakelite walled ionization chamber, 1000 mR range

(b) Victoreen Model 228, bakelite walled ionization chamber, 6000 mR range

All Victoreen ion chambers were calibrated by the Victoreen Company using intercomparison with instruments whose calibrations are traceable to the US National Bureau of Standards and their accuracy is within $\pm 3\%$. A copy of the calibration certificate containing the approximate correction factors is enclosed with this report (see pp. 6844 and covers correction factor vs. KVP as plotted in Figure 3. D'S)

(6) Thermoluminescent dosimeters (TLD) manufactured by Conrad, model No. P27, containing 43 mg. of powdered LiF- encapsulated in polyethylene capsule, having a diameter of 5 mm. and a length of 17 mm. These dosimeters were precalibrated by the company and equipped with low energy filters. Intercalation curves relating LiF-TLD

---Page Break---

readings with Victoreen readings are part of this report (see Tables 1 D'S, 2.DS and Figures {DS ind 5 DS).

(2) Conrad Thermoluminescence Dosimetry System Model 100 B Readout Instrument
{or reading the itadated LiF-TLD dosimeters.

{Radiation sensitive film package, Model Du Pont SX-249126 (high sensitivity.

(f) Sensitometer, Model Mackbeth Anseo (property of the Health Physics Division,
Brookhaven National Laboratory). In (erealibration curves of film and Victoreen readings
sre part of thir report (we Table 3 DS, Fgures © DSund 7 D8, pp. 67-68

fd datasheets pp. 111-114)

(@) Rando-Phantom, Model Ran-100, manufactured by Macklett Laboratory, Inc. was
wed in lieu of the patient, with a radio sbxorplsty equivalent to human tissues, simulating
?rom sectional ies and contents typical of the human body.

The soft tissues of the phantom were molded of «thermosetting isocyanate rubber, a
juste both physically and chemically to the desired values of Z and specific gravity

In order to be able to measure the oval doses, the anatomic location of the ovaries was
determined by a radiologist and a slot accommodating the thickness of a Victoreen 228 ion
chamber was cut into the appropriate section (section No. 90 of the phantom), Table 4 DS
contains data concerning exposures at the location of the ovaries at a depth of 12.5

with the Rando. Phantom

The irradiation procedure was carried out by positioning the Rando-Phantom in such
a manner that it should closely simulate the positioning of the patient in an actual diagnostic
situation. With this positioning the gonadal exposure was measured using a Victoreen
chamber and next under identical conditions « LiF-TLD capsule

Results of these measurements are reported in Table 5 DS and Figure 8 DS. Figure 8
DS indicates that the relationship between Victoreen and corresponding TLD-LiP reading
is linear within the range of slight experimental errors

In vivo measurements were performed on male patients in the Ponce District Hospital,

Using TLD-LIF dosimeters to determine testicular in vivo exposures associated with ex-

posure of the considered abdominal X-ray diagnostic examinations. The results of these in vivo

measurements are reported in Table 6 D and are also compared to exposures on the

Rando Phantom obtained under identical radiological conditions (KVP, MAS, TFD etc.)

measured first with a TLD-LIF dosimeter, then with a Victoreen chamber. Table 6 D'S

Shows very satisfactory agreement of in vivo and in phantom readings, thus reestablishing

the reliability of the Rando-Phantom as research tool and also establishing confidence in

the validity of those in phantom tradition data (ovaries exposure) that are rather

complicated to measure in vivo. Figure 9 D'S demonstrates this correlation between in vivo

and in phantom readings

Units recommended by the International Commission on Radiological Units and Measure-

ment (published in NBS Handbook No. 85, 1964), are used throughout this report.

Rad ~ for absorbed dose

Roentgen ~ for exposure dose

Absorbed dose is dependent upon the mass absorption coefficient of the absorbing medi-

um, which in turn is energy dependent

Using the customary spectral composition of the diagnostic X-ray beam in the 50-100 KEV.

region, one Roentgen exposure dose in air corresponds to 877 rads of absorbed dose in air.

ey

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(One Roentgen exposure dose in soft tissue, under the stated stipulations, corresponds to 0.92

rad of absorbed dose in soft tissue)

Table 7 contains the mean gonadal doses by type of examination. Each value was measured several times in order to minimize experimental error. A Rando-Phantom was used in lieu of the patient. Victoreen chamber was used to determine the exposures and the results were converted into millirads by multiplying the corrected readings by the standard absorption factor (0.92). Table 8 D-S serves as a worksheet to compute the per capita per annum doses by sex as referred to the total population of the Southern Region, 1968 reported in Table 9 D-S,

The method of calculation is given herewith

In order to determine the corresponding gonadal doses (absorbed) one must multiply the exposure doses (mR) by the factor 0.92 (the proper conversion factor for soft tissues, as explained previously)

The first column of Table 8 D'S presents the Mean Gonadal Exposure Doses by Sex and by Type of Examination.

The second column of these Tables containing the Mean Absorption Doses is obtained by multiplying the first column (Exposure Doses) by the conversion factor 0.92, as given in NBS. No. 85, 1964

The third column of the Tables contain the Total Number of Examinations by Type of Examination and by Sex.

Each entry in the fourth column is computed by multiplying the corresponding entry of columns two and three, resulting in the Global Gonadal Absorption Dose by Sex and by Type of Examination.

The Total and Grand Total column contain the corresponding totals of Examinations and Global Gonadal Absorption Doses. The second figure in this column gives the Mean Gonadal Absorption Dose by Sex and the Average; computed by dividing the corresponding entries of column four by those of column three. The Average Gonadal Dose weighted by the corresponding number of cases.

The first figure of the Total column is obtained by dividing the corresponding second column entry by 92.

Using the Global Irradiation Dose in Table & D-S with the proper population figures, the per capita annual average radiation dose due to all the generally performed abdominal and thoracic diagnostic X-ray examinations in the Southern Region, Puerto Rico-1968 is computed thus: 22.7 mads per person per year for males 86.4 mads per person per Year for females and 43.6 mads per person per year for both sexes.

Table 10 D'S contains the calculation of the mean gonadal doses by sex and by type of thoracic examination and the mean gonadal dose due to all thoracic examinations computed with the method described above

It is interesting to observe that although the number of x-ray examinations per 100 patients is higher in the Southern Region than the corresponding figure in the Western Region (1967/8 140.6 vs. 84.1), the per capita gonadal dose in the SR in 1968 is lower than the corresponding figure in the W-R. in 1968 (43.6 vs 56.4). This may very well be due to technically sounder practices in the S., associated presumably with the generally higher, industrial and technical level of that geographic region. As an illustration of what is meant by "technically sounder practices" it is worthwhile to point out that only 60.2% of the thirty-three diagnostic X-ray units in use in the Southern Region-1968 had variable collimators while only seventeen (27.77%) of the seventy-eight diagnostic X-ray units in the

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Western Region 1968 had variable collimators. The importance of good collimation in relation to the unintentional gonadal doses demonstrated in Figure 10 D'S which compares

the anatomical regions of the body exposed to direct radiation during thoracic X-ray

Diagnoses performed with

(a) a variable collimator,

(b) a cone,

(c) no collimation

The thoracic examination formed a large part (40-50%) of all diagnostic radiology in

the Southern Region in 1968, though the gonadal dose was only 1-2 mrad in the average

chest diagnostic X-ray examination

Certain radiological practices designed to save time for the radiologist may have adverse effect on the gonadal dose. It was observed that certain institutions practice the following

procedure in the "small intestinal series" After the patient swallows the barium, 5-6 expo-

surements of the 11" by 17" area are made at prescribed intervals by the X-ray technicians. The

films are then interpreted by a radiologist. In this procedure the testis are almost always in

the primary beam, resulting in testicular dose of approximately 1500 mrad per examination:

whereas the testicular dose associated with the "gastrointestinal series" routine per-

formed by spot film technique is only about 176.6 mrad (see Table 7 SD),

This example should be indicative of how significant sound radiological practices are in

keeping the intentional gonadal doses as low as possible

It may be concluded then, that since the unintentional gonadal doses dependent upon a series of radiological parameters such as beam quality, collimation, direct testicular shielding, filtration, and exposure rate. These parameters require careful evaluation in each case by the physicist in order to keep the unintentional gonadal dose as small as possible without interfering with the quality of the diagnostic information required.

Optimising all parameters with this performance index in mind is the declared purpose of every professional involved in the complex field of radiation protection

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Figure 1 DS:

Figure 2 S:

Figure 3 DS:

Figure 4 DS:

Figure 8 DS:

Figure 6 DS:

Figure 7 DS:

Figure 8 DS:

Figure 9 Ds:

Figure 10 Ds:

UST OF FIGURES.

Determination of Half Value Layer in the most common X-ray unit,
Southern Region, Puerto Rico-1968,

Determination of Half Value Layer, by graphical method,
?ranemited radiation vs, absorber thickness

?Comction factor of Victoreen 227 and 228 chambers,

LIF-TLD powder and Vietoreen 228 ionchamberintercaliraton curves
(Ref, Table 15}

LIF-TLD powder and Victoreen 227 intercaibration curv
(ef. Table 205},

Indirect beam exposures as measured by Victoreen 227 chamber and
by relative optical density of DuPont SX249-135A film v.vllage
splied 20cm. caudal from central beam incidence

Indirect beam exposures as measured by Victoreen 221 chamber and
by relative optical density of Du Font SX249-135A films vs. voltage
applied 20cm. caudal from central beam incidence.

[LIP-TLD reading vs Victoreen reading, radiation simultaneous and
Under dental conditions

(A) Correlation of in vivo and in phantom testicular exposures

(B) mR per in vivo count vs. LAF phantom count,

Influence of collimation techniques on the body area exposed to

direct radiation, and as a consequence on the gonadal dose received
by the patient during thoracic X-ray diagnosis.

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DETERMINATION OF HML. MN THE MOST COMMON X-RAY UNITS.

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NO. TEMPERATURE. CORRECTION WAS MADE.

4) VIETOREEN CHAMBER-227 |DOOR WAS USED TO MEASURE EXPOSURE.

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DETERUNATION OF HALF VALUE LAYER SY GRAPHICAL

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FIGURE 4 05

LIF-TLD POWDER ANO VCTOREEN 228 JON CHAMEER wTER?

MATION CURVES (REF, TABLE 108) y

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FIGURE 50-S

LIF-TLD POWDER AND VCTOREEN-227

INTERCALIBRATION CURVE (REF TABLE 20S)

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VICTOREEN READING ~ mR

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FIGURE 80s

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LIST OF TABLES:

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Comparison of testial and ovarial exposures per examination at

measured hy Vietoreen 228 (IR) and by TLD-LAP detewter: ong

Preker 300 Xr: init and Rando Phottom,

Souther Region, Puerta Rico 1968,

Comparison of vivo and in phantom testicular exposures by type of examination. Southern Region, Puerto Rico-1968

Mean yearly effective per X-ray examination by type of examination and sex. Southern Region, Puerto Rico-1968,

Estimated dose per patient due to each thoracic X-ray examination, Southern Region, Puerto Rico-1968,

Estimation of the mean per capita gonadal dose due to 3 selected especially hazardous abdominal diagnostic ray examinations, Southern Region, Puerto Rico: 1968

Estimated per annum mean gonadal dose due to all medically necessary abdominal and thoracic X-ray examinations.

Estimated per annum mean gonadal dose due to all medically necessary abdominal and thoracic X-ray examinations. Southern Region, Puerto Rico 1968

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(OF GENETICALLY HAZARDOUS ABDOMINAL DIAGSOSTIC X-RAY EXAMINATLONS

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GENETICALLY SIGNIFICANT

DOSE

"The unintentional radiation of the gonads affects not only the patient, It may damage

the patient's offspring, and future generations via the genetic material transmitted from
Irradiated parent to ei

In order to express the magnitude of this effect in a quantitative fashion, a representative
parameter called The Genetically Significant Dose (GSD) was designed

In their basic paper on the subject (see ref 8) Penfil and Browns explain how the GSD is
computed and how its used as a index to measure genetically transmittal radiation
hazards: Their general formula

N_i

$= N_i P_i$

ations of the U.S. Public Health Service (see ref. 8)

\sum

{use the publ

In this formula

, \bar{D} = the average gonadal dose to persons age (i) who receive X-ray examinations,

[N = the number of persons of specific sex receiving the examination in the age class

considered

, = the expected future number of children of a person age (i), and

5,

the number of persons in the population of age (i)

The GSD as computed by the Penf-rown formula gives the average gonadal dose per offspring (referred to a given population) due to unintentional gonadal radiation of the parent generation

?The formula used is

?wate $>$), (Ponaie_

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ns ones to perform the evaluation, Table 2. GSD was first compiled to compute the
number of examinations performed in the Southern Region of Puerto Rico in 1988
by type of examination

Next work sheet was set up for each type of examination, a sample of which attached
to this report. This contains the NI values and gonadal development values which correspond
to the type of examination as shown. The product of the last two columns are
entered into the seventh column (NI, Dim. Pin and the product of the
ninth and tenth (NI, Di, Pf) was entered into the eighth column. The sum of the seventh
and eighth columns

$2 \text{ (sum Dim Pin + NI DEE,}$

This was divided by NP, which is the overall sum of products formed from population
figures in the corresponding age sex group by the number of expected children
The GSD is the quotient of those two numbers. Table 3. GSD estimate of GSD
values by sex and type of examination as well as total GSD values by the total number
of examinations considered in the report

Among all types of diagnostic X-ray examinations considered, the highest values are associated with Lumbar Spine, VP and Gastrointestinal Series, Except for examination involving the pelvic region (which may have the testes in the direct beam) female GSD

is higher than male GSD"

The genetically significant dose in 1965 in Puerto Rico's Southern Region is lower than the values reported for the USSR (1964), Sweden (1955) and Japan (1960). The number of diagnostic X-ray examinations of all kinds per 100 population is 11. Second only to the USSR (1968) which had 83,

---Page Break---

Table 1 GSD:

Table 2 GSD:

Table 3 GSD:

Table 4 GSD,

Table 6 GSD:

LIST OF TABLES:

?Number of thoracical diagnostic X-ray examinations in the reproductive age (15-44) by geographic location, by medical facility and by sex Southern Region, Puerto Rico-1968,

?Number of abdominal diagnostic X-ray examinations by type of examination, age and sex. Southern Region, Puerto Rico-1968,

?Number of thoracical diagnostic X-ray examinations by type of examination, age and sex. Southern Region, Puerto Rico 1968.

Genetically significant doses in millirads by type of examination, age and sex. Southern Region, Puerto Rico 1968.

?Comparison of reported annual genetically significant dose from diagnostic radiology (selected countries).

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TABLE 2 (6.5.0.)

NUMBER OF ABDOMINAL, DIAGNOSTIC. X-RAY EXAMINATIONS

BY TYPE OF EXAMINATION, AGE_AND SEX

SOUTHERN REGION, PIERO RICD=1968

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EXAMINATION, sex] o-te | 15-29 | 30-46 45+] sora, iutat

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[Gastrointestinal } 62 | 1,407 1,670 79] 3,200

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TABLE 4 6.8.0,

(CPRETICALLY SUGSIFLCANT DOSES I MILLIRADS ay TYPE OF EXAYTMAT

SSOUTIERN REGION, PUERTO RICT=1968

Genetically Significant Dose

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TABLE 5 (6.8.D.)

(COMPARISON OF REPORT ANNUAL GENETICALLY SIGNIFICANT DOSE.

"FROM DIAGHOSTIC RADIOLOGY (SELECTED COUSTRIES)

rr arreany ? ?

Significant Examinations

Bose. in Per 100

study silsrede Population

United States (1954) 4 55 3

Sweden (1955) * 2»

Japan (1960)+ » a

Southern Region of

Puerto Rico (1968) | 36.2 soa

aged on Population Dose From X-rays, U.S. 1964, U.S.

Dept. of Health, Ed. and Welfare,

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APPENDIX |

WESTERN REGION

1968

A) DOSE MEASUREMENT -1968

8) THE GENETICALLY SIGNIFICANT DOSE 1968

?The following appendix contains satsticl and dosimetsc material ref

co 1968, tabulated and up dated with rs

: the mal

ine diferent geographic

Certain tables containing recent data on thoraciel examina

GSD values, etc. were added.

Computations of

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LIST OF TABLES

Table W: Number of abdominal X-ray examinations by type of examination, age and sex. Western Region, Puerto Rico-1968,

Table 2W: Number of thoracical X-ray examinations by type of examination and sex. Western Region, Puerto Rico-1968,

nae

Table 3 W: Mean gonadal per examination dose due to each thoracical X-ray examination: Western Region, Puerto Rico-1968.

Table 4 W: Mean gonadal dose per X-ray examination by type of examination and by sex. Western Region, Puerto Rico-1968,

Table 5 W: Computation of the mean per capita gonadal dose due to selected

soup of genetically hazardous abdominal diagnostic X-ray examinations

Western Region, Puerto Rico-1968,

?Table 6W: Per capita, per annum mean gonadal doze due to genetically hazardous
stdominai and thoracial X-ray examinations.

Wester Region, Puerto Rico-1968

?Table7 W: Genetically significant doses in

Western Region, Puerto Rico-1968,

ids by type of examination,

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TABLE 4-41

MEAN GONADAL DOSE PER X-RAY EXAMINATION BY TYPE OF EXAMINATION AND BY SEX.

WESTERN REGION, PUERTO RICO-1968

Millirads per examination

Type of Examination Yale Female.

Chest 1.81 92

Photofluorography 2 Id

?Tomography - -

Abdomen 88, 226

Cholecystograph 9 168

Lumbar spine 69 1,336

Gastrointestinal Series 146 632

Barium Enema 1,232 2,972

Lup. 386 21

Pelvis 904 49,

Hip Joint 102 251

Pelvic = Lona

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THRE

?COMPUTATION OF THE MEAN PER CAPITA GONADAL DOSE DUE TO A SELECTED $\phi x 0$

?OF GENETICALLY HAZARDOUS ABDOMINAL DIAGNOSTIC. XRAY EXAMINA

ESTER REGION, PUERTO RICO-1968

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Exposure | Absorption reaction |

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TABLE TW

CCENETLCALLY SIGNIFICANT DOSES 1% MELLIRADS AY TYPE OF EXAMINATION
WESTERN REGION, PUERTO RICD-1968

> Se BE

Type of L Ip MEADS PER FUTURE OFFsRPIC

Franination Tae Fesale ?

Abdones 2.6 5.0. 3

cholecysto-

my 0.10, 2.0, Lo

lumbar Spine 16. 15.8 8.7

serie . 0.95 18 zo |

Barium fnena 15.3 46 9.87

Liver. 6.26 25.2 20.73

Petes 6.68 2.02 3.85,

ip Joine 3.20 19) | 2.56 |

Pelvineery, = ors 01s

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Exazinaeions :

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APPENDIX 2

THE X-RAY TECHNICIAN

This appendix considers the operating personnel of medical X-ray units in Puerto Rico.

There are more than one thousand X-ray operators on the island. Approximately six hundred are licensed and the remainder lack formal training; more often than not, their knowledge of the principles and practices involved in efficient radiation protection is inadequate.

In the course of the present survey, we found operators who have been working in this field for more than twenty years, still unlicensed,

In radiography, approximately ninety percent of the exposures are made by the X-ray technician upon the written request of the physician. The amount of radiation received by the patient, the shielding of the testes and collimation used are direct results of the knowledge, conscientiousness and preparation of the technician. Lack of knowledge on the part of the technician may result in the most tragic consequences.

Recently, one acquaintance was severely injured in a traffic accident. Although X-ray technicians are taught that a long bone of the human body should never be photographed without including the joint in this case the operator radiographed the broken femur only.

[An operation was performed, Two days later, due to complaint of the patient, further

"adiogmaphs were made to taclude the joint ofthe femur, which was found to be badly
?damaged. This necessitated a second operation which resulted in enormous suffering to the
Patient and was a probable causo of the development of bilateral pneumonia. We ete this,
?example, from among many others, to ilustate the responsiblity of the technician and
the necessity of proper taining

?The best Xray equipment is of no use if ts used by operators who are uninformed as
to the potential hazards of X-ray techniques necessary forthe reduction of unnecessary
?exposure. A nutseor a medical asistant-not licensed eh an Xray technician-cannot be
?expected to atain competency after brie instruction given by = doctor ora salman,

Xetay technology ia complex field, which equires specific training and experience, espe-
ally in Uhe more advanced techniques. To our knowledge only afew states require the
loensing of every Xray technician forthe sake of public safety,

?The ole of Kays in diagnostics and in therapy is of extreme medical significance,
However, since extreme health hazards may be the result of incorrect application, the

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?operation of medical Xray units in public and private institutions should be restricted by
lw to technicians edveated and licensed under the close supervision of the Department of

Health.

The Health Department of the Commonwealth of Puerto Rico is presently trying to improve the economic and professional level of island technicians, to establish uniform (Commonwealth standards, and regulations to protect patients and occupationally exposed personnel

Following its brief history of the development of The X-ray Technicians Association in Puerto Rico, based upon information given by the Association President, Mrs. Ana C. Lopez de Cr,

A small group of technicians organized for the first time in 1948. The Association was registered at the office of the Executive Secretary of Puerto Rico, Department of State, Apr 27, 1948.

The group immediately became the standard-bearer of a profession that claimed to be legally recognized and regulated under the laws of Puerto Rico. The preparatory school on the island at that time offered a substandard course, Only those interested in the field as a profession entered the Bayamón District Hospital and San Juan City Hospital as students, After completing their island studies, many continued to study and practice in the United States, increasing their professional knowledge

In subsequent years, the Association strived to interest the Puerto Rican Legislature in approving law which recognized and regulated the profession, In 1968, the Legislature

?pproved s Bil, which became Law 7

?Two Xray technicians were added tothe Board of Examiners asthe result ofan amend-
ment to Law 78 approved bythe Legislature in 1967.

?Members ofthe Board of Examiners at:

1. Dr. dosé T. Medina, President

2 De dons Tome

4. De. done Correa

5

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Several courses are conducted on the island to prepare X-ray technicians for licensing.

?The Association now hopes to mise profesional standard to the university level, since

?moe sophisticated curriculum is required by complex modern X-ray unit.

?The following list shows the X-ray techincians licensed since the Board of Examiners
began in 1964. Aa extmated 800 are working in Puerto Rico,

?There are approximately 400-500 technicians working with X-ray units in private offices with only « practical background,

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LICENSED X-RAY TECHNICIANS IN PUERTO RICO

ame lasve Date License No

Abreu Dovsl, Herberto 75/64 1

?Acevedo Nieves, Carmen Socorro" 2

Acevedo Rodriquez, Saris C. " 3

?Acosta, Carmen Della " 4

Alea Frasquers, Rafal * 5

Allende, Og, * 6

Alicea Cartagens, Juan Bautista ? 7

?ImodSeur Rondo, Miguel » &

?Alvarez Cabrera Lidia : 8

Andale de Claudio, Rosario . 10

?Andino de Aivare, Sar un

?Arrovo Sire, damita > ry

?Atocho Valentin, Rubén ° 3

Antoyo Velazquer, Etain » 1%

?Aula Jastniano, Maria Luisa 7y23j04 15

?ies Huerta, Carmen * 16

Benitez Figueroa, Carmen . 1

?Berefos Paro, Srafin 18

Berrios Rivers, Deli . 19

Borrero Martinez, sis Alfredo ? 20

Calderon Calderon, Hila D, a

CCaraallo Soto. Liss Marfa

Cordova, Carlos

(Carmo Evia, Maré Luisa

aria Infante, Ral

?Castro Encernacion, Marcelo

Castro, Mari Magdalena

?Castro Gonziler, Carmen Lydia

(Castro de Thomas, Alejndrna

(Casto de Varela, Mara Ramonita

CCentono, Ross Mi

?Chines Rivera, Jess

?Gintron, Alma Margie

Collazo Gonzalez, Pablo T

Collazo de Rivera, Ma

Colin Gémer, Ana Maria

CColén Rodrigues, Manuel

Cordero Rodriguez, Carlos Juan

Cortes Encamacion, Juana

Cortés, Carmen Iraida

(Conta Gomez, Rona Milagros

Crespo Romero, Idegarda

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?Cruz Carmona, Ana Luisa

Cruz de Esquerdo, Blena

(Cruz Garcia, Ana Bisa

(Gaus Torees Eménida

(Crue River, Fermin

De Arce Oni, Florencio

Disila Gales, Ramon M.

De dest Gonaer, Secundine

De desis Lapes, Herminia

De deat Osorio, Isabel

De Is Cruz Fonrodona, Juan

Delgado Crespo. William

Det Valle de Martinez, Carmen

Dessus Medina, Vitor

Diaz Abraham, Manuela

?Disa Gabriel, Yanina

Dias Medina, Evangelina

Dian de Palacios. Ana Trinidad

Domenech Mestre, Adels|

Fehevari, Teresa

Echevarrs de Torres, Dominga

Falcon Rivers, Susana

Feliciano, Rosa Ins

Felix Ronse, Ange! Lae

Fernindes Rivers, Angel S

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Figueroa Reyes, Resalina

Bruno Loseda, Josefina

Castillo Ramos, Nivin

Figueroa Reyes, Sonia

Figueros Rodrigues, Marta

Figueroo Romin, Lydia

Flores ane, Juanita,

Flores Santon, Catlor Ernesto

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Fuentes, Le M,

ia Rivera, Sonia

rio, Cuillermina

Gauittens, Ruby ?.

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eeninder, Maria del Paar or

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{ein Orozco, Pablo Juan * 99

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Marin Cuevas sara Lu : uz

Martero Ortiz iba ek a ns

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Martines, Ans Ine . ns

Martinez Forts, Mara V. * ne

Martines, Leis Lat - nt

Master de Morales, Eulalia ? ns

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Merced de Flores, Bath

Mili, Luz Maria

Miranda, Areos G.

Miranda Mos, Josefina

?Moreno Garni, Eusebio

Monserate Micanda, Maria M.

Montero Cruz, Masia Dolores

Morales Andino, Héctor

Morales de Cardona, Leticia

?Mores de Dine, Marta

?Morales de Machargo, Enriqueta

?Morales, Emma Encarnacion

?Moree Ori, Jone 8

Morales de Ramos, Maria M.

Morales Rosa, Aida Esther

?Muior de Coldn, Monserate

Mutioz Orza, Felipe

Nite, Esther Maria

[Navarro Archilla, Roberto

Negron, dosé i.

Nieto de Alvarez, Marie A

Nieves, Ricardo,

[Nieves Biez, Marfa Socoro

[Nieves de Pintado, Ana Irene

Nieves Santiago, Awilda

Nites Rivera, Nelly

casio Bermides, Avrora

casio Vazquez, Pedro Juan

Olivero, Praca B,

Ortoga de Reyer, Carmen E,

Ortn de Car

Ortiz Espinosa, duanita

Ortie de Paleon, Marta

?José Ernesto

Lis Felipe

Oris Quiles, Resaldo

Pabey Rodrigue, Antonia

Pada Gonadles, Miriam

Pagan Vale, Asuncién

de Vive, Fea

niagua Rondon, Guadalupe

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Pinto de Velgoques, Julia E.

Planae Sosa, Raquel

?Quintans Ramos,

Preto de Divila Edel

?Quintero de Delgado, Carmen,

Raldin, Juan A,

Ramery Bard, Lats B

Ramirez Aimoddvar, Fernando Ly

Ramirez, Maris Teresa

Ramee de Rivors, Miguelina

Ramos Ayala, dunn

?Ramos Cabin, Milagros

?Ramos Calderon, Rose

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amor Colan, Eva

Ramos Figueroa, Erasmo

Reyes, Camen [

Rijs de Melecio, Carmen Luz

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?Rivers Carto, Nile

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Rivera Matis Isabel

Rivera Lopes, Maria G.

Rivera Martine, Héctor Las

Rivera Meténdeá, Ol

Rivers Carmona, Modesta

Rivera, Pedro L

Rivera de Rosario, Carmen Le

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Rivera Suire, Milagros

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Rodeiguez, Matilde

Rodriguer Rodriguez, Margarita ?

Rodeiguer de Toledo, Edith

Rodriguer de Torres, Francisca

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Rotrinaez Varga, Maria

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Rowilo Febus, Ramona

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Sanchez Gonzales. José A

?inches Rosario, José Lats

Santiago Cra. Lyin Esther

Santiago Pormta, Luis

Santiago Rivers Jose Ania

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Santiago Rolon, Aurelio.

Santor Rivera, Carmen Asmidia

Serrano Siet, Juanita

Siaca Nevares, Juanita

Sera, Jacinto

Alvares Laneza Salgado, Carmen 7/22/64

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REFERENCES

Adrian, GM. and Crooks, H.E: A Comparison of Radiographic Techniques with Special Reference to Dosage. Brit. J. Radiol. 26:352, 1958.

Atix, Frank H.: Luminescence Dosimetry. 1967,

Brown, J.G.: X-rays and Their Application, 1968.

linger, Friedrich: Medical Radiation Biology. 1957

Gilead M.: Evaluation of Health Hazards Due to Unintentional Imadiation ofthe Gonads During Routine Abdominal Xray Examination of Mate and Female Patients

in Puerto Rico, RI, West. Reg, doint Rad, Survey. Comm, of PR. Nuclear Center,

Dept of Health. p7, 1968,

Medical Directory of Puerto Rico, First Edition. P.R. Med, Foundation, 1968

Medical Radiation Information for Litigation. U.S. Dept. Health, Ed. and Welfare
Pub, Health Service,

Penfil,R.L. and Brown, M.I.: Genetically Significant Dose to the United States
Population from Diagnostic Medical Roentgenology, 1984, Radiol. 90:209-216, 1968.

Piesch, E: The Indication of Absorbed Dose in Critical Organs by Energy Independent
Personae! Dosimeters, Health Physics, Pergamon Press. Vo. 18. 1988,

Plan for Hospital. Comm. of PLR. Dept of Health, 1968,

Popul

1969.

for Dose from X-rays, US-1964. U.S, Dept of Health, Ed. and Welfare,

Preliminary Result of 6296 Xray Protection Surveys (1962-67). U.S. Dept. of

Health, Ed. and Welfare Pub. Health, Service. 1968.

Radiation Protection Survey Report Manual, U.S. Dept. of Health, Ea. and Welfare
Pub, Health Servic, 1967

Radiation Quantities and Units, Internat. Comm, Radiot Units and Me
(Le R.U) 1962

Yoshinaga, Horuma and others: Estimation of Exporure Pattern and Bone Marrow
snd Gonadal Doses during Fluoroscopy. rit. J. Radiol. Vol 40.1967.

Radltion Bio-tfects, Summary Report. US. Dept. of Health, Bd. and Welfare
Pulp Health Service. Jan-Dec. 1969,

ue

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