Online ISSN : 2249-4618
Print ISSN : 0975-5888
DOI : 10.17406/GJMRA

Global Journal

of Medical Research: D

Radiology, Diagnostic Imaging and Instrumentation



Highlights

- Exposure of the Population
- Ingestion of Coins in Children
- Radiation Related to Medical
- Emergency Care at EHU Oran

Discovering Thoughts, Inventing Future

VOLUME 19 ISSUE 2 VERSION 1.0

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Volume 19 Issue 43 was originally issued as D2

Global Journal of Medical Research: D
Radiology, Diagnostic, Imaging and Instrumentation

Volume 19 Issue 43
Originally issued as D2

Global Journal of Medical Research: D
Radiology, Diagnostic, Imaging and Instrumentation
Volume 19 Issue 2 (Ver. 1.0)

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Offset Typesetting

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Global Journal of Medical Research: D
Radiology, Diagnostic and Instrumentation
Volume 19 Issue 2 Version 1.0 Year 2019
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

Exposure of the Population of Ngaoundere-Cameroon to Ionizing Radiation Related to Medical Diagnosis in 2018

By Mathurin Neossi Guena, Baudouin Djoumessi Nanfack & Joseph Gonsu Fotsing

University of Ngaoundéré

Abstract- *Background:* Medical applications are the main source of exposure to ionizing radiation of human origin. Our objective was to determine the data on exposure to ionizing radiation of medical origin of the population of Ngaoundéré in 2018.

Methodology: It was a cross-sectional descriptive study conducted within a period of one year, in the different hospitals of Ngaoundéré, with a functional medical imaging service. The variables studied were age, sex, type of examination, anatomical region and effective dose. The statistical analysis was performed using the Microsoft Office 2016 software, Sphinx V5; the effective dosage was calculated using the Internet Dose calculation Module.

Keywords: *exposure, ionizing radiation, conventional radiology, city of ngaoundéré, 2018.*

GJMR-D Classification: *NLMC Code: QZ 241, QT 162.U4*



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Exposure of the Population of Ngaoundere-Cameroon to Ionizing Radiation Related to Medical Diagnosis in 2018

Mathurin Neossi Guena [α], Baudouin Djoumessi Nanfack [σ] & Joseph Gonsu Fotsing [ρ]

Abstract- Background: Medical applications are the main source of exposure to ionizing radiation of human origin. Our objective was to determine the data on exposure to ionizing radiation of medical origin of the population of Ngaoundéré in 2018.

Methodology: It was a cross-sectional descriptive study conducted within a period of one year, in the different hospitals of Ngaoundéré, with a functional medical imaging service. The variables studied were age, sex, type of examination, anatomical region and effective dose. The statistical analysis was performed using the Microsoft Office 2016 software, Sphinx V5; the effective dosage was calculated using the Internet Dose calculation Module.

Results: In 2018, 4136 diagnostic acts using ionizing radiation were carried out; it concerned only conventional radiology with an average of 0.02 per capita. The total collective dose received by the population was 8300 mSv, and an average dose of 0.040 mSv per inhabitant. The proportion of the population that has actually benefited from a conventional radiology examination is 2.07%, an individual effective average dose of 2 mSv.

The most frequent acts involved the thorax, limbs, spine and pelvis with respectively 53.9%; 19.6%; 14.3% and 6.7%. Acts involving the spine, pelvis and hip, skull and abdomen contributed the majority of the collective effective dose respectively with 39.99%, 25.96%, 10.53% and 8.84%. The age group performing most exams in men is 25 to 49 and 25 to 54 in women; the number of acts is higher among men 2457(59,4%) acts compared to women 1679(40,6%) acts. The collective dose per sex is higher among women with 4487.22 (54.06%) compared to men with 3812.98(45.94%).

Conclusion: Only 2.07% of population of Ngaoundere benefited from a conventional radiology examination in 2018 with an individual effective average dose of 2 mSv. The annual per capita effective dose in Ngaoundéré in 2018 is 0.040 mSv.

Keywords: exposure, ionizing radiation, conventional radiology, city of ngaoundéré, 2018.

I. Introduction

Medical applications are by far the largest source of exposure to ionizing radiation of human origin. Thus, diagnostic procedures account for more than 97% of artificial exposure and nearly 26% of total exposure of the population [1]. This exposure leads to absorption by the subject in contact with a dose likely to induce harmful biological effects on the body which are of two types, the so-called deterministic short-term effects directly related to cellular lesions for which a threshold of appearance has been defined and the so-called stochastic long-term or random effects dominated by cancers and genetic anomalies and which can develop from few hours to several years [1]. It would therefore be important to regularly estimate this medical exposure and analyze its evolution over time. A recent publication on the exposure of the population to ionizing radiation in the United States points out that medical exposure per year and per individual has increased six-fold, since the 1980s [2]. Directive 97/43/ Euratom [3] states in Article 12 on the estimation of doses received by the public: "Member States shall ensure that the distribution of individual doses generated by exposures for medical purposes is determined for the population and for the reference groups concerning it, depending on whether the Member States deems it necessary". The current revision of Directive 96/29/ Euratom [4] on basic radiation protection standards should introduce an additional requirement: "Member States shall ensure that the distribution of individual doses due to medical exposure is determined and takes into account the age and sex distribution of the exposed population". In recent years, many actions, both at European and American level, have been initiated in order to harmonize methods of collecting information and thus to have reliable indicators on the medical exposure of the population.

This is the case of the European Union's Dose Datamed project (2005-2007) which led to the publication of the report "radiation protection no. 154: European guidance on estimating population doses from medical x-ray procedures (2008)" [5] and the "International action plan for the radiological protection of patients" action plan led by the International Atomic Energy Agency (IAEA). Great Britain is undoubtedly the country that has done the most in this field because, in the late eighties, the National Radiological Protection Board (NRPB) set up a national system of dose evaluation. By type of examination based on

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measurement campaigns conducted by a sentinel network of hospital services. Other countries, such as the Netherlands, Switzerland or Norway, also rely on annual activity data from all or some hospitals. For several years now, the fleet of heavy imaging equipments has expanded in Cameroon, with the creation of multiple imaging centers for public and private purposes therefore, an increase in examinations and protocols, with the result of irradiation of the population. However, the global exposure of the population to ionizing radiation of medical origin has never been evaluated in our country in general and in Ngaoundere in particular despite the creation of the National Radiation Protection Agency in 2002 with the primary mission of protecting people, goods and the environment against ionizing radiation [6].

It is also responsible for the dosimetry of patients, professionals, the public, the environment in the imaging services. This is why it is necessary to set up a long-term system to monitor practices both from the point of view of the knowledge of the nature, the frequency and the distribution of examinations in the population, then from the point of view of doses given to patients during these examinations. Thus, we proposed to conduct this pilot study to evaluate the medical exposure of the population of Ngaoundéré to ionizing radiation of medical origin in 2018, which could be the start point for monitoring these populations.

II. Methodology

The study was carried out in the two Hospitals with medical imaging departments equipped with ionizing radiation equipment in the city of Ngaoundéré, namely the medical imaging department of the Regional Hospital and the Patient Clinic. This was a descriptive cross- sectional study, conducted within a period of one year, from January to December 2018, including all patients coming to perform a medical imaging examination, using ionizing radiation. The diagnostic acts selected for the study were those of conventional radiology, which are the only ones currently performed in the city of Ngaoundere and grouped according to the anatomical zone explored. Finally, 25 areas were defined for this study. The variables studied were the frequencies of diagnostic procedures by anatomical region, age, sex, examination required, anatomical region, indication of examination, irradiation parameters and irradiation dose. The collection took place as practices in the imaging centers over a period of one year. The extrapolation of the results of the survey sample to the general population was based on data from the last census of the general population of Cameroon; which estimated the population of Ngaoundere at about 200,000 inhabitants. The study will therefore make it possible to estimate the population actually exposed to radio diagnostics in the public sector as well as in the private sector. In accordance with the recommendations of European Commission (EC) Report No. 154 [5], the dosimetric indicator used in this study to estimate the dose to the population related to medical exposure is the effective dose E (expressed in milli sievert, mSv) which is an indicator of the risk of health detriment linked to individual exposure to ionizing radiation. Being a standardized indicator, it allows comparisons between different countries and study of the evolution of the exposure that results from this or that type of act over time. Effective doses were calculated using the conversion factor values defined in ICRP Publication 60 [7]. From the number of Nt acts and the average effective dose and associated with each type of act t, it is possible to calculate the collective effective dose $S = \Sigma Et \times Nt$ [8]. The annual average effective dose per inhabitant is obtained by dividing the collective effective dose S by the total population size for the year studied, whether or not exposed to ionizing radiation. The statistical analysis was carried out using the software sphinx V5, Excel 2016 and the effective dose was calculated from the Internet Dose calculation Module (MICADO) online software of the National Institute for Radioprotection and Nuclear Safety (NIRNS) of France.

III. Results

a) Total number of acts and collective effective dose for the population of Ngaoundéré in 2018

It is estimated that 4136 diagnostic procedures were performed in Ngaoundéré from January to December 2018. Of the 4030 patients, of whom 2394 (59.4%) were men and 1636 (40.6%) women, the sex ratio was H/F of 1.5 (Figure 1) and an average act number of 0.02 per inhabitant, 2.07% of the population of Ngaoundere performed at least one conventional imaging examination in 2018, so 0.84% women and 1.22% of men. The mean age was 37 +/- 19.25 years with 1-month and 96-years extremes, the most represented age groups were 30-34 years with 378 (9.13%) cases, 35-39 years with 298 (7.20%) cases, 25-29 years with 266 (6.43%) cases, 40-44 years with 216 (5.22%) cases, 45-49 years with 214 (5.17 %) cases, and 20-24years with 202 (4.88%) cases (Table 1). The age group performing the most examination in men is 25-49 years and 25-54 years in the women.

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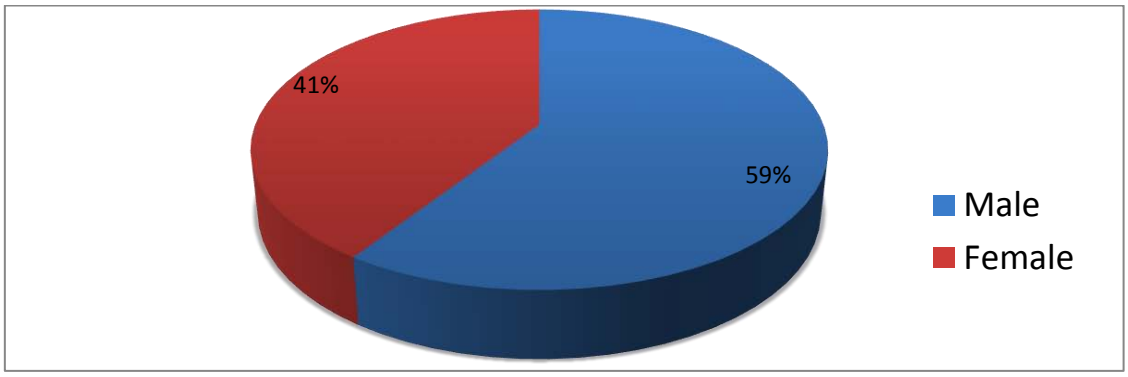


Figure 1: Distribution of acts performed by sex

Table 1: Distribution of number of acts performed by sex and age

Age group		Frequency of act			Total	
	Male	Percentage	Female	Percentage		Percentage
0-1	16	0,39%	28	0,68%	44	1.06%
1-8	50	1,21%	38	0,92%	88	2.13%
5-9	44	1,06%	50	1,21%	94	2.27%
10-14	64	1,55%	50	1,21%	114	2.76%
15-19	72	1,74%	38	0,92%	110	2.66%
20-24	140	3,38%	62	1,50%	202	4.88%
25-29	172	4,16%	94	2,27%	266	6.43%
30-34	252	6,09%	126	3,05%	378	9.13%
35-39	176	4,26%	122	2,95%	298	7.21%
40-44	154	3,72%	62	1,50%	216	5.22%
45-49	138	3,34%	76	1,84%	214	5.17%
50-54	76	1,84%	78	1,89%	154	3.72%
55-59	82	1,98%	52	1,26%	134	3.24%
60-64	100	2,42%	68	1,64%	168	4.06%
65-69	40	0,97%	34	0,82%	74	1.79%
70-74	40	0,97%	20	0,48%	60	1.45%
75-79	10	0,24%	24	0,68%	38	0.92%
80-84	18	0,44%	18	0,44%	36	0.87%
85-89	12	0,29%	8	0,19%	20	0.48%
90-94	6	0,15%	4	0,10%	10	0.24%
95 -	2	0,05%	2	0,05%	4	0.1%
Empty	792	19,14%	620	14,99%	1412	34.14%
Total	2457	59,38%	1679	40,57%	4136	100%

b) Distribution of acts and collective effective dose by anatomical area explored.

The most frequent acts involved the thorax, limbs, spine and pelvis with respectively 53.9%; 19.6%; 14.3% and 6.7% of cases (Table 2). The spine (lumbar and cervical spine), pelvic (pelvis, hip and hysterosalpingography (HSG)), skull and abdomen (intravenous urography, barium enema (BE) and abdomen without preparation (AWP) acts contributed to the majority of the collective effective dose with 39.99%, 25, 96 %, 10,53 and 8,84 % respectively, the total effective dose S resulting from all the acts is equal to 8300 mSv (Table 3).

Table 2: Distribution of imaging by anatomical region and sex

Exams	Workforce				Total	
	Male		Female			
AWP	50	1,21%	28	0,68%	39	1,89%
FOREARM	62	1,50%	28	0,68%	45	2,18%
ARM	62	1,50%	50	1,21%	16	0,77%
BASIN	16	0,39%	16	0,39%	56	2,71%
ANKLE	70	1,69%	40	0,97%	55	2,66%
CLAVICLE	6	0,15%	12	0,29%	9	0,44%
ELBOW	22	0,53%	10	0,24%	16	0,77%

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SKULL	124	2,99%	58	1,40%	91	4,40%
FEMUR	46	1,11%	28	0,68%	47	2,27%
KNEE	94	2,27%	56	1,35%	75	3,63%
HIP	66	1,60%	34	0,82%	50	2,41%
HSG	0	0%	68	1,64%	34	1,64%
LEG	112	2,71%	60	1,45%	86	4,16%
BE	4	0,1%	8	0,19%	6	0,29%
HAND	28	0,68%	18	0,44%	23	1,11%
FOOT	28	0,68%	22	0,53%	25	1,21%
WRIST	18	0,44%	12	0,29%	15	0,73%
CERVICAL SPINE	32	0,77%	20	0,48%	26	1,26%
DORSAL SPINE	26	0,63%	18	0,44%	22	1,06%
LUMBAR SPINE	238	5,75%	252	6,09%	245	11,85%
THORAX	1348	32,59%	880	21,28%	1114	53,87%
DGOT	2	0,05%	0	0%	1	0,05%
IVU	12	0,29%	2	0,05%	7	0,34%
URETHROCYSTOGRAPHY	6	0,15%	0	0%	3	0,15%
SHOULDER	66	1,60%	34	0,82%	50	2,41%
TOTAL	2457	59,38%	167	40,57%	2068	100%

Table 3: Collective Dose Associated with Each Type of Examination

Examens	Dose Collective (mSv)	Percentage
AWP	134,98	1,63%
FORE ARM	24,82	0,30%
BASIN	486,9	5,87%
ARM	4,42	0,05%
CLAVICLE	13,6	0,16%
ANKLE	13,36	0,16%
ELBOW	4,72	0,06%
FEMUR	18,16	0,22%
KNEE	26,02	0,31%
HIP	520,58	6,27%
HSG	1147,62	13,83%
LEG	33,16	0,40%
HAND	3,38	0,04%
BE	254,12	3,06%
FOOT	5,56	0,07%
WRIST	3,22	0,04%
CERVICAL SPINE	352	4,24%
DORSAL SPINE	473,54	5,78%
LUMBAR SPINE	2967,26	35,75%
SHOULDER	138,24	1,67%
URETHROCYSTOGRAPHY	74,96	0,90%
DGOT	28,50	0,34%
THORAX	346,56	4,18%
IVU	344,66	4,15%
SKULL	873,6	10,53%
TOTAL	8300	100%

c) The most frequent acts by sex and age

The data presented in Table 4 and Figures 2 to 6 provide the following information: The exposure of patients under five years is primarily in the chest region with 23.52% for males and 30.88% for females. For limbs, 29.417% males and 13.23% females for limbs, and skull 2,94% for males and 0% for females, no pelvic x-ray under five years. For children aged 5 to 20 years, irradiation affects the majority of limbs with 32.11% for males and 13.13% for females. For adults between 21 and 50 years old, this irradiation concerns all the most frequent acts. As early as the age of 50 years, radiation is predominant for thoracic, lumbar spine and pelvic examinations; in general, the male sex is more representative of the irradiated anatomical area.

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Table 4: Distribution of the number of acts for the most frequent examinations and by sex and age

Exams	Thorax		Lumbar spine		Members		Pelvis		Skull	
Sex	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-1	8	18	0	0	6	8	0	0	2	0
1-4	24	24	0	0	34	10	0	0	2	0
5-9	4	30	2	2	22	10	4	0	0	2
10-14	24	16	2	2	32	12	0	4	4	0
15-19	24	20	2	2	34	14	4	0	2	0
20-24	70	24	14	6	40	8	4	8	10	8
25-29	112	52	8	8	40	12	12	12	6	6
30-34	190	62	20	18	40	10	6	14	6	0
35-39	126	80	8	26	24	16	0	16	4	2
40-44	108	30	16	12	20	10	6	2	2	0
45-49	60	46	22	18	24	8	8	2	2	4
50-54	44	48	8	6	18	8	10	2	0	2
55-59	50	16	8	10	8	22	6	0	2	2
60-64	54	34	6	12	18	4	10	6	0	0
65-69	20	16	0	6	6	12	2	0	0	0
70-74	22	16	10	4	6	0	2	2	0	0
75-79	10	12	6	6	0	2	0	2	0	0
80-84	18	18	2	0	0	0	2	2	2	2
85-89	10	4	2	0	0	2	0	0	0	0
90-94	6	4	2	0	0	0	0	0	0	0
95-	0	2	0	0	0	0	0	0	0	0
Empty	374	296	100	114	320	242	70	74	66	44
Total	2228	868	490	252	924	410	280	146	182	72

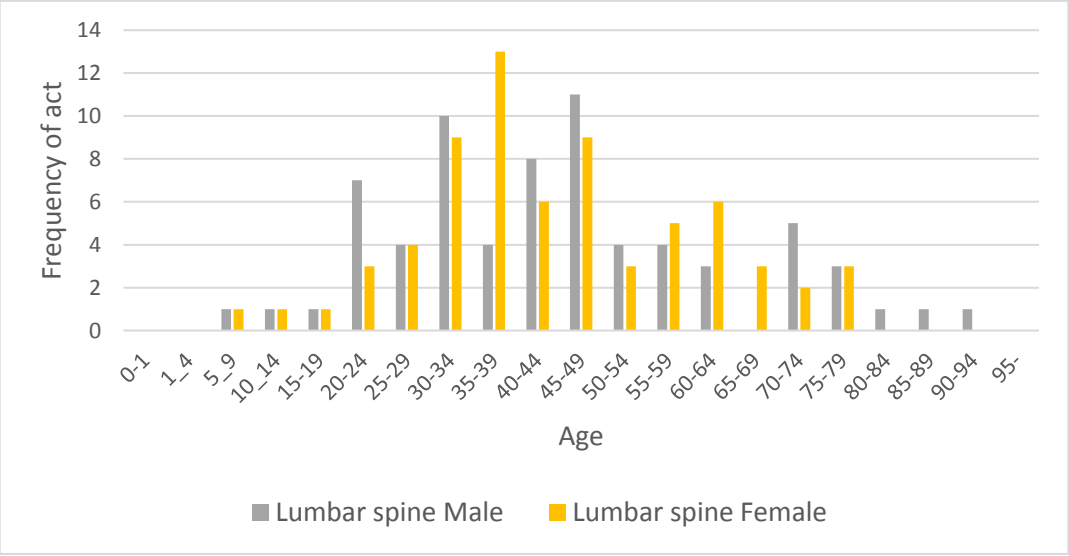


Figure 2: Distribution of the number of lumbar spine acts by age and sex

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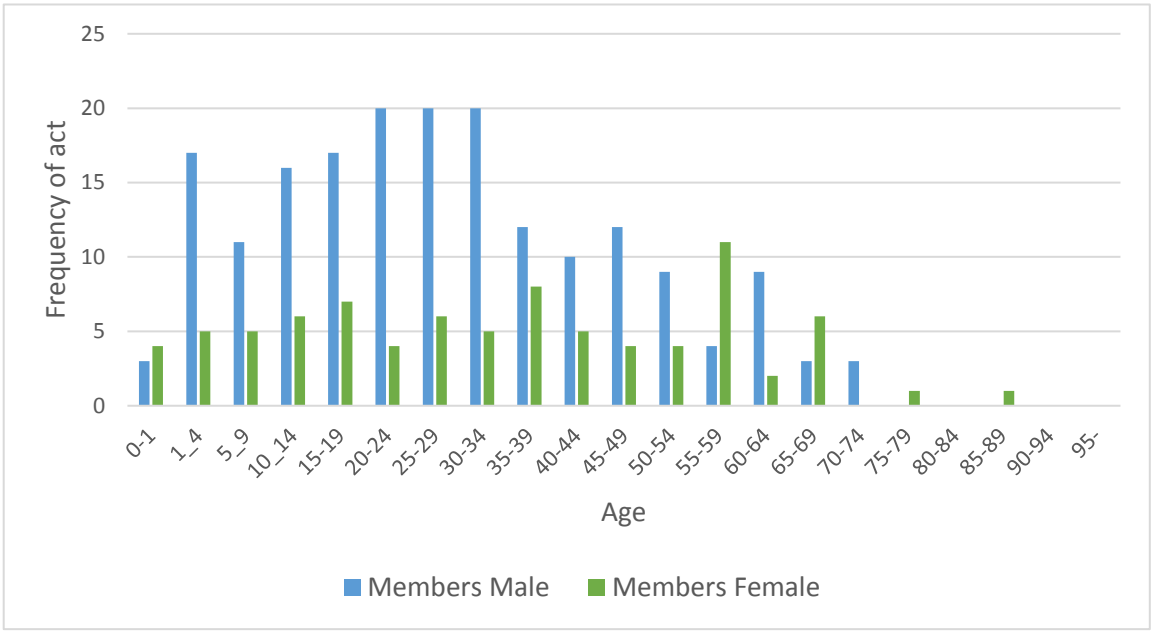


Figure 3: Distribution of number of members' acts by sex and age

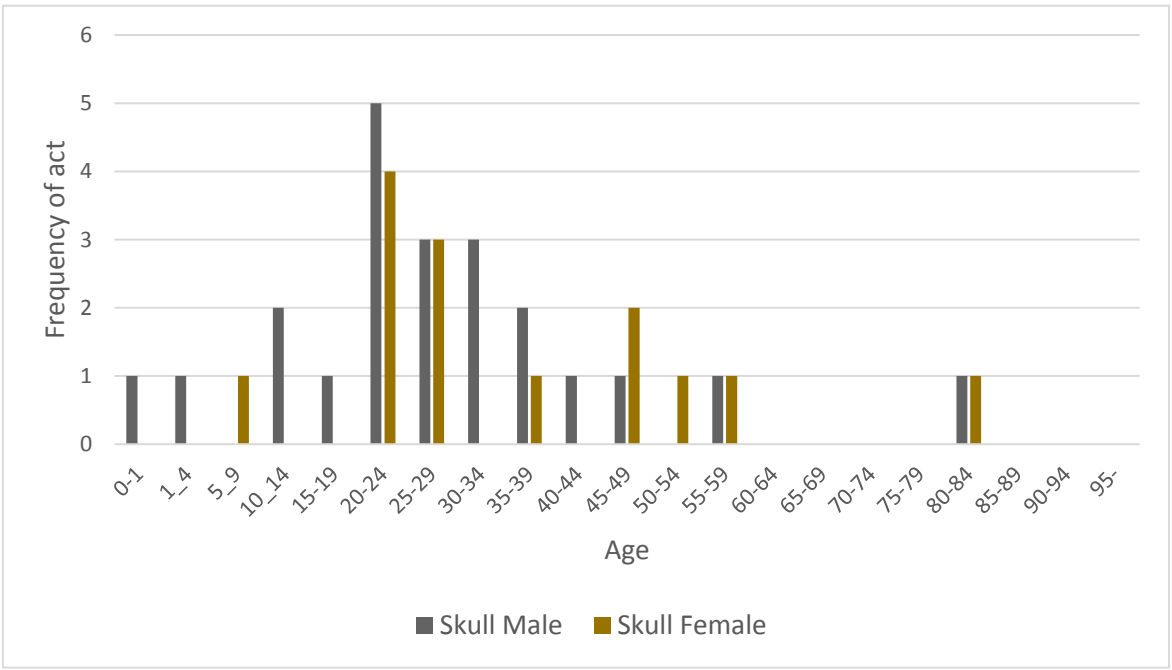


Figure 4: Skull act number distribution by age and sex

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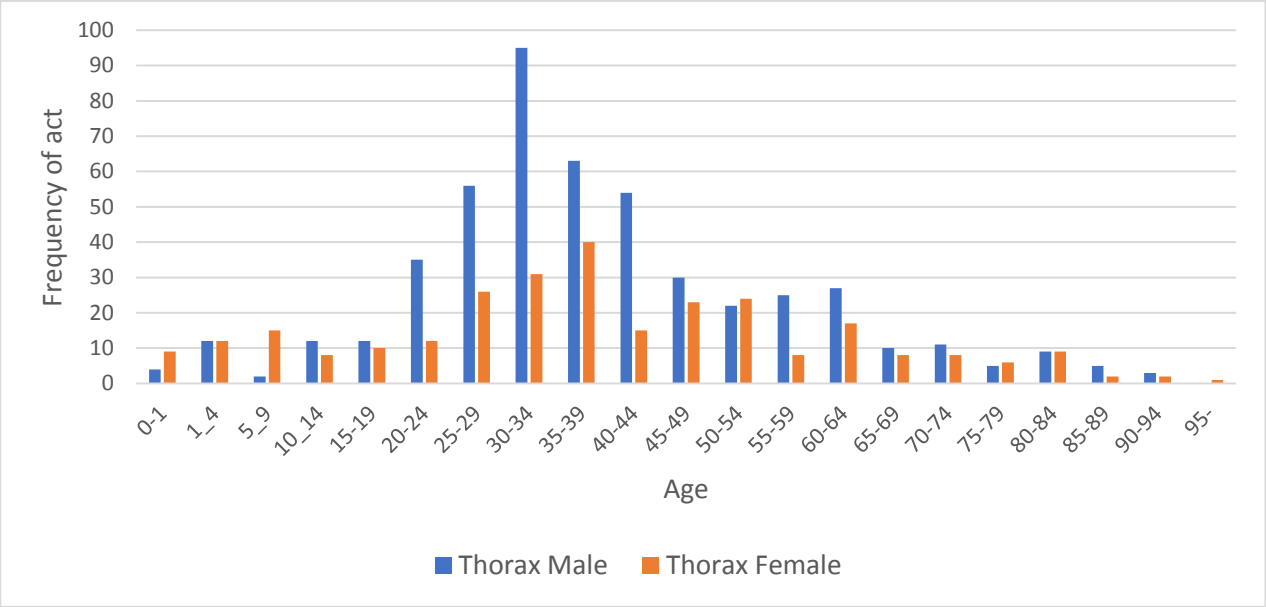


Figure 5: Distribution of the number of thorax acts by sex and age

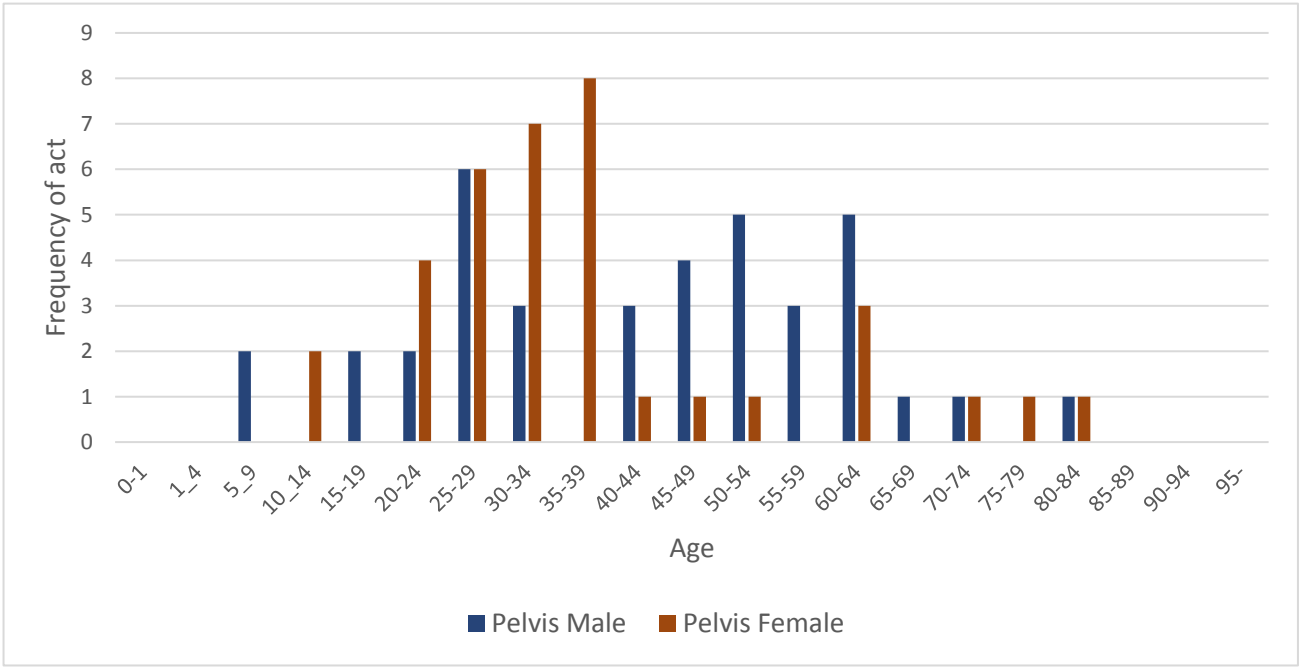


Figure 6: Distribution of number of pelvis acts by sex and age

d) Average effective dose per inhabitant at Ngaoundere in 2018

According to National Institute of Statistics (NIS) data, the population of Ngaoundere is about 200,000, which leads to an average collective effective dose of 0.04 mSv per capita in the general population. The individual average effective dose in 2018 for the population actually exposed (2.07% of the total population) is 2 mSv, according to sex 2.67 mSv in women and 1.55 mSv in men. The most irradiated age group ranges from 20 to 64 years with a dose of 4680.66 mSv (56.39%), the 30-34-year groups receive 896.76 mSv (10.80%) and 35 -39 years 706.7 mSv (8.51%) (Table 5 and figure 7). The collective dose amount per sex is higher among women with 4487.20 mSv (54.06%) than men with 3812.98 mSv (45.94%) (Figure 8).

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Table 5: Distribution of collective effective dose by sex and age

Age group	Dose (mSv)				Total	
	Male		Female			
0-1	4,76	0.06%	7,06	0.09%	11,82	0,14%
1-4	17,98	0.22%	8,3	0.1%	26,28	0,31%
5-9	32,58	0.39%	17,02	0.21%	49,6	0,60%
10-14	42,3	0.51%	109,66	1.32%	151,96	1,83%
15-19	51,98	0.63%	28,44	0.34%	80,42	0,97%
20-24	151,7	1.83%	317,18	3.82%	468,88	5,65%
25-29	218,68	2.63%	365,78	4.41%	584,46	7,04%
30-34	340,3	4.1%	556,46	6.70%	896,76	10,80%
35-39	324,32	3.91%	382,38	4.61%	706,7	8,51%
40-44	231,7	2.79%	198,16	2.39%	429,86	5,18%
45-49	340,92	4.1%	243,66	2.94%	584,58	7,04%
50-54	237,08	2.86%	100,32	1.21%	337,4	4,07%
55-59	161,18	1.94%	135,38	1.63%	296,56	3,57%
60-64	197,12	2.37%	178,34	2.15%	375,46	4,52%
65-69	58,042	0.70%	27,82	0.34%	85,86	1,03%
70-74	109,86	1.32%	38,02	0.46%	147,88	1,78%
75-79	19,38	0.23%	96,06	1.16%	115,44	1,39%
80-84	32,94	0.40%	30,7	0.37%	63,64	0,77%
85-89	15,76	0.19%	0,98	0.012%	16,74	0,20%
90-94	13,52	0.16%	0,50	0.01%	14,02	0,17%
95 -	29,94	0.36%	12,6	0.15%	42,54	0,51%
Empty	1180	14.22%	1632,4	19.67%	2812,4	33,88%
Total	3812,96	45,94%	4487,22	54,06%	8300	100%

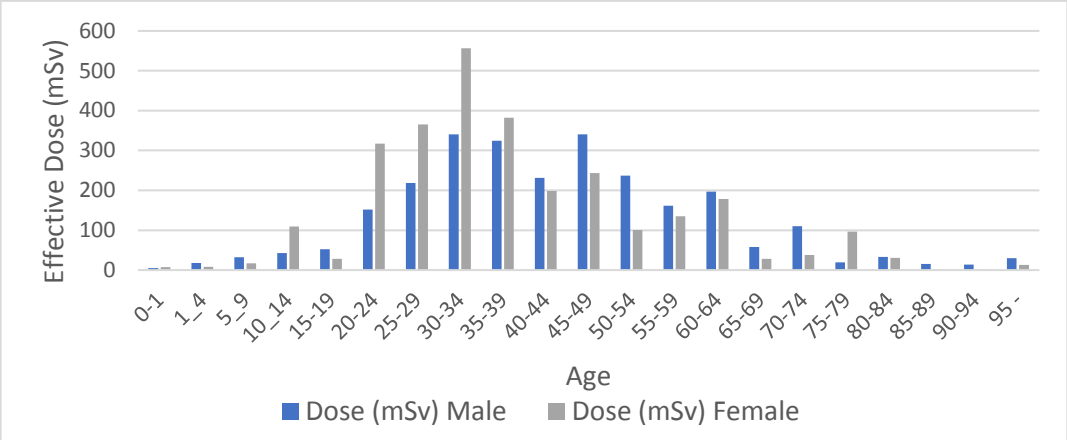


Figure 7: Distribution of collective effective dose by sex and age

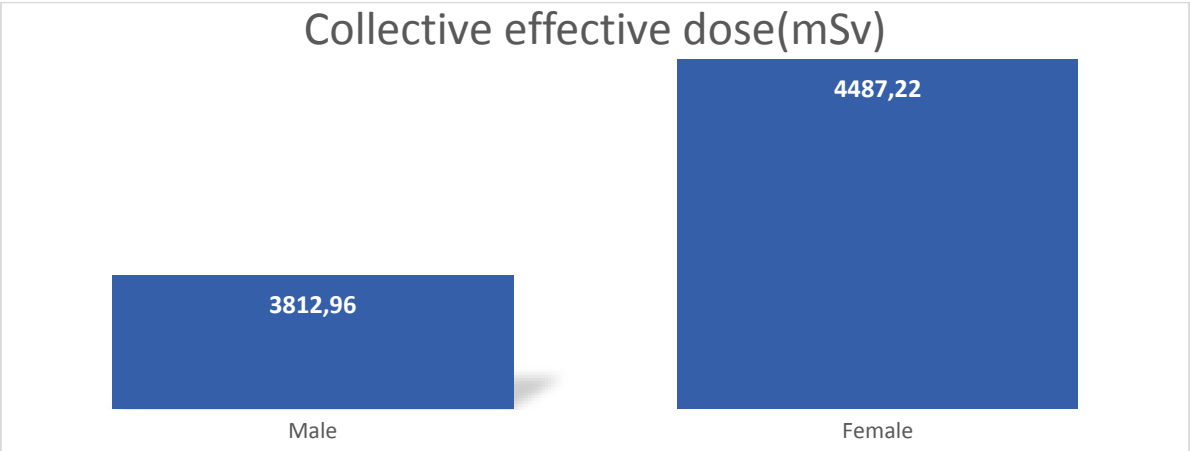


Figure 8: Collective effective dose by sex

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IV. Discussion

a) Frequency of act

The number of conventional radiology acts per anatomical region per 1,000 inhabitants in Ngaoundéré in 2018 is 20.68, which is lower than those achieved in France with 744 acts in 2007; Switzerland 762 acts in 1998; Norway 742 acts in 2002; Germany with 1,080 acts in 2003, Belgium with 1,160 acts in 2001 and the United States with 1,033 acts in 2006 [8]. Indeed, the development of medical imaging is recent in the city of Ngaoundere, many equipment are outdated, operating intermittently. The high price of imaging exams relative to the average income of populations is a handicap to examinations. The low number of these examinations also makes it possible to limit the irradiation of the population. Imaging is varied across all anatomical regions with predominance of the thorax which accounts for more than half of the acts with 53.9% followed by limbs with 24.23% and the lumbar spine with 11.85%. Specialized examinations are very rare, hysterosalpingography (HSG) is 1.64%, intravenous urography (IVU) 0.34%, barium enema (BE) 0.29%, urethrocystography0.15 % and duodenal gactro esophageal transit (DGOT) 0.05%. The high frequency of an act takes into account its involvement in the management of common pathologies, this is the case of chest x-ray whose involvement in the management of pulmonary, cardio-mediastinal and costal pathologies is more to demonstrate. In addition this examination is strongly realized within the framework of the visits of employment, the systematic medical visits and even the visits before the registration in universities, the granting of a visa to travel in certain countries [9] which is not the case for examinations such as limbs, spine, skull whose indications are more specific and limited, often occurring in cases of trauma, pain and lameness.

Our data are similar to those of France recorded in the National institute of Health and Medical Research report of 1994 [10] where the chest x-ray represents 31%, followed by the spine of 8.3%. As for the specialized exams, their request is rather weak because of the absence in our city of the specialists being able to request these examinations; more over they are rather expensive. Chest x-rays are found at all ages, with the limbs predominantly 0-5 years old, the pelvis predominating in adolescents up to 50 years, and the lumbar spine predominantly at the age of 50 years and more. The distribution of x-rays according to the age marries the pathologies which concern these age groups, the thoracic pathologies are found at all the ages, those of the limbs concern the children and the young adults, the pelvis and the lumbar spine mainly concern the adults. Our data corroborate those of Switzerland [11] where it was examined by x-ray of patients under five, from the thorax region, for children aged five and over, radiography mainly affects the limbs and joints for adults under 50 years, this radiation is also mainly followed by the limbs and the thorax, from 50 years. Hence, the thorax dominates.

b) Effective Dose

The amount of collective dose per sex is higher among women with a total of 4487.22 mSv (54.06%) compared to men with a total of 3812.96 mSv (45.94%). Among the most irradiating examinations are the lumbar spine and the pelvis, these are examinations concerning thick areas and composed of very dense structures that require a significant load in terms of kilo voltage and milli ampere and therefore a high dose of radiation to cross them. The annual effective dose per inhabitant in Ngaoundere in 2018 of 0.04 mSv is lower than that of the United Kingdom with 0.41 mSv, Denmark 0.46 mSv excluding nuclear medicine, the Netherlands 0.52 mSv, Sweden 0.72 mSv, France in 2007 1.29 mSv, Norway 1.15 mSv in 2002, Luxembourg 1.98 mSv in 2002, Belgium 1.97 mSv in 2001, Germany 1, 76 mSv in 2003, United States 3 mSv in 2006 [8] and Switzerland 1.07 mSv in 1998, 1.21 mSv in 2008 and 1.42 mSv in 2013 [11].It should be noted that, the annual per capita effective dose in Ngaoundéré in 2018, equal to 0.04 mSv, is lower than the European and American average values and to the natural irradiation which is 2.4 mSv [12]. This wide difference in dose can be explained by the presence of numerous radio diagnostic procedures including CT and nuclear medicine and a wide range of protocols by modality in these countries and also the very high number of irradiating acts in these cities compared to the city of Ngaoundere. In conventional radiology, the acts exposing the abdomen (Spine, IVU, BE and AWP), the pelvis (pelvis, hip and HSG) and the skull contribute mainly to the collective effective dose with respectively 48.83%, 25.96% and 10.53% of the collective effective dose, which is the same with data from France 2007 [8] where the acts exposing the abdomen, the pelvis and the digestive tract contribute mainly to the collective dose with 41, 5%, 29.8% and 11.8% of the collective effective dose. These are exams for which a large amount of irradiation is used and the contrast examinations are dynamic, requiring multiple incidences and shots.

V. Conclusion

At the end of this study, it appears that, the medical exposure to ionizing radiation in Ngaoundere is mainly done by conventional radiology, the total number of examination is 4136 is an average number of act of 0.02 act per inhabitant, the examinations are more frequently performed in men and the irradiation is more important for women, the most affected age groups are those aged 25 to 49 for men and 25 to 54 for women. The most common examinations are the thorax, the

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limbs, the lumbar spine and the skull; the most radiating examinations are the lumbar spine, the abdomen and the pelvis. The collective effective dose is 8300 mSv with 4487.22 mSv in women and 3812.96 mSv in men, an effective average dose per capita of 0.04 mSv well below European, US and natural irradiation values. The proportion of the population that has actually benefited from a conventional radiology examination is 2.07%, an individual effective average dose of 2 mSv per person.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Global Journal of Medical Research: D
Radiology, Diagnostic and Instrumentation
Volume 19 Issue 2 Version 1.0 Year 2019
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

Abdominal Ganglionic Tuberculosis with Inferior Vena Cava and Common Iliac Vein Thrombosis- A Case Report

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Keywords: *thrombosis, lymph nodes, ganglionic tuberculosis, IVC.*

GJMR-D Classification: *NLMC Code: WF 200*

ABDOMINALGANGLIONICTUBERCULOSISWITHINFERIORVENACAVAANDCOMMONILIACVEINTHROMBOSISACASEREPORT

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Dr. Sanjay M. Khaladkar [α], Dr. Amit A. Choure [σ] & Dr. Suhani Jain [ρ]

Abstract- Abdominal tuberculosis may show an unusual presentation. IVC thrombosis in abdominal TB is very rare. IVC thrombosis occurs due to Virchow's triad- stasis, injury, and hypercoagulability. Acquired thrombosis of the IVC can occur secondary due to external compression, pathological changes within the vein wall, and spontaneous thrombosis within the normal vessel wall. IVC compression by retroperitoneal lymph nodes can distort IVC causing both venous stasis and turbulence, thus facilitating the formation of thrombus. In ganglionar form of tuberculosis, venous compression by lymph nodes can cause IVC thrombosis in the absence of any hemostatic abnormality. We report a case of a 60-year old female who presented with abdominal distension and swelling in the bilateral lower limbs for one month. Ultrasound detected ascites and lymphadenopathy at porta hepatis. Computed axial tomography (CT scan) of the abdomen showed multiple well-defined lymph nodes at porta hepatis, peripancreatic region, celiac axis, left renal hilum, preaortic, and para-aortic regions, precaval and paracaval regions and in right internal iliac region. Most of the lymph nodes showed peripheral enhancement with central hypodense areas of necrosis. IVC distal to renal veins showed persistent filling defect with peripheral enhancement in contrast study extending to the right common iliac vein suggestive of IVC and right common iliac vein thrombosis.

Keywords: thrombosis, lymph nodes, ganglionic tuberculosis, IVC.

I. Case Report

A 60-year old female patient presented with abdominal distension and swelling in the bilateral lower limbs for one month. There were no bowel and bladder complaints. There was no history of fever, cough, hemoptysis, breathlessness, and chest pain. There was a history of antipsychotic medication for psychiatric disorders whose details were not known. Crepts were noted in bilateral infrascapular and infraclavicular regions.

Ultrasound done elsewhere showed ascites and enlarged lymph nodes at portahepatis.

Computed axial tomography (CT scan) of the thorax (Figures: 1-3) showed small patchy areas of alveolar consolidation in the peripheral portion of the right middle lobe and lingula, and the left perihilar region. Multiple small nodular lesions were noted in the peribronchial region in the anterior basal segment of the right lower lobe and segmental bronchi of lingula. Multiple lymph nodes of size 5 to 10 mm were noted in pretracheal, right paratracheal, subcarinal region, in prevascular space and aortopulmonary window. Bilateral axillary lymph nodes also noted, the largest right axillary lymph node measured 13x13mm. Most of the lymph nodes showed peripheral enhancement with central hypodense areas of necrosis. Lymph nodes were also noted in the right juxtadiaphragmatic region, the largest measuring 13x9mm. There was no pleural effusion on either side.

CT scan of the abdomen and pelvis (Figures: 4-8) showed changes of fatty infiltration in the liver. Multiple well-defined lymph nodes of size 1 to 2 cms were noted at portahepatis, peripancreatic region, celiac axis, left renal hilum, preaortic and para-aortic regions, precaval and paracaval regions and in right internal iliac region. Most of the lymph nodes showed peripheral enhancement with central hypodense areas of necrosis. A conglomerated matted lymph nodal mass of size 35 x 24 mm noted in the precaval region. Multiple ill-defined and nodular soft tissues infiltrate noted within the mesentery. Moderate ascites noted with mild peritoneal enhancement without septations. Ileo-caecal junction and other bowel loops appeared normal. IVC distal to renal veins showed persistent filling defect of size 10 (Anteroposterior) x 16 (Transverse) mm extending over a length of 67mm with peripheral enhancement in contrast study extending to right common iliac vein suggestive of IVC and right common iliac vein thrombosis.

Given the above findings, the possibility of tuberculous etiology with IVC thrombosis was considered.

Renal function tests and liver function tests were normal. CRP was positive. Hemoglobin was 8.5%.WBC count was normal. ESR raised- 48. The platelet count was 2.1 lakh/mm^3. Sputum for AFB was negative. Serum Amylase and Lipase were normal. Ascitic fluid showed the absence of coagulum and cobweb. The appearance was cloudy. The glucose level was 5mg/dl. ADA was 40 U/L. LDH was 500 Sigma Units. The number of

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nucleated cells was 800 cells/mm^3, which were predominantly lymphocytes. The patient put on Antituberculous treatment. After two months of follow up, the patient showed symptomatic improvement.

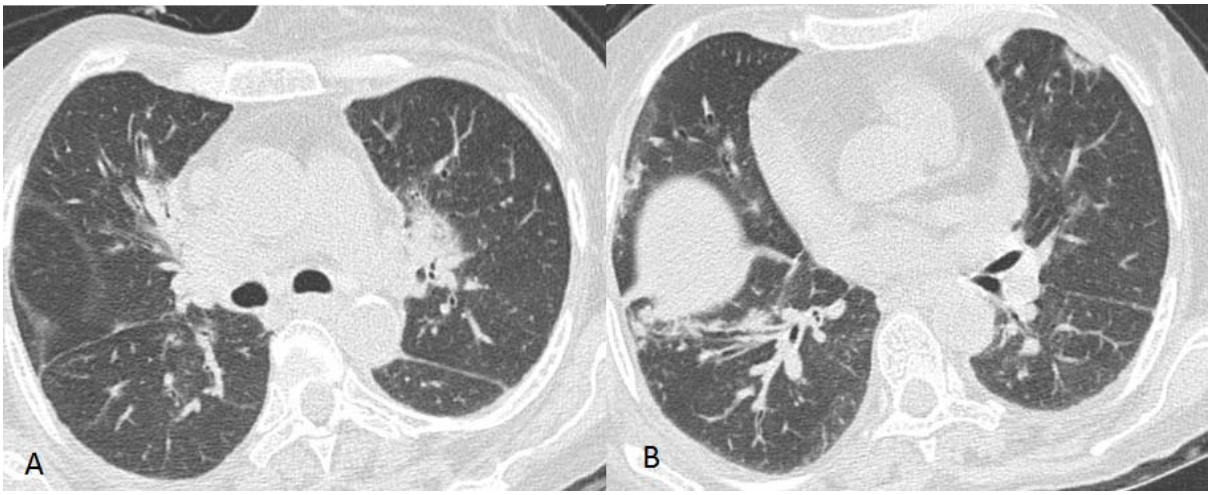


Figure 1: HRCT of thorax showing patchy areas of alveolar consolidation in the right middle lobe, in lingula (A) and multiple small nodular lesions in the peribronchial region in the anterior basal segment of the right lower lobe.(B)

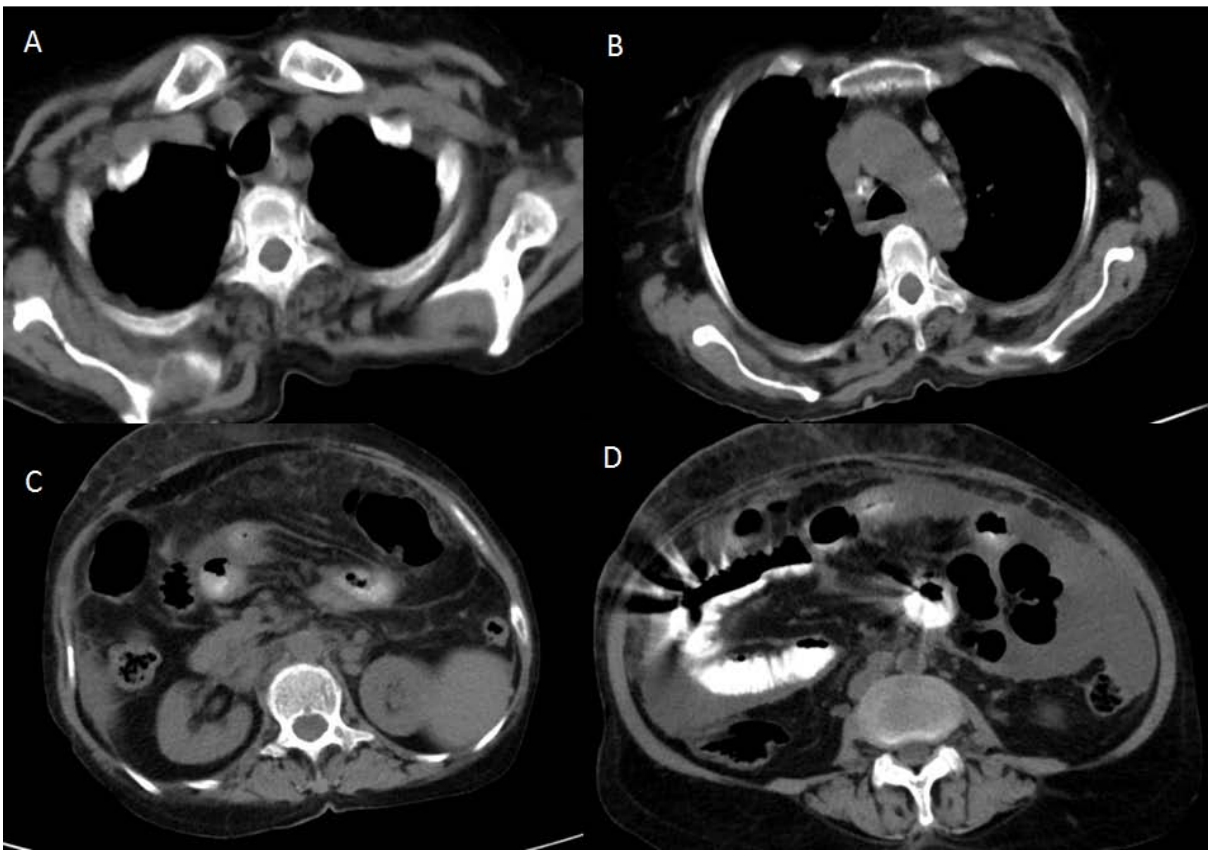


Figure 2: Plain CT thorax (A, B) - showing lymph nodes in right axilla (A) and prevascular space (B). Plain CT abdomen (C, D) - showing lymph nodes in the left para-aortic region (C), lymph node in inter aortocaval region and ascites (D)

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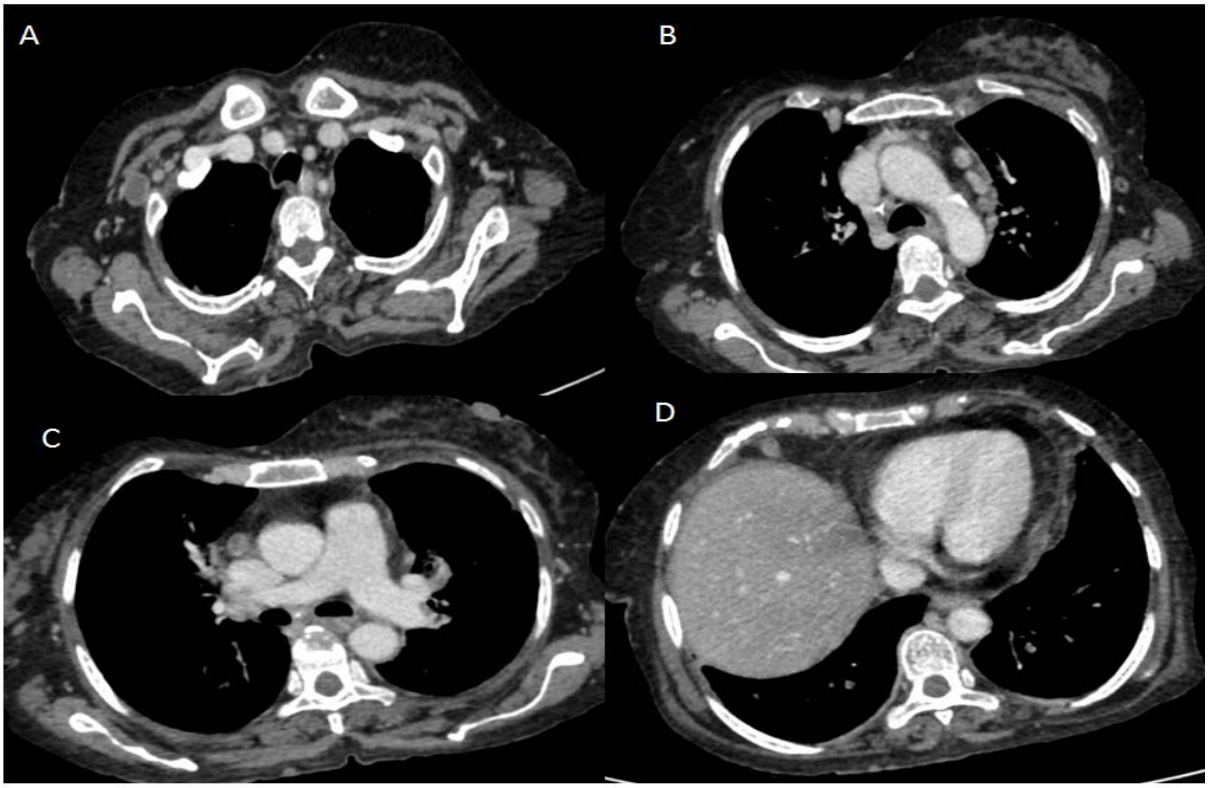


Figure 3: Contrast-enhanced CT scan of thorax showing lymph nodes in right axilla (A), in prevascular space (B,C), and the right juxtadiaphragmatic region (D) showing peripheral enhancement with central hypodense areas of necrosis.

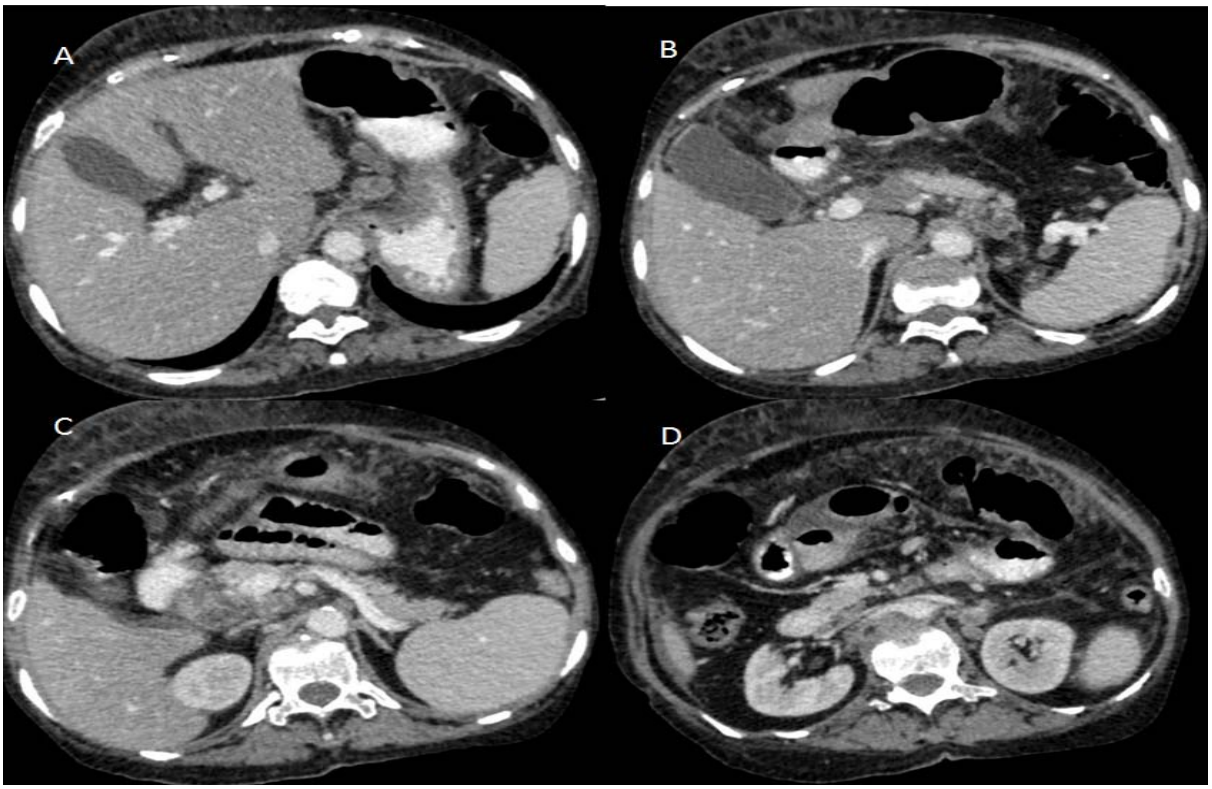


Figure 4: Contrast-enhanced CT scan of the abdomen showing lymph nodes at the celiac axis (A, B), in precaval region (C), in the left para-aortic and preaortic region (D) showing peripheral enhancement with central hypodense areas of necrosis.

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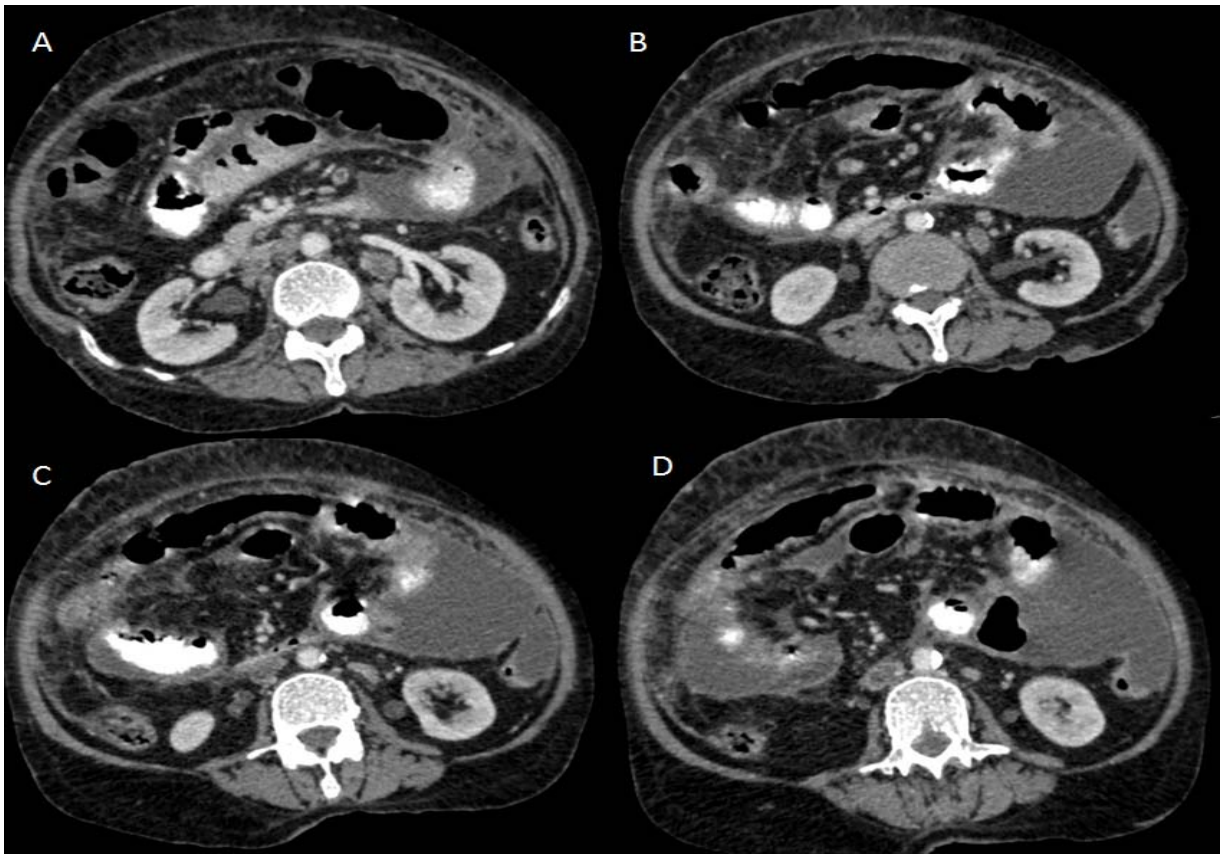


Figure 5: Contrast-enhanced CT scan of the abdomen showing lymph nodes at left para-aortic and inter-aortocaval region (A, B), a filling defect in IVC suggestive of IVC thrombosis (C, D).

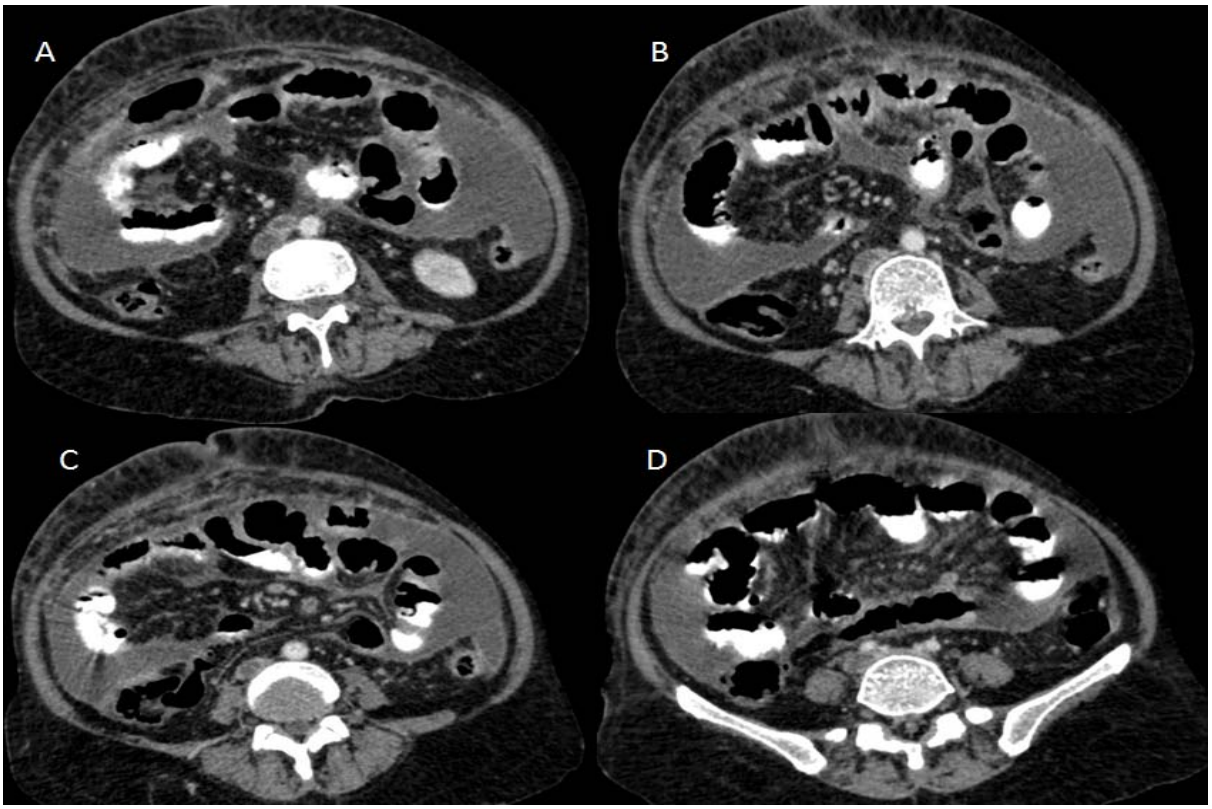


Figure 6: Contrast-enhanced CT scan of the abdomen showing lymph nodes in precaval region (A) with thrombosis in IVC (A-C) extending right common iliac vein (D)

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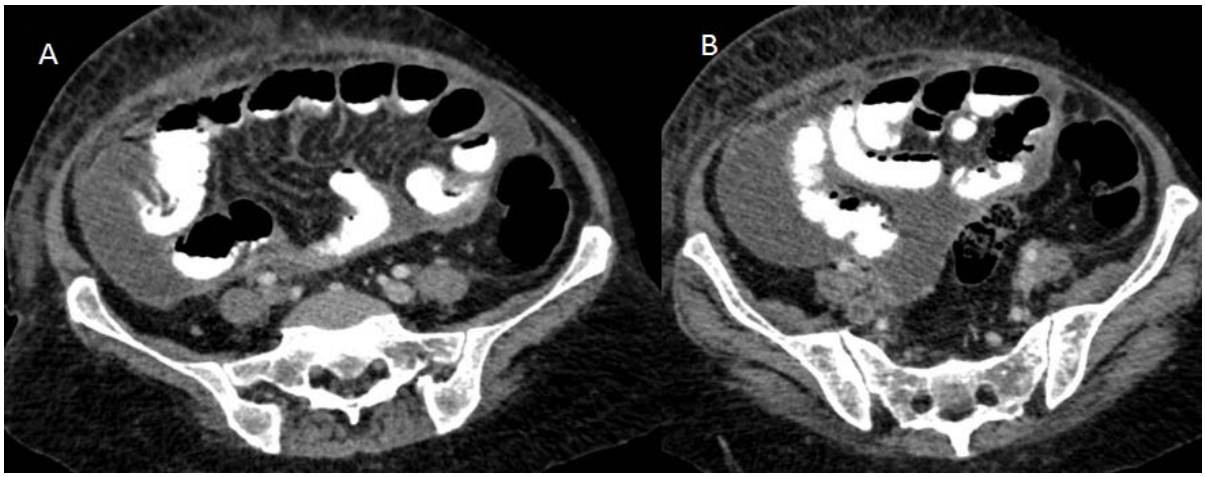


Figure 7: Contrast-enhanced CT scan of the abdomen showing thrombosis in the right common iliac vein (A, B)

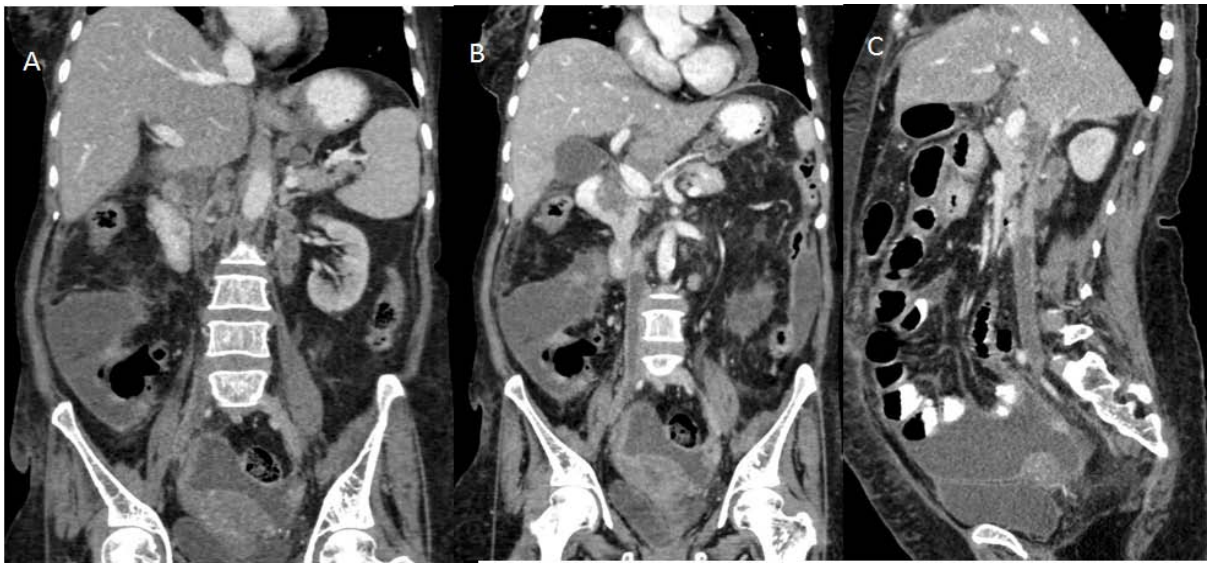


Figure 8: Contrast-enhanced CT scan of the abdomen (Coronal-A,B) and sagittal (C)-showing lymph nodes in left para-aortic, interaortocaval and precaval regions (A) with thrombosis in IVC extending right common iliac vein (B,C)

II. Introduction

Abdominal tuberculosis may show an unusual presentation. IVC thrombosis in abdominal TB is very rare. It can occur due to mass effect by retroperitoneal lymph nodes with increased chronic inflammation and subsequent reactive thrombocytosis.[1]

The thromboembolic complication in infection due to mycobacterium tuberculosis occurs in 1.5-3.4% of tuberculosis infection. The risk factor for deep vein thrombosis is related to hypercoagulable state secondary to the inflammatory state. [2]Thrombotic phenomenon can occur in deep veins in the lower limb, portal vein, IVC, cerebral venous sinus, central retinal vein and IJV. [2, 3]

III. Discussion

Tuberculosis can present as venous thromboembolism. Venous thromboembolism can occur early or late in the course of the disease in spite of ATT.[4]

Tuberculosis can cause thrombosis by various mechanisms like venous compression, local invasion or by producing the hypercoagulable state. [4, 5]

IVC thrombosis is related to the spectrum of deep vein thrombosis. It is usually under-recognized as it is not commonly identified or pursued. Hence IVC thrombosis presents as a diagnostic and therapeutic challenge.[6] IVC thrombosis occurs due to Virchow's triad- stasis (alteration in blood flow), injury (changes in the vessel wall), and hypercoagulability (alteration in the blood constitution).[5] Acquired thrombosis of the IVC can occur secondary due to external compression, pathological changes within the vein wall, and spontaneous thrombosis within the normal vessel wall. [6] IVC compression by retroperitoneal lymph nodes can distort IVC causing both venous stasis and turbulence, thus facilitating the formation of thrombus. [6]

In the peripheral blood, disseminated TB causes activation of mononuclear cells. There is

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an increased synthesis of tumor necrosis factor- Alfa (TNF-Alfa) and Interleukin-6 due to the interaction of mononuclear cells activated with mycobacterial products[2].

Inflammation, hemostatic changes, and hypercoagulable state are associated with tuberculosis, causing deep vein thrombosis. Hypercoagulability in Tuberculosis is due to increase platelet aggregation, reactive thrombocytosis, increase plasma fibrinogen levels, and decrease Antithrombin-III and Protein-C. Deficiency of Protein-S and high frequency of antiphospholipid levels also observed in tuberculosis. Cytokines activate vascular intima by their proinflammatory character and make the endothelium thrombogenic[7]. These also stimulate the hepatic synthesis of coagulation proteins.[2] Hypercoagulability also increased by bed rest and immobility of the patient due to morbidity caused by the disease.

In ganglionar forms of tuberculosis venous compression by lymph nodes can cause IVC thrombosis in the absence of any hemostatic abnormality. [2]

Underlying predisposed thrombophilic state with minor obstruction caused by lymph nodes or direct compression by large matted tuberculous lymph nodes may cause IVC thrombosis. [7]

In our case, the coagulation profile was normal, eliminating the predisposed thrombophilic state. Hence direct venous compression by matted retroperitoneal lymph nodes along with changes in vessel wall was a probable explanation for IVC and right common iliac vein thrombosis.

Treatment

Antituberculous treatment (ATT) causes improvement in hemostatic changes in the first month of treatment. [8] Hence it is started immediately along with anticoagulant therapy. Rifampicin affects cytochrome P-450 and can induce hypercoagulable state by decreasing production and increasing the clearance of anticoagulant hepatic proteins. Hence there is a higher risk of development of DVT in the initial phase of treatment.[5,9] Hence a higher dose of warfarin is necessary to achieve therapeutic INR levels.[2]

IV. Conclusion

IVC thrombosis in abdominal TB is very rare. Tuberculosis can present as venous thromboembolism. Venous thromboembolism can occur early or late in the course of the disease in spite of ATT. Tuberculosis can cause thrombosis by various mechanisms like venous compression, local invasion, or by producing the hypercoagulable state.

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Global Journal of Medical Research: D
Radiology, Diagnostic and Instrumentation
Volume 19 Issue 2 Version 1.0 Year 2019
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

Calculation of Internal Radiation Dose due to Acute Ingestion of 60Co by Adopting HATM Model

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Abstract- Activity of radionuclide, absorbed dose, committed equivalent dose, committed effective dose due to acute intake of 1 Bq of 60Co through ingestion have been calculated by using locally developed software that has been prepared basing on the human alimentary tract model. Due to ingestion, maximum radiation dose is deposited in the alimentary tract, which consists of seven tissue compartments, e.g., OC, OP, ST, SI, LC, RC, and RSC. Tissue masses of alimentary tract for Bangladeshi people have been considered to calculate the above-mentioned quantities for different age groups such as newborn, 1 yr, 5 yrs, 10 yrs, 15 yrs (male and female) and adult (male and female). Regarding age the variation of absorbed dose, committed equivalent dose and committed effective dose follows the sequence: newborn >1 yr> 5 yr> 10yrs > 15 yrs> adult female > adult male.

Keywords: absorbed dose, committed equivalent, and committed effective dose, human alimentary tract model (HATM).

GJMR-D Classification: Code: WN 600



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Calculation of Internal Radiation Dose due to Acute Ingestion of ^{60}Co by Adopting HATM Model

Haron-Or-Rashid [α], A.H.M. R. Quddus [σ], M. S. Hossain [ρ] & K. H. Sarker [ω]

Abstract- Activity of radionuclide, absorbed dose, committed equivalent dose, committed effective dose due to acute intake of 1 Bq of ^{60}Co through ingestion have been calculated by using locally developed software that has been prepared basing on the human alimentary tract model. Due to ingestion, maximum radiation dose is deposited in the alimentary tract, which consists of seven tissue compartments, e.g., OC, OP, ST, SI, LC, RC, and RSC. Tissue masses of alimentary tract for Bangladeshi people have been considered to calculate the above-mentioned quantities for different age groups such as newborn, 1 yr, 5 yrs, 10 yrs, 15 yrs (male and female) and adult (male and female). Regarding age the variation of absorbed dose, committed equivalent dose and committed effective dose follows the sequence: newborn >1 yr> 5 yr> 10yrs > 15 yrs> adult female > adult male. Absorbed dose, committed equivalent dose, and committed effective doses are found maximum for newly born age group; then, it decreases as the age increases. Regarding compartment the trends of variation of maximum absorbed dose are: ST > LC > OP > RSC > RC >SI for ^{60}Co. The variation pattern of committed equivalent dose is RSC > LC > RC > ST > SI >. The highest committed effective dose per Bq intake for each radionuclide has found in the alimentary tract of a newborn baby. This value in the stomach is 1.11 x 10^{-8} mSv/Bq. For other age groups, these values are slightly smaller than those for a newborn baby.

Keywords: absorbed dose, committed equivalent, and committed effective dose, human alimentary tract model (HATM).

I. Introduction

Radionuclides once entered into the body through different routes of entry [1] can't be eliminated. It gives out energy continuously as long as it remains inside the body. So it is necessary to assess internal radiation dose to measure the risk of human health. Occupational workers, and the public can be internally exposed by radiation due to the ingestion of contaminated food following nuclear reactor accident, accidental intake during the use of unsealed radioisotope in the field of nuclear medicine, radioisotope production laboratory and research facility or during routine work at the workplaces with an unsealed radioisotope. That's why the authorities such as UNSCEAR [2], IAEA [3], and ICRP [4] develop radiation safety standards. Internal radiation dose cannot be measured directly; of course, some models are there. This can be used for assessment of internal radiation dose, based on the radioactivity by bioassay measurement and whole-body counting.

The present study describes a generic methodology for the calculation of internal radiation doses due to the acute intake of beta-emitting radionuclides through ingestion. Visual Basic language software has been developed. The software is user-friendly and is found to work well as desired. This software can comfortably be used for calculation of internal radiation doses due to the intake of radioisotopes through ingestion by radiation workers and the public at large.

The activity of radionuclide, absorbed dose, committed equivalent dose, committed effective dose due to acute intake of 1 Bq of ^{60}Co through ingestion have been calculated by using the software that has been prepared based on the HATM. Due to ingestion maximum radiation dose is deposited in the alimentary tract, which consists of seven tissue compartments, e.g., e.g., Oral Cavity (OC), Esophagus (OP), Stomach (ST), Small Intestine (SI), Left Colon (LC), Right Colon (RC) and Rectosigmoid Colon (RSC). Tissue masses of alimentary tract for Bangladeshi people have been considered to calculate the above-mentioned quantities for different age groups such as newborn, 1 yr, 5 yrs, 10 yrs, 15 yrs (male and female) and adult (male and female).

a) The HATM

There are various ICRP, and MIRD models that are similar in terms of their assumption and defining equation. Contemporary internal dosimetry models began with the single compartment models of ICRP [5], and [6]. The MIRD methodology [7-9] and ICRP [10] and [11] developed the concept of source and target organs. ICRP [12] and ICRP [13] continue to refine to internal dosimetry model.

The new human alimentary tract model (HATM) [14] considers the movement of radionuclides

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throughout the tract from ingestion to elimination. The model (HATM) includes compartments representing the oral cavity (OC) and esophagus (OP) to account for doses received from transit or retention of activity in the upper regions of the tract. The model partitions the large intestine into three parts frequently addressed in colonic transit studies. It also includes compartments to account for nuclear transformations due to retention of a radionuclide in tissues of the tract in those cases where tissue retention is found by available information. The model includes pathways to account for absorption from the oral mucosa, stomach, or segments of the colon if specific information is available. HATM provides age- and gender-specific transit times for all of the tract depicted in the model and, for the upper (oral cavity, esophagus, and stomach), also provides material-specific transit times.

The 1990 recommendations of ICRP introduced specific risk estimates and tissue weighting factors, w_T, for radiation-induced cancer of the esophagus, stomach, and colon, requiring dose estimates for each of these regions. HATM takes account of sites of radionuclide absorption and retention in the tract and routes of excretion of absorbed radionuclides into the tract. Doses are calculated for sensitive cells in each region: mouth, esophagus, stomach, small intestine, and colon.

II. Methodology

The proposed work is calculation based. An expression has been derived in work for the committed equivalent dose to some regions of the human body due to intake of some beta-emitting radionuclides through ingestion considering physiological parameters for different age groups of Bangladeshi population. The viewpoints of HATM [14] have been adopted to formulate mathematical equations for retention and the number of radioactive disintegrations that take place in different compartments of the digestive tract at a given time after intake of radionuclides. Subsequently, the equivalent dose, committed equivalent dose, and committed effective dose in each tissue or organ of interest have been formulated. A database library has been generated in Microsoft Access to store relevant data for assessment of retention and cumulated activity and equivalent doses in each of the compartments for different age groups of Bangladeshi population and ICRP reference subjects. Software has been developed to calculate the above-mentioned quantities rapidly.

a) Mathematical Formalism

H. Bateman's general equation [15] of activity can be written as

$$A_i = N_o \sum_{i=1}^{n} C_i e^{-\lambda_i t}$$
$$= N_O\left(C_1 e^{-\lambda_1 t} + C_2 e^{-\lambda_2 t} + \ldots\ldots\ldots\ldots + C_n e^{-\lambda_n t}\right) \quad (1)$$

Here A_i is the activity in organ i (i=1,2,3……7)

λ_i is the transfer rate of the radionuclide from the organi

$$C_m = \frac{\prod_{i=1}^{n} \lambda_i}{\prod_{i=1}^{n} (\lambda_i - \lambda_m)}$$
$$= \frac{\lambda_1\lambda_2\lambda_3\ldots\ldots\ldots\lambda_n}{(\lambda_1 - \lambda_m)(\lambda_2 - \lambda_m)(\lambda_3 - \lambda_m)\ldots\ldots\ldots\ldots(\lambda_n - \lambda_m)} \quad (2)$$

For materials deposited into first, second, 3rd, 4th, 5th, 6th, and 7th compartment can be obtained by putting i=2, 3, 4, 5, 6, and 7 respectively into Eqn. (9)

$$A_1 = N_o e^{-\lambda_1 t} \quad (3)$$

$$A_2 = N_O \lambda_1 \lambda_2 \left(\frac{e^{-\lambda_1} t}{(\lambda_2 - \lambda_1)} + \frac{e^{-\lambda_2} t}{(\lambda_1 - \lambda_2)} \right) \quad (4)$$

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$$A_3 = N_0\lambda_1\lambda_2\lambda_3\left(\frac{e^{-\lambda_1 t}}{(\lambda_2-\lambda_1)(\lambda_3-\lambda_1)}+\frac{e^{-\lambda_2 t}}{(\lambda_1-\lambda_2)(\lambda_3-\lambda_2)}+\frac{e^{-\lambda_3 t}}{(\lambda_1-\lambda_3)(\lambda_2-\lambda_3)}\right) \quad (5)$$

$$A_4 = N_0\lambda_1\lambda_2\lambda_3\lambda_4\left(\begin{array}{l}\frac{e^{-\lambda_1 t}}{(\lambda_2-\lambda_1)(\lambda_3-\lambda_1)(\lambda_4-\lambda_1)}+\\ \frac{e^{-\lambda_2 t}}{(\lambda_1-\lambda_2)(\lambda_3-\lambda_2)(\lambda_4-\lambda_2)}+\\ \frac{e^{-\lambda_3 t}}{(\lambda_1-\lambda_3)(\lambda_2-\lambda_3)(\lambda_4-\lambda_3)}+\\ \frac{e^{-\lambda_4 t}}{(\lambda_1-\lambda_4)(\lambda_2-\lambda_4)(\lambda_3-\lambda_4)}\end{array}\right) \quad (6)$$

$$A_5 = N_0\lambda_1\lambda_2\lambda_3\lambda_4\lambda_5\left(\begin{array}{l}\frac{e^{-\lambda_1 t}}{(\lambda_2-\lambda_1)(\lambda_3-\lambda_1)(\lambda_4-\lambda_1)(\lambda_5-\lambda_1)}+\\ \frac{e^{-\lambda_2 t}}{(\lambda_1-\lambda_2)(\lambda_3-\lambda_2)(\lambda_4-\lambda_2)(\lambda_5-\lambda_2)}+\\ \frac{e^{-\lambda_3 t}}{(\lambda_1-\lambda_3)(\lambda_2-\lambda_3)(\lambda_4-\lambda_3)(\lambda_5-\lambda_3)}+\\ \frac{e^{-\lambda_4 t}}{(\lambda_1-\lambda_4)(\lambda_2-\lambda_4)(\lambda_3-\lambda_4)(\lambda_5-\lambda_4)}+\\ \frac{e^{-\lambda_5 t}}{(\lambda_1-\lambda_5)(\lambda_2-\lambda_5)(\lambda_3-\lambda_5)(\lambda_4-\lambda_5)}\end{array}\right) \quad (7)$$

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$$A_6 = N_0\lambda_1\lambda_2\lambda_3\lambda_4\lambda_5\lambda_6\left(\begin{array}{c}\frac{e^{-\lambda_1 t}}{(\lambda_2-\lambda_1)(\lambda_3-\lambda_1)(\lambda_4-\lambda_1)(\lambda_5-\lambda_1)(\lambda_6-\lambda_1)}+\\ \frac{e^{-\lambda_2 t}}{(\lambda_1-\lambda_2)(\lambda_3-\lambda_2)(\lambda_4-\lambda_2)(\lambda_5-\lambda_2)(\lambda_6-\lambda_2)}+\\ \frac{e^{-\lambda_3 t}}{(\lambda_1-\lambda_3)(\lambda_2-\lambda_3)(\lambda_4-\lambda_3)(\lambda_5-\lambda_3)(\lambda_6-\lambda_3)}+\\ \frac{e^{-\lambda_4 t}}{(\lambda_1-\lambda_4)(\lambda_2-\lambda_4)(\lambda_3-\lambda_4)(\lambda_5-\lambda_4)(\lambda_6-\lambda_4)}+\\ \frac{e^{-\lambda_5 t}}{(\lambda_1-\lambda_5)(\lambda_2-\lambda_5)(\lambda_3-\lambda_5)(\lambda_4-\lambda_5)(\lambda_6-\lambda_5)}+\\ \frac{e^{-\lambda_6 t}}{(\lambda_1-\lambda_6)(\lambda_2-\lambda_6)(\lambda_3-\lambda_6)(\lambda_4-\lambda_6)(\lambda_5-\lambda_6)}\end{array}\right) \quad (8)$$

$$A_7 = N_0\lambda_1\lambda_2\lambda_3\lambda_4\lambda_5\lambda_6\lambda_7\left(\begin{array}{c}\frac{e^{-\lambda_1 t}}{(\lambda_2-\lambda_1)(\lambda_3-\lambda_1)(\lambda_4-\lambda_1)(\lambda_5-\lambda_1)(\lambda_6-\lambda_1)(\lambda_7-\lambda_1)}+\\ \frac{e^{-\lambda_2 t}}{(\lambda_1-\lambda_2)(\lambda_3-\lambda_2)(\lambda_4-\lambda_2)(\lambda_5-\lambda_2)(\lambda_6-\lambda_2)(\lambda_7-\lambda_2)}+\\ \frac{e^{-\lambda_3 t}}{(\lambda_1-\lambda_3)(\lambda_2-\lambda_3)(\lambda_4-\lambda_3)(\lambda_5-\lambda_3)(\lambda_6-\lambda_3)(\lambda_7-\lambda_3)}+\\ \frac{e^{-\lambda_4 t}}{(\lambda_1-\lambda_4)(\lambda_2-\lambda_4)(\lambda_3-\lambda_4)(\lambda_5-\lambda_4)(\lambda_6-\lambda_4)(\lambda_7-\lambda_4)}+\\ \frac{e^{-\lambda_5 t}}{(\lambda_1-\lambda_5)(\lambda_2-\lambda_5)(\lambda_3-\lambda_5)(\lambda_4-\lambda_5)(\lambda_6-\lambda_5)(\lambda_7-\lambda_5)}+\\ \frac{e^{-\lambda_6 t}}{(\lambda_1-\lambda_6)(\lambda_2-\lambda_6)(\lambda_3-\lambda_6)(\lambda_4-\lambda_6)(\lambda_5-\lambda_6)(\lambda_7-\lambda_6)}+\\ \frac{e^{-\lambda_7 t}}{(\lambda_1-\lambda_7)(\lambda_2-\lambda_7)(\lambda_3-\lambda_7)(\lambda_4-\lambda_7)(\lambda_5-\lambda_7)(\lambda_6-\lambda_7)}\end{array}\right) \quad [9]$$

Where

λ_R = The radioactive decay constant for the radioactive nuclide

λ_{OC}, λ_{EP}, λ_{ST}, λ_{SI}, λ_{LC}, λ_{RC}, λ_{RSC} are constants for the loss of the material from oral cavity, esophagus, stomach, small intestine, left colon, right colon and rectosigmoid colon respectively.

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b) Absorbed Dose

The absorbed dose in a particular organ after a certain time (t) of intake is given by

$$D(t) = 1.6\times10^{-19}\times10^{6}\times10^{3}\sum[A(t)\sum SEE(t \leftarrow S)_i]_j \text{ mSv} \quad (10)$$

Where,

A(t) is the activity at any organ after a time t from ingestion.

$$SEE(T \leftarrow S)_i = \frac{Y_i E_i AF(T \leftarrow S)_i w_R}{M_T} \text{ MeV } Kg^{-1} \text{ per transformation}$$

Where,

Y_i is the yield of radiations of type i per transformation

E_i is the average, or unique energy of radiation i in MeV

AF(T ← S) is the absorbed fraction that is the average fraction of energy in T from radiation arising in S;

$W_{R,}$ the radiation weighting factor and M_T is the mass of the target organ in kg.

c) Committed Equivalent Dose

The committed equivalent dose for each type of radiation is given by

$$H(T \leftarrow S)_i = U_s \times 1.6\times10^{-13} \times SEE(T \leftarrow S)_i \text{ Sv} \quad (11)$$

Where U_s is the number of the transformation of j in S over the lifetime following intake of the radionuclide. This is the expression for the number of transformations in the various organs in the tract following ingestion of 1 Bq of activity.

Oral cavity: $$U_{OC} = \frac{1}{\lambda_{OC} + \lambda_R}$$

Esophagus: $$U_{EP} = \frac{1}{(\lambda_{OC} + \lambda_R)(\lambda_{EP} + \lambda_R)}$$

Stomach: $$U_{ST} = \frac{1}{(\lambda_{OC} + \lambda_R)(\lambda_{EP} + \lambda_R)(\lambda_{ST} + \lambda_R)}$$

Small intestine: $$U_{ST} = \frac{1}{(\lambda_{OC} + \lambda_R)(\lambda_{EP} + \lambda_R)(\lambda_{ST} + \lambda_R)(\lambda_{SI} + \lambda_R + \lambda_B)}$$

Left colon: $$U_{LC} = \frac{1}{(\lambda_{OC} + \lambda_R)(\lambda_{EP} + \lambda_R)(\lambda_{ST} + \lambda_R)(\lambda_{SI} + \lambda_R + \lambda_B)(\lambda_{LC} + \lambda_R)}$$

Right colon: $$U_{RC} = \frac{1}{(\lambda_{OC} + \lambda_R)(\lambda_{EP} + \lambda_R)(\lambda_{ST} + \lambda_R)(\lambda_{SI} + \lambda_R + \lambda_B)(\lambda_{LC} + \lambda_R)(\lambda_{RC} + \lambda_R)}$$

Rectosigmoid colon:

$$U_{RSC} = \frac{1}{(\lambda_{OC} + \lambda_R)(\lambda_{EP} + \lambda_R)(\lambda_{ST} + \lambda_R)(\lambda_{SI} + \lambda_R + \lambda_B)(\lambda_{LC} + \lambda_R)(\lambda_{RC} + \lambda_R)(\lambda_{RSC} + \lambda_R)}$$

d) Committed Effective Dose

Committed effective dose for any organ of alimentary tract is the product of committed equivalent dose and tissue weighting factor

$$E(\tau) = \sum H_i \times W_i \quad \text{mSv} \quad (12)$$

Where W_i is the tissue weighting factor.

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III. Results and Discussion

Activity, absorbed dose, committed equivalent dose, and committed effective doses due to acute ingestion of 1 Bq of ^{60}Co. Tissue masses of alimentary tract for Bangladeshi people have been considered to calculate the above-mentioned quantities for different age groups such as newborn, 1 yr, 5 yrs, 10 yrs, 15 yrs (male and female) and adult (male and female).

a) Activity

Activity has been calculated at different compartments of HAT of the subjects of age groups: newborn, 1 yr, 5 yrs, 10 yrs, 15 yrs (male), 15 yrs (female) and adult (both male and female) and time elapsed as considered in the work is mostly 0.5 hr, 1 hr, 2 hrs, 4 hrs, 8 hrs, 12 hrs, 24 hrs and 48 hrs after the ingestion of the radionuclide.

Figs. 1-7 show the variation of activity in OC, OP, ST, SI, LC, RC, and RSC for all age groups. By studying the nature of the graphs, it is found that the tissues of all the seven organs (excepting oral cavity) show a tendency of rising of activity initially and subsequent falling. The radionuclide ^{60}Co is absorbed in one organ, which is caused after the release of it from the previous organ. The significant aspects of the absorption in and release from these organs are described below:

The activity-time graph for ^{60}Co has been constructed for the above-mentioned seven tissues of the alimentary tract. By studying the nature of the graphs it is found that the tissues of all the seven organs (excepting oral cavity) show a tendency of the rise of activity initially and subsequent falling.

Activity-versus-time graphs are plotted for OC (Fig. 1), OP (Fig. 2), and ST (Fig. 3). Fig. 1 shows that for OC, at around 0.001 hr after ingestion of the radionuclide, the activity reaches 0.97 Bq, and at 0.2hr after ingestion, it reaches to around $2.47\text{x}10^{-3}$Bq. The observation (a sharp fall) can be accepted because OC is the first organ, and its transit time is very short.

The excreted radionuclide will then appear in the next tissue, e.g., OP. After the lapse of the time at OC, the activity in OP should show growth, and this is observed in work; the peak is found to appear at around 0.02 hrs after ingestion. The value in the OP attains the maximum value at this time, the calculated result and the rising rate being 0.19Bq and 9.5Bq/hr, respectively. The activity change with time shows a sharp fall. After 0.4hrs, the activity level reduces to $3.07\text{x}10^{-6}$ Bq. This time is also short, again possibly due to the low transit time of the organ.

The excreted radionuclide is then deposited in the later tissue, e.g., ST. Fig. 3 shows that for ST, the activity level reaches to the maximum value (=0.89Bq) at 0.15hrs after ingestion. The rising-rate is 5.9Bq/hr. Then the activity level decreases exponentially. Finally, it reduces to a value of approximately $1.97\text{x}10^{-4}$ Bq at a time 10hrs after ingestion.

The excreted radionuclide from ST is then deposited in the later tissue, e.g., SI. Fig. 4 shows the pattern of change. In the case of SI, the maximum value of activity appears at about 1.2hrafter the ingestion; the maximum significance being 0.36 Bq. Then it falls, and in doing so, it takes a time of about 15hrs in total to reach the value of $2.29\text{x}10^{-5}$Bq.

The radionuclide then goes to the next tissue, e.g., LC, and the pattern of retention in the organ is shown in Fig. 5 In LC, activity level rises to 5hrs after ingestion, which is remarkably different from that of the other organs. The maximum value attained is 0.73 Bq. During the falling down process, this organ takes a very long time, e.g., approximately 96 hrs to reach it of approximately $4.2\text{x}10^{-4}$Bq.

Fig. 6 shows the variation of the activity with time for the organ RC. One may observe from the figure that in the case of RC, it rises up to attain the maximum value (=0.36) in 15hrs of duration; the rising rate being 0.024Bq approximately. The activity value then continuously decreases, and after an elapse of 150 hrs, the organ retains approximately $6.31\text{x}10^{-5}$Bq of activity in total. The falling rate is guided by an approximately exponential function.

The RSC graph (Fig. 7) shows that up to around 27 hrs after ingestion, the activity rises, being significantly different from that of the other ones. The peak value is about 0.27Bq, the rising rate being 0.01Bq/hr. Then the activity level decreases exponentially. Around 180hrs, duration is necessary for the activity level to fall to the value of 5.09×10^{-5} Bq.

b) Absorbed Dose

Figs. 8-13 show the variation of absorbed dose in 0 to 48 hrs by OP, ST, SI, LC and RC organs for a new-born baby who is supposed to have ingested 1 Bq of the radionuclide ^{60}Co. The absorbed dose in OP decreases very rapidly, its value becoming practically insignificant after around 0.4 hours. The absorbed dose in OP, ST, SI, LC, RC, and RSC increases exponentially (approximately) and then decreases. This pattern of variation is expected mainly because of the biological excretion phenomenon. Of course, the effect of radioactive half-life is also active in these cases.

The maximum absorbed dose per Bq intake of ^{60}Co is found to be $1.4\text{x}10^{-11}$, $1.95\text{x}10^{-11}$, $1.84\text{x}10^{-12}$, $1.60\text{x}10^{-11}$, $7.89\text{x}10^{-12}$, and $1.38\text{x}10^{-11}$mSv in the compartments of OP, ST, SI, LC, RC, and RSC respectively. The maximum absorbed dose in OP occurs quickly after the process of intake. Similar results are found for all the other age groups: 1 yr, 5 yrs, 10 yrs, 15 yrs (male), 15 yrs (female), adult (male) and adult (female). The absorbed dose in different parts of the human alimentary tract for the adult (male) is found to be the lowest because of the relatively larger tissue

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mass. The absorbed doses for the female from the radionuclide are very close to that of the male. The values increase with the decrease in age.

c) Committed Equivalent Dose

Figs. 14-16 show the variation of committed equivalent dose in OP, LC, ST, SI, RC, and RSC for eight different age groups of people due to ingestion of the radionuclide ^{60}Co. The equivalent dose is the maximum in the case of subjects of new-born age group. Then it decreases as age increases; its value is becoming almost the same for 15 yrs (male), 15 yrs (female), adult (male), and adult (female) because of their having approximately similar body mass [16].

The maximum committed equivalent dose per Bq intake of ^{60}Co is found to be $3.07x10^{-9}$,$9.21x10^{-8}$, $2.08x10^{-8}$, $2.59x10^{-7}$, $2.59x10^{-7}$, and $6.05x10^{-7}$mSv for OP, ST, SI, LC, RC, and RSC respectively. Fig. 17 shows the variation of committed equivalent dose in OP, LC, ST, SI, RC, and RSC for a particular age group of subjects, e.g., newborn child. The committed equivalent dose has a minimum value in OP due to a very tiny number of transformations (only 40) occurring there. In the next organ, e.g., ST, this value rises due to its larger number of transformations. In SI, this value is again decreasing due to its larger mass. In LC and RC, this value is almost the same because of their equal mass and transformation number. In RSC committed equivalent dose is maximum due to its lowest mass. For age groups: 1 yr, 5 yrs, 10 yrs, 15 yrs (male), 15yrs (female), adult (male), and adult (female) similar results are found.

d) Committed Effective Dose

The variation of committed effective dose in the organs OP, ST, SI, LC, RC, and RSC for the different age groups of people due to the ingestion of the radionuclide ^{60}Co is shown in Figs. 18-20. As expected, the committed effective dose is the maximum in case of a subject of new-born age group. Then it decreases as age increases; its value is becoming almost the same for 15 yrs (male), 15 yrs (female), adult (male) and adult (female) subjects because of their having close body mass.

The maximum committed effective dose per gram intake of ^{60}Co is found to be $1.22x10^{-10}$, $1.10x10^{-8}$, $2.41x10^{-9}$, $3.11x10^{-8}$, $3.11x10^{-8}$, and $7.26x10^{-8}$ mSv for OP, ST, SI, LC, RC, and RSC respectively. In the case of a new-born baby, the variation of committed effective dose in the organs OP, ST, SI, LC, RC, and RSC is given in Fig. 21.

Committed Effective dose has a minimum value in OP due to a very tiny number of transformations. In the next organ e.g., ST this value is rising due to its greater number of transformations. In SI, this value is again decreasing due to its larger mass. In LC and RC this value is almost the same because of their equal mass and transformation number. In RSC, committed equivalent dose is the maximum due its lowest mass. Similar results are found for subjects of age groups: 1 yr, 5 yrs, 10 yrs, 15 yrs (male), 15yrs (female), adult (male), and adult (female).

IV. Conclusion

Due to ingestion, maximum radiation dose is deposited in the alimentary tract, which consists of seven tissue compartments, e.g., OC, OP, ST, SI, LC, RC, and RSC. The transfer of radionuclides from the oral cavity to the esophagus has been considered an instantaneous process that gives less retention but activity in the entry route.

The following important observations could be made from the study:

a. The time required to get an insignificant value of activity depends more on the decay constant of radionuclides than the rate invariable of the considered organ. In this work, it is observed that activity values became insignificant approximately after 0.3 hrs in OC, 0.4 hrs in OP, 10 hrs in ST, 15 hrs in SI, 96 hrs in LC, 150 hrs in RC, and 180 hrs in RSC.
b. The absorbed dose for a newborn baby has been observed to be higher than that of others having higher body mass. This is justified since the absorbed dose is inversely proportional to the mass of the tissue compartment of the alimentary tract. It thus becomes high for a newborn baby as the tissue mass is less than those of other age groups. Regarding age, the variation of absorbed dose, committed equivalent dose, and committed effective dose follows the sequence: Newborn >1 yr> 5 yr> 10yrs > 15 yrs> adult female > adult male.
c. Absorbed dose for an alpha-emitting radionuclide is higher than beta-emitting radionuclides due to higher radiation weighting factor (w_R).
d. The absorbed dose, committed equivalent, and committed effective dose show a common tendency that these values are maximum for a subject of newly born age group; then, it decreases as the age increases for all the radionuclides of interest.
e. Regarding compartment the trends of variation of maximum absorbed dose are: ST > LC > OP > RSC > RC >SI
f. Regarding tissue compartments the variation pattern of committed equivalent dose is: RSC> LC > RC > ST > SI > OP
g. The highest committed effective dose per Bq intake for each radionuclide is found in the alimentary tract of a newborn baby. These values for stomach are $3.72\ x10^{-6}$mSv/Bq, $2.16x10^{-6}$mSv/Bq, $8.64x\ 10^{-7}$mSv/Bq, $1.80x10^{-7}$mSv/Bq, and $1.11x10^{-8}$mSv/Bq.

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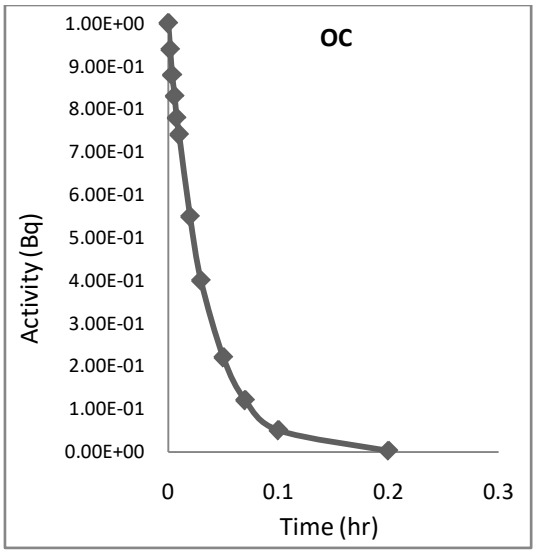


Fig. 1: Time variation of activity in OC

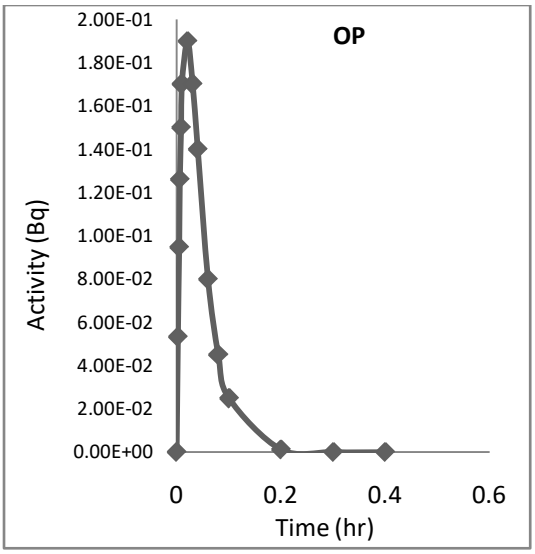


Fig. 2: Time variation of activity in OP

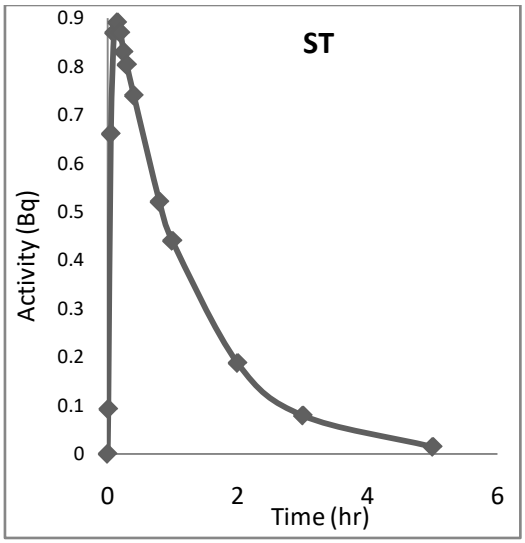


Fig. 3: Time variation of activity in ST

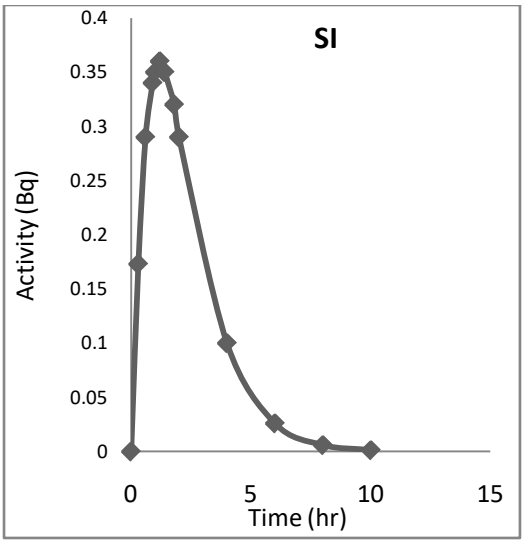


Fig. 4: Time variation of activity in SI

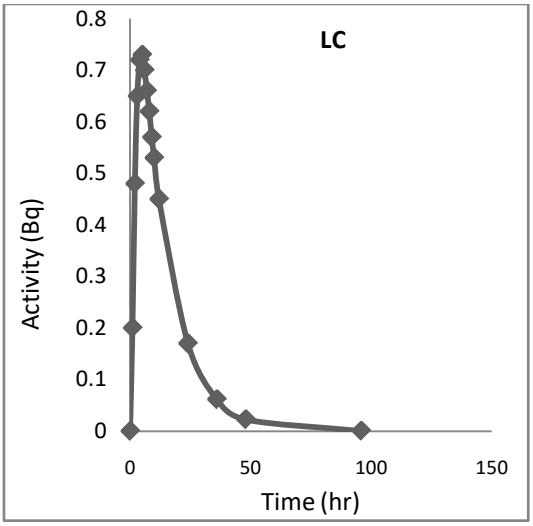


Fig. 5: Time variation of activity in LC

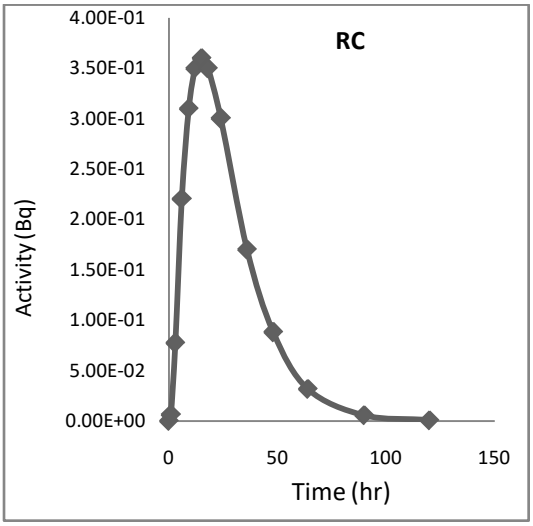


Fig. 6: Time variation of activity in RC

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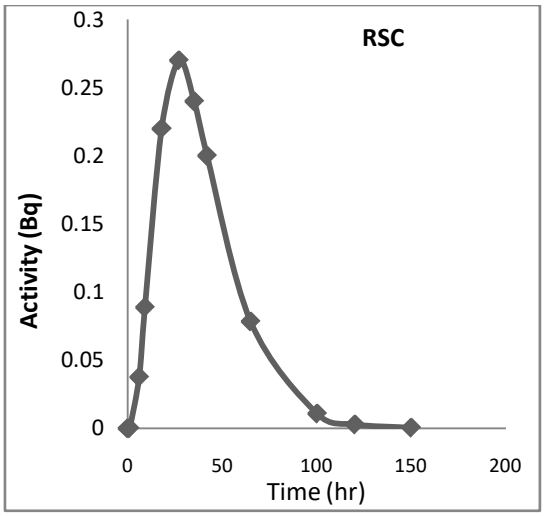


Fig. 7: Time variation of activity in RSC

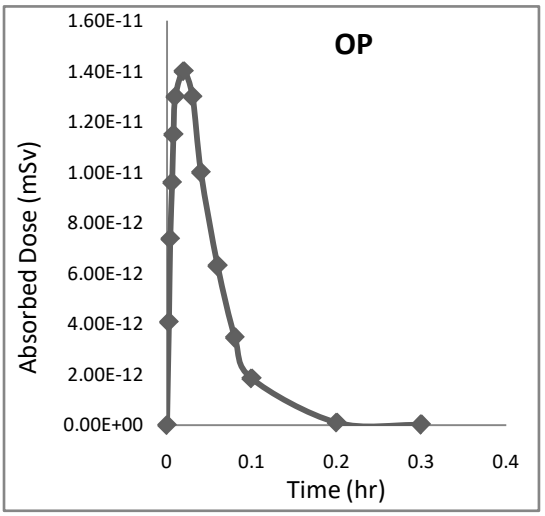


Fig. 8: Time variation of absorbed dose in OP

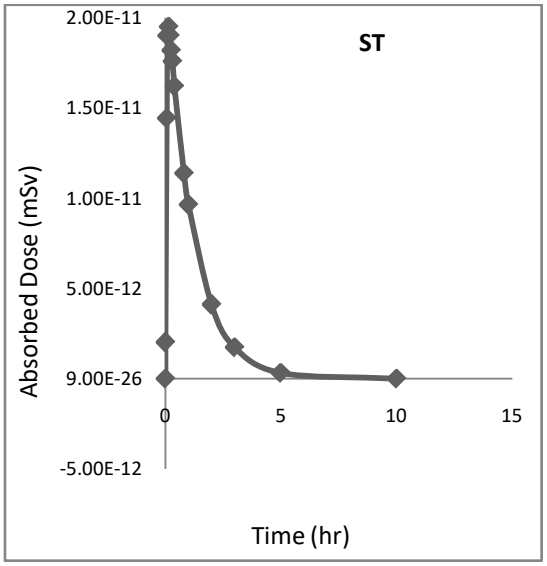


Fig. 9: Time variation of absorbed dose in ST

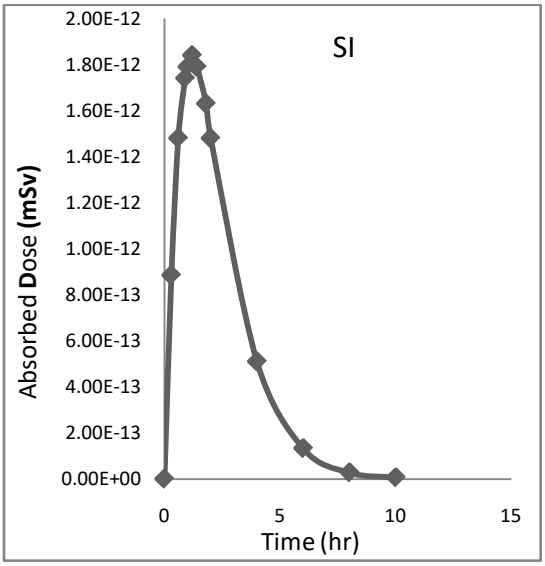


Fig. 10: Time variation of absorbed dose in SI

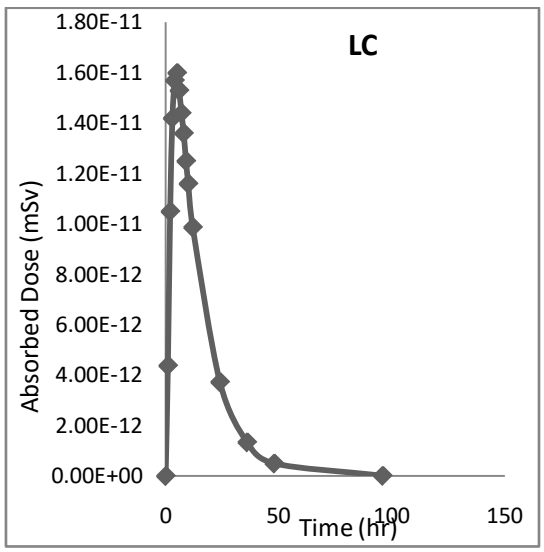


Fig. 11: Time variation of absorbed dose in LC

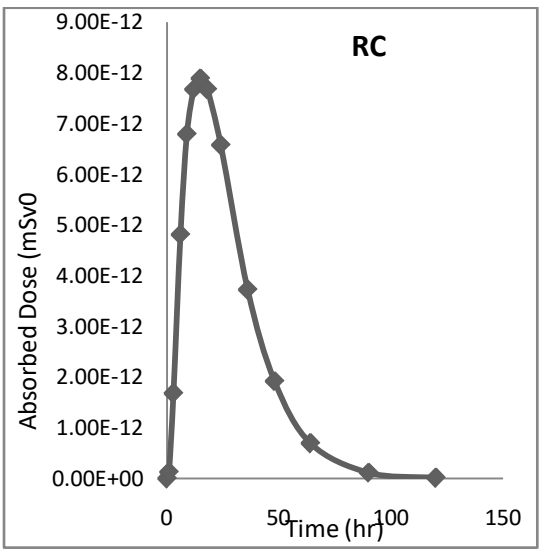


Fig. 12: Time variation of absorbed dose in RC

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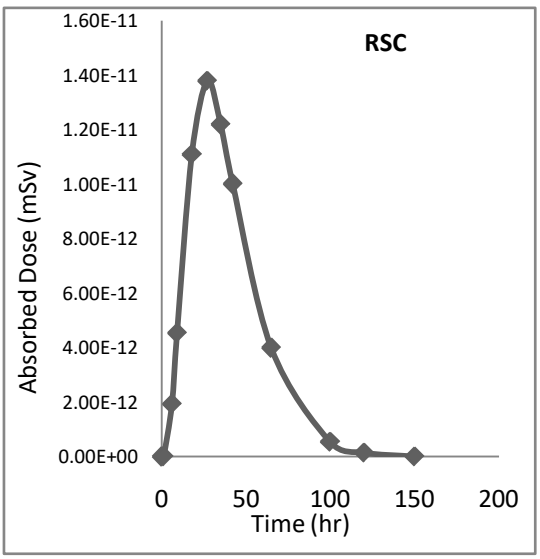


Fig. 13: Time variation of absorbed dose in RSC dose in RSC

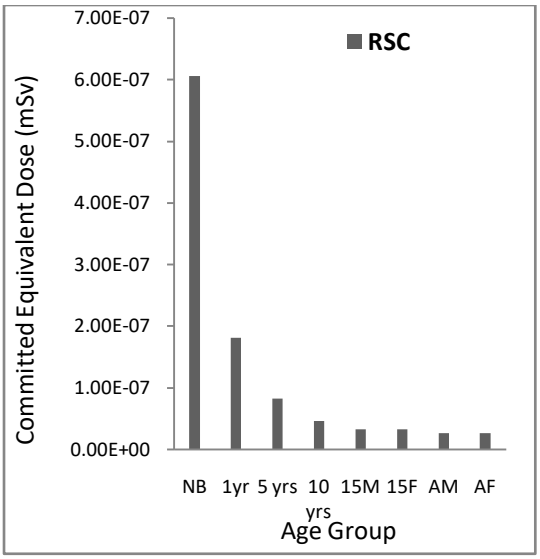


Fig. 14: Age variation of committed equivalent

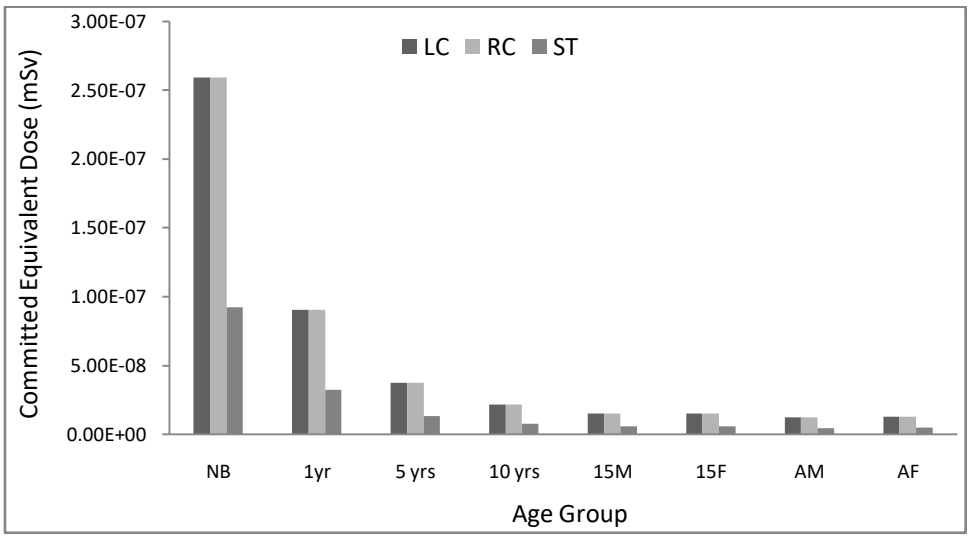


Fig. 15: Age variation of committed equivalent dose LC, RC and ST

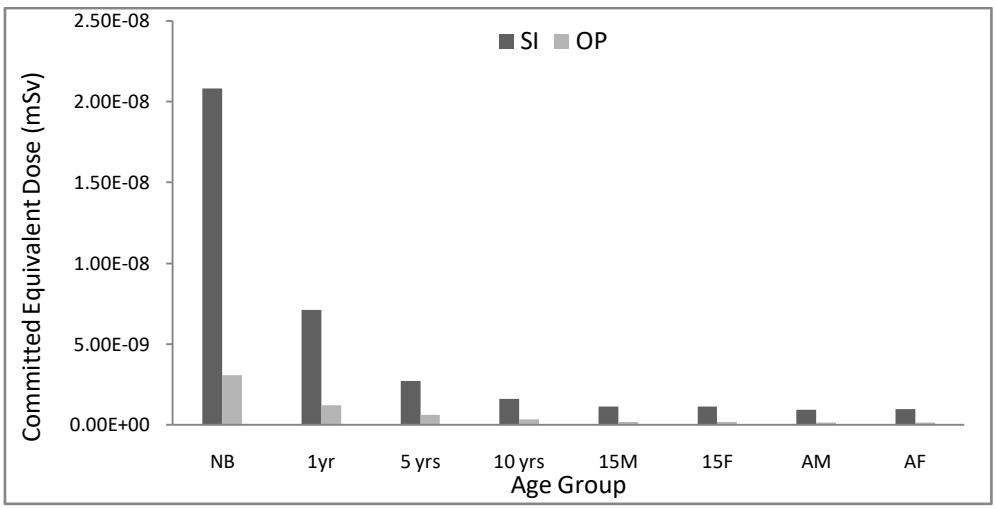


Fig. 16: Age variation of committed equivalent dose in SI and OP

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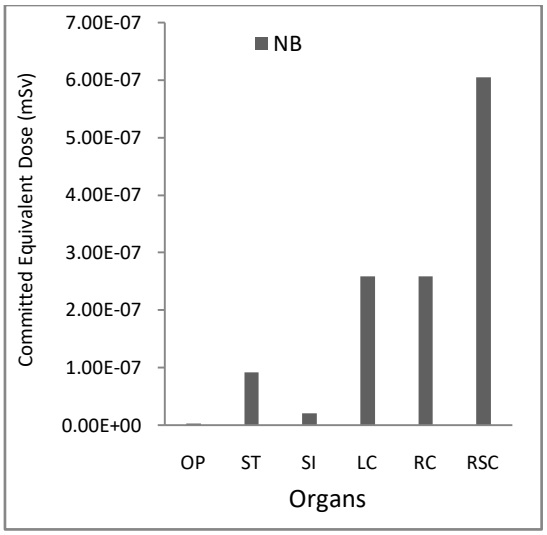


Fig. 17: Organ variation of committed equivalent dose

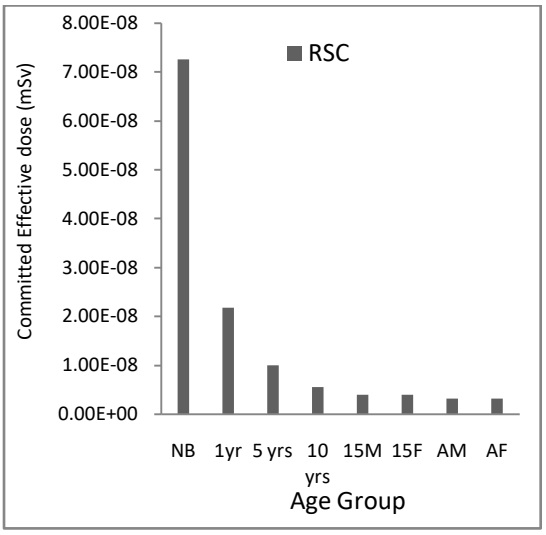


Fig. 18: Age variation of committed effective dose in RSC

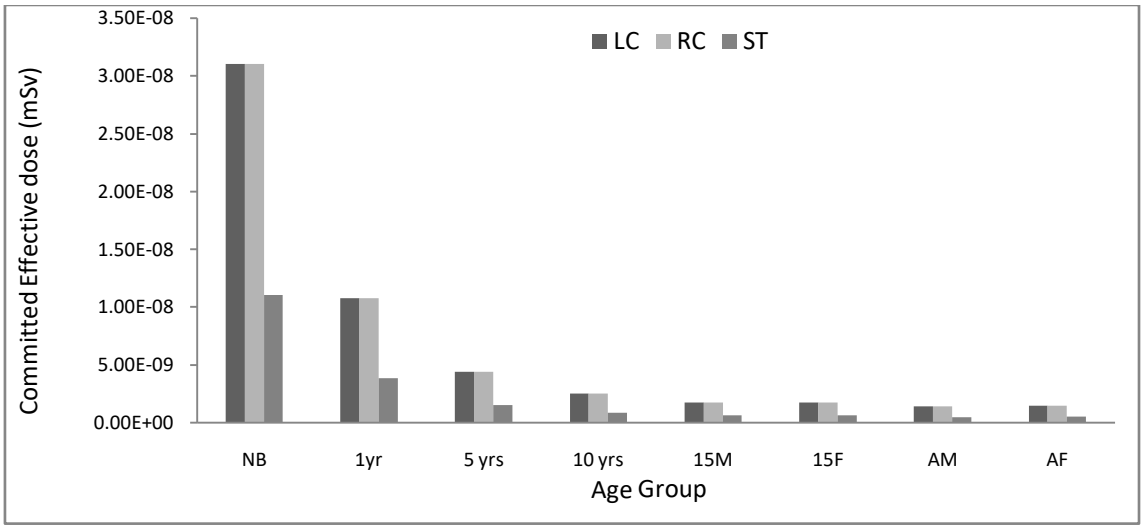


Fig. 19: Age variation of committed effective dose in LC, RC and ST

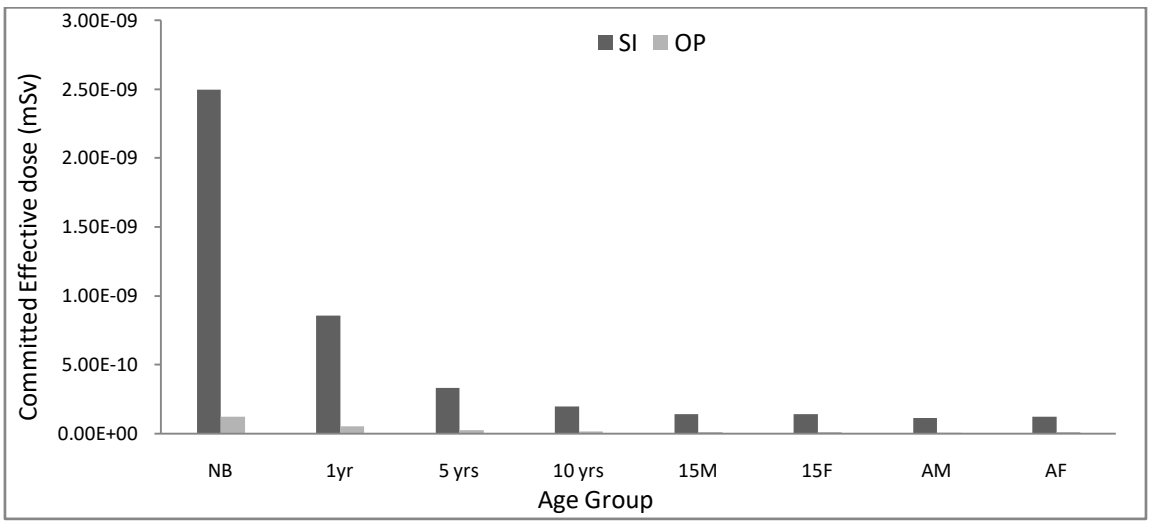


Fig. 20: Age variation of committed effective dose in SI and OP

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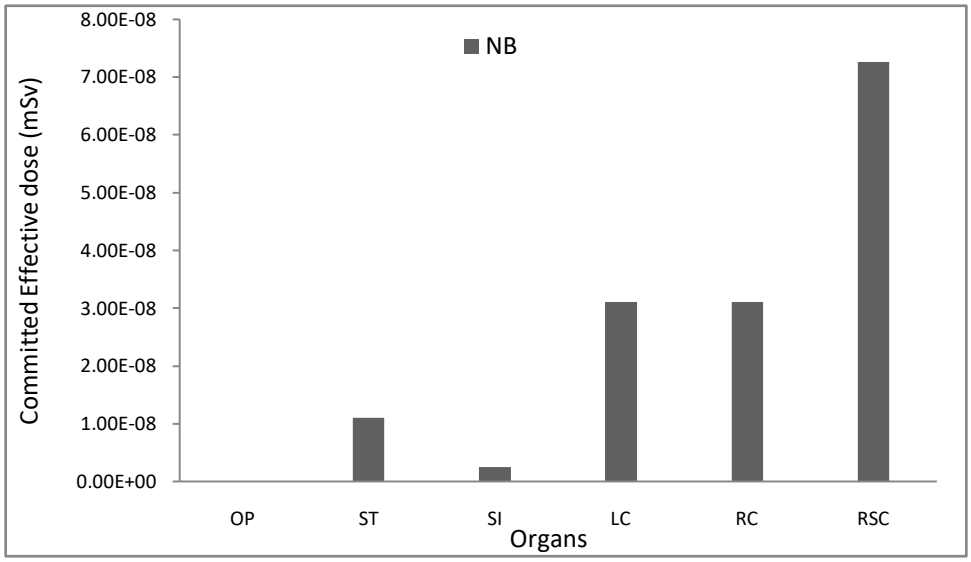


Fig. 21: Organ variation of committed effective dose

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Global Journal of Medical Research: D
Radiology, Diagnostic and Instrumentation
Volume 19 Issue 2 Version 1.0 Year 2019
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

Ingestion of Coins in Children in Pediatric Intensive Care Unit: Our Experience in Emergency Care at EHU Oran

By Sid Ahmed Bakri, Houcine Sadok, Dalila Boumendil, Djilali Batouche & Djamila-Djahida Batouche

Summary- The ingestion of coins is an accident frequently encountered in children. In most cases, the ingestion is asymptomatic but requires instrumental exploration.

Aim: is to report the experience of the pediatric resuscitation service in the management of these coins ingested at the EHU Oran.

Material-Methods: A prospective study from 01/01/2018 to 10/12/2019 was performed in the pediatric resuscitation department. Any child who has ingested a coin is referred to the 0RL department for an endoscopic exploration.

A front and side cervical x-ray is taken to visualize the EC. The children were explored by a rigid endoscope under halogenated anesthesia and sedation by propofol in spontaneous ventilation and without trachéal intubation

Keywords: *coin, child, digestive endoscopy.*

GJMR-D Classification: *NLMC Code: WB 105, WS 205*



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Ingestion of Coins in Children in Pediatric Intensive Care Unit: Our Experience in Emergency Care at EHU Oran

Sid Ahmed Bakri [α], Houcine Sadok [σ], Dalila Boumendil [ρ], Djilali Batouche [ω] & Djamila-Djahida Batouche [¥]

Summary- The ingestion of coins is an accident frequently encountered in children. In most cases, the ingestion is asymptomatic but requires instrumental exploration

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Results: 35 foreign bodies (coins) ingested by the children were taken care of. Our children are divided into 19 boys (54,28%) and 16 girls (45,7%) with an average age of 25 months ± (extreme 7 months-120 months). 85,7% of children were asymptomatic and 100% of children were explored; coin extraction was possible in 98.16% of the cases, without any complications

Conclusion: The endoscopic extraction of the coin from the upper digestive tract is harmless and effective

Keywords: coin, child, digestive endoscopy.

I. Introduction

Ingestion of coins is an accidental situation frequently encountered in the pediatric population. In most cases, the ingestion remains without clinical consequences and the extraction of the EC requires a rigid endoscopy.

II. Material - Methods

We conducted a prospective study from 1/1/2018 to 10/12/2019. All children who have ingested a coin are referred to the ORL service of EHU Oran, which calls the pediatric resuscitation anesthesia service for a instrumental exploration, in an anesthetic environment. After having visualized the EC by a frontal and lateral cervical X-ray, the children are then admitted to the emergency unit, after observing a fast before exploration and a consent signed by the parents.

Sedation at the time of endoscopy is systematic in all children. Extraction is possible after halogenated anesthesia with a facial mask, and sedation performed by injection of propofol 3 mg / kg, fentanyl 1 gamma/kg (this attitude depends on the experience of the operator. The material used is a laryngoscope rigid, claw clips, "crocodile" clips.

If endoscopic exploration does not visualize a foreign body, an uninhabited abdominal x-ray (ASP) is performed in the recovery room.

The explored children are monitored 2 hours after the digestive endoscopy and then redirected to the ORL department.

III. Results

In one year we collected 35 cases of coin ingestion. Our children are divided into 19 boys (54,28%) and 16 girls (45,7%).

The average age of the children is 25 months (extreme 7 months-120 months), with a peakage frequency observed at 36 months and 5 years (fig. 1).

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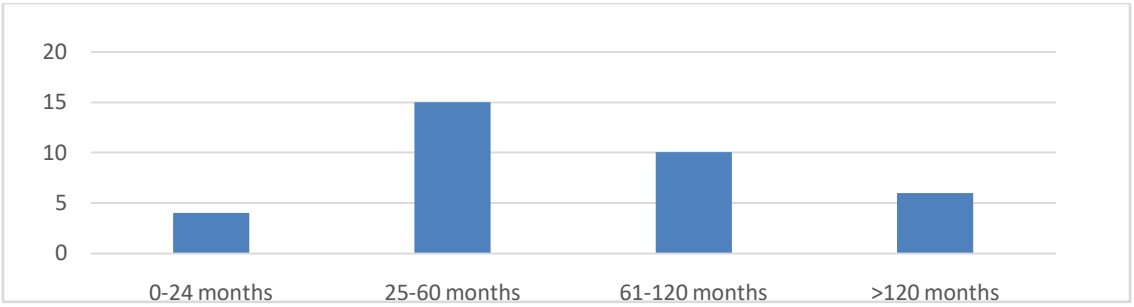
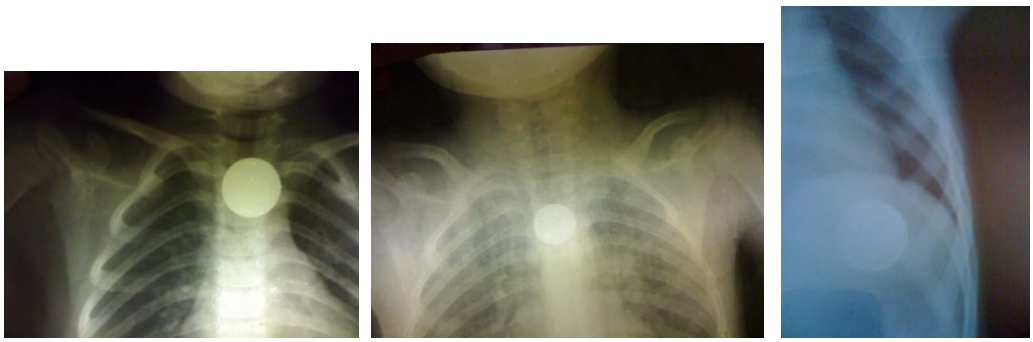


Fig. 1: Graphical breakdown representing the workforce by age expressed by age class in months

The average time for taking charge is 19.14 ± 0.729 hours; the children are oriented from different wilayas of central and western Algeria. All the children had no particular antecedents except two ashtmatic under treatment.

Ingestion was asymptomatic in 30 cases. It was followed by a hyper sialorrhea in 01 cases, a swallowing gene with vomiting in 2 cases and dysphagia in 2 cases. The clinical examination was unremarkable in all children.

Front and side cervical radiography visualized the presence of a foreign body (coin) at the upper part of the esophagus in 28 children (80%), at the middle part of the esophagus in 05 cases (14 , 2%) and twice the foreign body was in the distal esophagus. (Fig. 2)



(a) (b) (c)

Fig. 2: Location of the coin in different place of the esophagus: (a) upper part of the esophagus, (b) middle esophagus, (c) location of the part in the stomach



Fig. 3: Different types of coins

The part was extracted on the 1st attemptin 80.6%, on the second attemptin 11.3% and on the third attempt in 1.6% of the remaining cases. The median extraction time for the coin was 1 minute, ranging from 35 to 80 seconds, the median duration of sedation was 10 minutes. No complications related to endoscopic treatment were observed. Or even the anestheticact. All the children were monitored for 02 hours in the recovery room and redirected to the ENT service. The children whose EC was viewed at the ASP had benefited from the control ASPs performed at the ENT service, remotely from the acute episode and which showed the progression of the EC along the digestive tract until its expulsion by natural way.

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IV. Discussion

The ingestion of coins is a frequent accident in children, with banal clinical consequences [1] and easily removed by endoscopy. [2]

The coins represent the foreign body (CE) most often encountered in children. [3 –4] with a peak frequency between 6 months and 6 years old [3.5]. In a series that analyzed 320 esophageal CEs, they were coins in 83.8%. Ingestion occurred when children played in the presence of an adult in 85.3% of cases [6]. Almost all of the ingestion in children under the age of 5 did not go unnoticed in our study. 76% of our children were asymptomatic on admission, there was no significant difference between room size and clinical sign on admission ($p = 0.478$).

The passage of CE of less than 2 cm in diameter is generally easy through the esophagus. On the other hand, CE of 2 cm in diameter can be more easily impacted during their progression in the digestive tract with a risk of obstruction and perforation which is then increased, which justifies their endoscopic extraction. Other blocking sites are the pylorus, duodenum, Treitz angle, Meckel's diverticulum, ileocecal valve, appendix and recto-sigmoid hinge. The EC located at the upper third and at the middle third of the esophagus must be removed as soon as possible, because they are blocked, either at the cricopharyngeal ring or at the aortic arch, which are areas at risk of complications. [1] [6]

In the event of a delayed diagnosis, several complications can arise such as: esophageal ulcer, esophageal stenosis [7], esotracheal fistula [8].

The most frequent location (95%) is the cervical esophagus under the cricopharyngeal muscle [9, 10], it was observed in 81% in our study, and justifies instrumental extraction. Several attitudes have been described in the literature to allow this extraction. This is the use of the Magill forceps [11-13], the use of the Foley probe [14, 15],flexible [16] or rigid esophagoscopy [17]. A review article discussed the management of coin ingestion (published by Waltzman) [2] based on a retrospective study and a prospective randomized trial. With the use of rigid esophagoscopy in symptomatic patients, On the other hand, children with localized EC of the lower third can be monitored for 12 to 24 hours in the absence of functional signs, in the hope of expulsion which may prevent the need for general anesthesia.

In our current practice, digestive endoscopy was performed in 100% of the cases. It is a digestive endoscopy with a rigid tube due to the lack of availability of the flexible pediatric endoscope. And no complications secondary to the endoscopic procedure were noted. Same technical procedure used by J.R. Benito Navarro et al. [19]. However, it is important to remember that esophagoscopy, whether flexible or rigid, is associated with a risk of esophageal perforation during the procedure evaluated between 5 and 10%.

As for the anesthetic protocol our attitude depends on the experienced operator or little, so the extraction procedure was performed without intubation, under anesthesia sevoflurane, and in 20% of cases associated with the injection of propofol spontaneous ventilation. This extraction was 100% successful. In the Cetinkursun et al [12] series, the extraction was performed without intubation under sedation inhaled with sevoflurane. Similarly in the series of Baralcoll [18], extraction was done in 21 children sedated by propofol in spontaneous ventilation and without tracheal intubation. Janik E et al [13] mentioned the risk of respiratory complications in the absence of tracheal intubation. Nevertheless, in our series, strictly respecting the rules of preoperative fasting, and as elsewhere, laryngospasm or desaturation have not been recorded as in the literature Cetinkursun S, et al [12].

The post-exploration suites were favorable, the children are monitored for 2 hours post-exploration, then handed over to the parents.

V. Conclusion

The ingestion of coins is a frequent accident in children and the diagnosis is most often evident by a cervical x-ray. Endoscopic exploration is easy with halogenated anesthesia and propofol sedation, after respecting the preoperative youngster. But like any accidental situation, prevention requires good education for parents and young children.

Conflict of interest

The authors declare that they have no conflict of interest.

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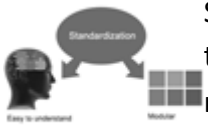


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18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



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Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



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Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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Global Journal of Medical Research

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ISSN 9755896



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