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RESEARCH ARTICLE

POTENTIAL OVERUSE OF CT IMAGING BY VARIOUS CLINICAL DEPARTMENTS OF A TERTIARY CARE TEACHING HOSPITAL

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Abstract

Computerized Tomography, commonly called as the CT scan is an ionizingnon-invasive, modality which uses combination of series of X ray images taken from the different angles to create cross-sectional images of the body. Even after the advent of advanced imaging techniques such as MRI, CT is still holds an edge over it because of its cost-effectiveness, availability and faster results. But all these factors are also seen to cause an adverse impact leading to overuse or "unethical" use of the CT regardless of the radiation exposure.In tertiary care teaching hospital, 200 patients attending out-patients and in-patients from all the clinical departments were taken into the study. They were categorized based on their age and the indication of CT imaging (underlying medical condition).The study showed a gradual rise in the CT investigation with increasing age upto the age of 70 years. It was observed that, highest CT imaging were done for the middle-aged group of 50-70 years and least being extremes of below 18 age group. The leading causes for which CT was most requested, were found to be for pre-surgical screening during COVID19 pandemic, followed by COVID19 infection severity detection, head trauma, suspected cases of stroke, renal stones and rhinosinusitis being the fifth leading causes respectively.The present research concludes that, CT investigation is an important benchmark in the field of diagnostic medicine, but careful scrutiny is required while advising these modalities to avoid the unnecessary radiation exposure. Hospital authorities must be responsible to prepare strict guidelines and frequent workshops should be conducted for health professionals to acquaint them with the updated guidelines, for recommending radiation involved imaging to maintain a cost-benefit balance, where the benefit is the diagnostic advantage and the cost being the radiation exposure.

Introduction:-

Computerized Tomography or Computerized Axial Tomography, commonly called as the CT scan is a non- invasive modality which usescombination of series of X ray images taken from the different angles of the body which are computer processed to create cross-sectional images of that part of the body(axial, coronal, sagittal planes). CT is widely used in the current era of advanced medical system to visualize the anatomical structures in the head,

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neck,thorax, abdomen and musculoskeletal system.CT can not only be used for diagnostic purposes, but also for therapeutic purposes where the X ray beam is used to deliver radiation therapy directed towards a precise single lesion point [1].CT is the investigation of choice for head trauma cases to detect intracranial bleed and fractures in the skull, other than that it also used to diagnose a variety of conditions such as renal calculi, liver disorders, tumors, abscess, intracranial space occupying lesions (ICSOL), degenerative changes of the brain, hydrocephalus, birth defects, spinal deformities, cysts, rhinosinusitis, deviated nasal septum, vascular or any other structural anomaly and after the COVID19 pandemic the use of HRCT (High resolution non-contrast CT) chest has become popular among both the patients and the health care workers, leading to the irrational use of the investigation which comes with a greater price of radiation exposure. Even after the advent of more advanced techniques such as the MRI, CT still holds an edge over it because of its cost-effectiveness, availability and faster results. But all these factors arealso seen to cause an adverse impact in terms of "unethical" use of the CT despite the radiation involved.Radiation exposure to CT imaging ranges from 2-8 mSv based on the part of the body (from CT head: 2 mSv to CT abdomen and pelvis: 8 mSv). The amount radiation exposed in a single CT is often unseen or neglected by the health professionals, which in turn has a negative impact on patients' health. This research highlights the inappropriate use of CT investigation by the various clinical departments in the hospital and emphasizes its negative effects on health.

Aims and Objectives:-

1. The objective of the study is to determine the frequency of CT scans requested from the major departments of the hospital i.e Causality, General Medicine, General Surgery, Pediatrics, ENT, Ophthalmology, Obstetrics and Gynecology.
2. To determine the common medical conditions which require frequent CT investigation.

Materials and Methods:-

200 patients attending the Out-patients and In-patients from all the clinical departments at a Tertiary care teaching hospital in India, who were recommended CT imagingfrom August to September 2021, were enrolled into the study.

Studypopulation:

Thepopulationwasselectedbythefollowinginclusionandexclusioncriteriamentionedbelow-

Inclusion Criteria:

1. Patients requiring CT scan with or without contrast (NCCT or CECT) as an investigation from all out patients and in patients departments in the hospital.
2. CT scan required for diagnostic purposes only.
3. CT scan as a part of follow-up investigation were also included.

Exclusion Criteria:

1. Patients who denied or who had contraindications for the CT investigation were excluded in study.

Datacollection

Patient's details,indication of CT scan along with the provisional diagnosis and patient's request for investigation were recorded for 2 months duration in the Department of Radiology of the hospital.

Data analysis

The collected data was categorized based on the age and the provisional diagnosis at the time of investigationor the reason for requesting the investigation. Number of cases which were advised CT scanfor each medical condition for a sample size of 200were recorded and percentagewascalculated. The categorization of data is as follows in Table 1:

Table 1:- Categorization of data based on age and provisional diagnosis of the patient.

Frequency based on the age of the patient	<18 years 18-30 years 31-50 years 50-70 years >70 years

Frequency based on the provisional diagnosis CT Head/ Sinuses	Head Trauma Rhinosinusitis Deviated nasal septum Stroke Suspected tumor/Intracranial space occupying lesion/ Hydrocephalus/Meningitis Mucormycosis post COVID19 infection
CT Chest/ Thorax	COVID19 infection As a part of precautionary pre-surgical screening during the COVID pandemic COPD Haemothorax/Pneumothorax/Pleural Effusion Pneumonia other than COVID19 infection Metastatic spread of carcinoma stomach and breast carcinoma
CT Abdomen/ Pelvis	Developmental anomalies (malformations in the kidney,situs inverses) Carcinoma Stomach Kidney/ureteric/bladder stones Gall stones/biliary obstruction Liver conditions such as Liver cirrhosis, Liver abscess Pancreatitis Carcinoma ovary/endometrium/cervix Others (Metastatic spread of carcinoma stomach and breast carcinoma, fracture pelvis, pelvic inflammatory disease, abdominal aorta aneurysm, trauma suspecting intra-abdominal bleeding or laceration)
CT spine/ extremities	Herniation of disc in the spine Trauma to the spine Scoliosis/kyphosis/lordosis Osteoarthritis in the spine Osteomyelitis in the bone

Results:-

A total of 200 patients were taken into the study, categorizing them based on age group and the cause of requesting CT investigation.

Age group classification:

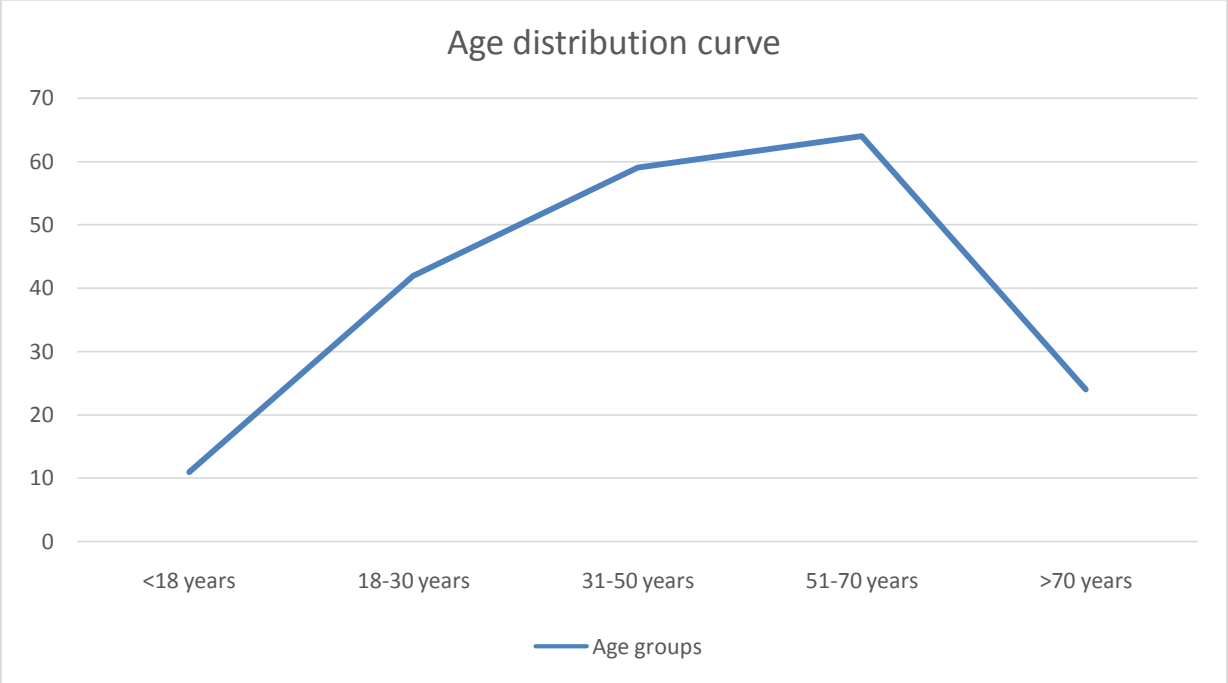
A gradual rise in the number of CT investigations with increasing age up to 70 years was observed. The extremes of age groups <18 years and >70 years were seen to have undergone 5.5% and 12% scans respectively. Evidently showing the highest scans done were between the age of 50-70 years and the least scans below the age of 18 years. Table 2 shows the distribution of the data and the corresponding percentage of distribution with the age groups. Figure 1 depict the age group classification of data in the form of line graph.

Table 2:- Frequency of CT scan based on the age of the patient.

AGE	NUMBER OF CASES (n=200)	PERCENTAGE
<18 years	11	5.5%
18-30 years	42	21%
31-50 years	59	29.5%

50-70 years	64	32%
>70 years	24	12%

Figure 1:- Age group classification.



Based on Medical Condition:

It was observed that CT Chest/Thorax was the most requested investigation, corresponding to 35% of all the CT scans done at the hospital, followed by CT Head and Sinuses (32%). CT for Abdomen and pelvis were done at the rate of 35%.Least number of CT scans were for Spine/Extremities disorders, which was around 10.5 percent.

CT Chest/Thorax (35%) > CT Head and Sinuses (32%) > CT Abdomen/ Pelvis (22.5%)>CT spine/ extremities (10.5%).

CT Chest/Thorax investigation performed as a part of precautionary pre-surgical screening during the COVID 19 pandemic covered the highest number of all the CT scans, which was 13.5% (27 out of 200). The second highest scans were done for COVID 19 infection diagnosis or to assess the extent of infection post RT-PCR or Rapid diagnosis test commonly known as the HRCT (High resolution non-contrast Computerized Tomography), followed by CT Head and Sinuses for head trauma cases and stroke comprising 11.5% and 9% respectively. Furthermore, CT investigation for Kidney/ureteric/bladder stones was observed to be the highest of CT Abdomen and Pelvis and Osteoarthritis of the spine being the highest among the Musculoskeletal CT. Table 3 represents the medical conditions and the corresponding number of CT scans with percentage distribution. Figures 2 and 3 represent CT imaging distribution based on the part of the body scanned and the provisional diagnosis at the time of imaging respectively.

As a part of precautionary pre-surgical screening during the COVID pandemic (13.5%)> COVID19 infection (12.5%) > Head Trauma (11.5%) > Stroke (thrombo-embolic or hemorrhagic) (9%) > Kidney/ureteric/bladder stones (6%); Rhinosinusitis (6%).

Figure 2:- CT imaging distribution based on the part of the body.

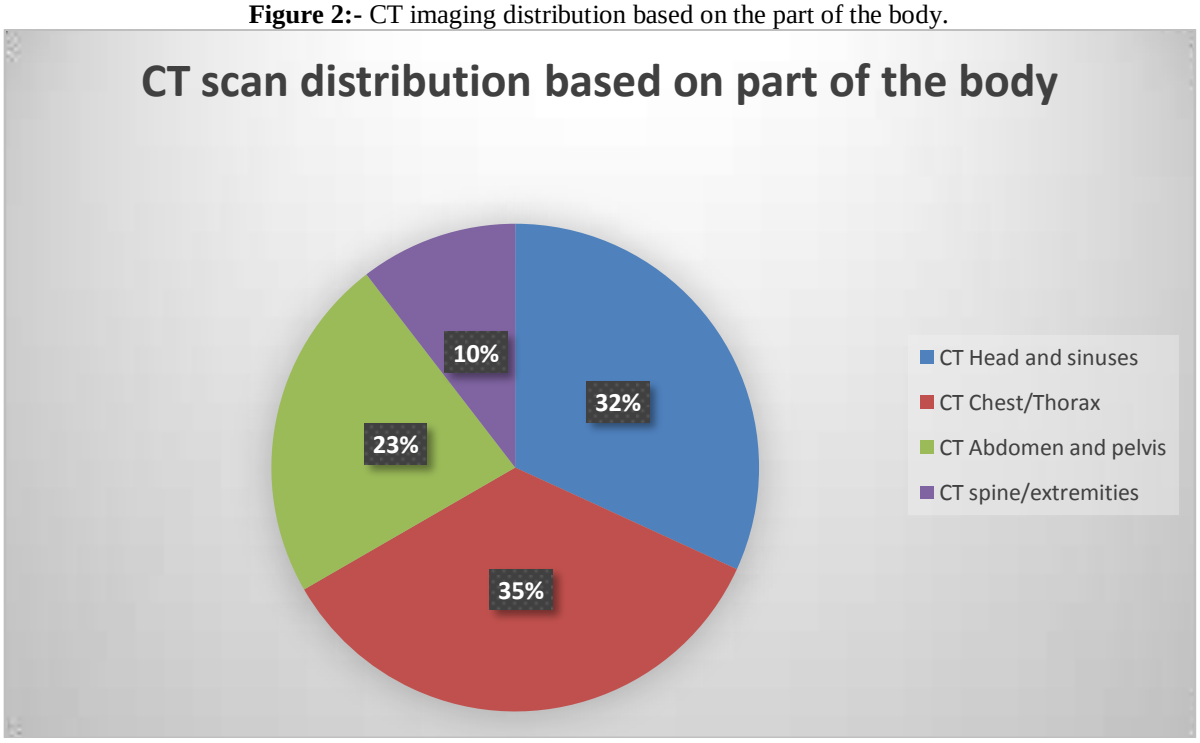


Figure 3:- Frequency distribution based on the medical condition requesting highest number of CT imaging.

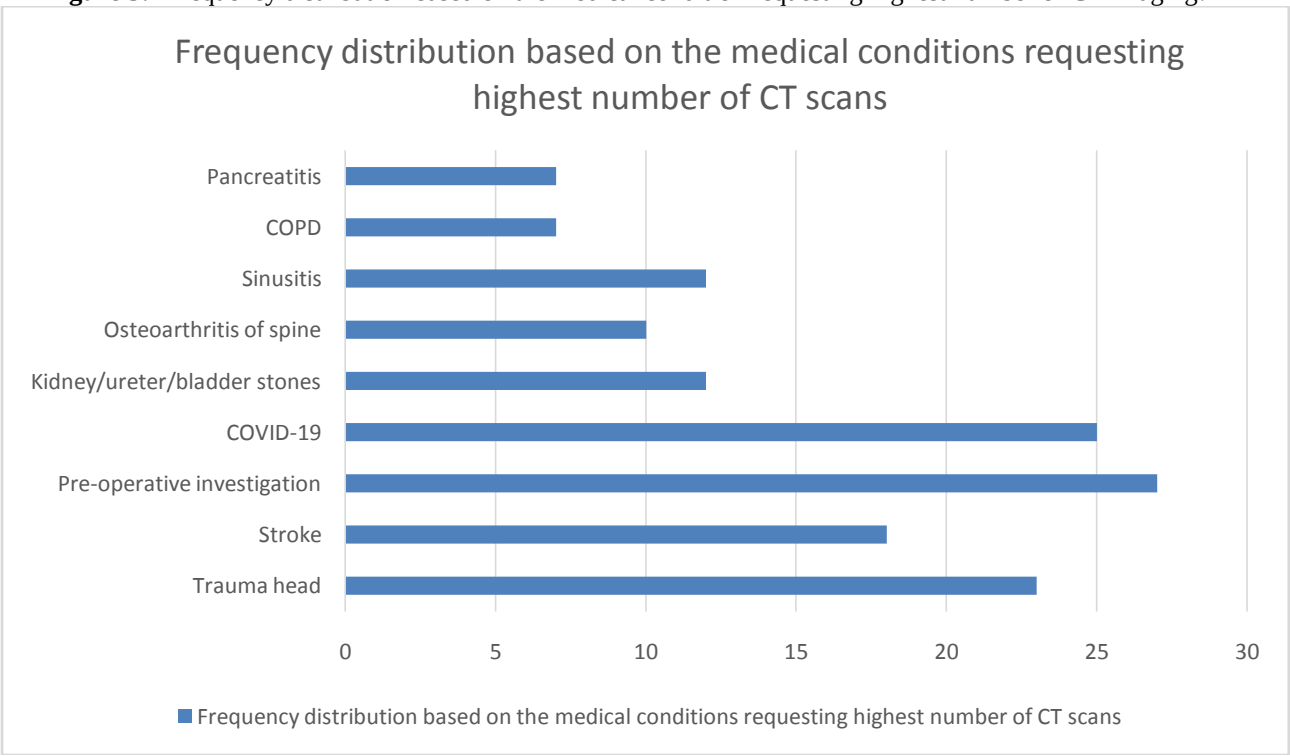


Table 3:- Frequency of CT scan based on the medical condition.

BODY PART	MEDICAL CONDITION	NUMBER OF CASES (out of 200)	PERCENTAGE

CT Head and Sinuses (32%)	Head Trauma	23	11.5%
	Rhinosinusitis (Acute/Chronic)	12	6%
	Deviated nasal septum	4	2%
	Stroke (thrombo-embolic or hemorrhagic)	18	9%
	Suspected tumor/Intracranial space occupying lesion/ Hydrocephalus/Meningitis	5	2.5%
	Mucormycosis post COVID 19 infection	2	1%
CT Chest/ Thorax (35%)	COVID 19 infection	25	12.5%
	As a part of precautionary pre-surgical screening during the COVID pandemic	27	13.5%
	COPD	7	3.5%
	Haemothorax/ Pneumothorax/ Pleural Effusion	5	2.5%
	Pneumonia other than COVID 19 infection	4	2%
	Metastatic spread of carcinoma stomach and breast carcinoma	2	1%
CT Abdomen/ Pelvis (22.5%)	Developmental anomalies (malformations in the kidney,situs inverses)	2	1%
	Carcinoma Stomach	2	1%
	Kidney/ureteric/bladder stones (renal calculi)	12	6%
	Gall stones/biliary obstruction	5	2.5%
	Liver conditions such as Liver cirrhosis, Liver abscess	4	2%
	Pancreatitis	7	3.5%
	Carcinoma ovary/endometrium/cervix	3	1.5%
	Others (Metastatic spread of carcinoma stomach and breast carcinoma, fracture pelvis, pelvic inflammatory disease, abdominal aorta aneurysm, trauma suspecting	10	5%

	intra-abdominal bleeding or laceration)		
CT spine/ extremities (10.5%)	Herniation of disc in the spine	5	2.5%
	Trauma to the spine	2	1%
	Scoliosis/kyphosis/lordosis	2	1%
	Osteoarthritis in the spine	10	5%
	Osteomyelitis in the bone (spine, knee)	2	1%

Discussion:-

This study with a sample size of 200, demonstrated increased CT imaging with increasing age upto 70 years, with peak at the 50-70 year age group. This is due the prevalence of medical conditions, for which CT imaging is commonly requested such as Stroke, Head trauma, renal calculi, osteoarthritis (spine, knee), pancreatitis, moderate to severe COVID19 infections were observed to be more common in the middle aged and older population. CT as an imaging modality was commonly used in younger populations (<18 years and 18-30 years) for conditions such as acute rhinosinusitis, head trauma, renal calculi or as a pre-operative workup during the pandemic. Above 70 years CT investigation was commonly used for suspected cases of stroke, head trauma, renal calculi, HRCT for COVID19 severity.

The current study, showed highest number of CT Chest scans were requested for the Precautionary pre-surgical work-up for surgeries during the COVID 19 pandemic, accounting to 27% of all the CT investigations done at the hospital. A report on "Role of CT in screening elective pre-operative patients" by the Royal College of Radiologists stated that CT chest has no role in detection of COVID19 in asymptomatic, isolated andtested patients.Low pick up rate and a 20% false negative rate is observed in symptomatic patients. Hence, does not recommend for screening before elective surgeries [2].With a low prevalence of COVID19, HRCT chest has no added value[3]. In a study on Preoperative Chest CT Screening for COVID19 in Asymptomatic Patients Undergoing Cardiac Surgery, done on 109 patients it was observed that only 8 patients showed CORADS scoring of 2 or higher, among which only 6 were tested COVID positive through RT-PCR. According to Vikesh A et al 5 out of 6 studies concluded pre-operative screening by CT chest is not justified in low prevalence population [4].Evidently depicting disparity in the number of CT scans done and the positive reporting of COVID19 infection [5].But the pre-operative CT Chest are continued to be done a part of protocol in hospitals regardless of the involved cost and the radiation exposure. To avoid HRCT imaging, screening can be performed through a symptom questionnaire and further RT-PCR testing in certain risk groups should be considered [6].

It was observed that HRCT Chest was advised by the doctorsfor RT-PCR or Rapid test COVID diagnosed patients to be done on the 5-7 day of infection in common practice to determine the severity of the disease irrespective of the symptoms. Asymptomatic or patients with mild to moderate symptoms with co-morbidities (as diabetes and hypertension) without any breathing difficulty were advised HRCT.A meta-analysis demonstrated that, in populations with a low disease prevalence, the positive predictive value of CT can be up to ten times lower than that of RT-PCR, owing to a low specificity of CT[7]. It was observed out of 25 HRCT scans done to diagnosed or suspected COVID cases 17 cases (68%) were asymptomatic, out of which 15 of them scored CORADS 1 or 2 (COVID-19 Reporting and Data System) and among the 8 symptomatic cases (patients with breathlessness), 5 (62.5%) scored CORADS 3 or higher. According to the guidelines by the Ministry of Health and Family Welfare, India (MoHFW) HRCT chest is advised only in severe disease, if the symptoms worsen in moderate disease and not advised in mild disease spectrum [8].Hossein Alimohammadi et alin their research mentions practical tools are needed to help physicians improve the appropriateness of their requests. The practicality and physicians' compliance for guidelines and protocols all over the world is questionable [9].

CT testing for head trauma cases were seen to be the third highest of all the CT scans done at the hospital. CT is the investigation of choice for both initial triage and follow-up, as it is faster and accurate in detecting both primary and secondary injuries that require neurosurgical intervention for head trauma cases. CT imaging is preferred over MRI which is rather accurate and non-radioactive because of its availability, speed and cost [10].Despite the radiation caused, these advantages of CT has led to the exploitation of the investigation by the health facilities even in cases of minor trauma without any danger signs (as unconsciousness, vomiting, seizures). Over-diagnosis by the heath facilities along with hypochondriac behavior of the patients are the main cause for the inappropriate use of investigations. A research done by Farzaneh Shobeirian et alstudy on overuse of brain CT emphasizes that using guidelines for requesting brain CT can eliminate unnecessary radiation exposure and financial burden along with detecting patients with important decisive damages [11]. A study on Stroke Code Overuse and Misuse states a focused history, physical examination, and neurologic testing is required to risk stratify patients and minimize unnecessary testing, which can be uncommon among physicians [12]. CT imaging is the initial investigation for all suspected cases of stroke (ischemic or hemorrhagic) but quick prior physical and neurological examination is often ignored by the physicians, which is essential to classify the patients based on the severity of the condition and urgency of management. Cases such as the Transient Ischemic Attack (TIA), which doesn't require emergency attention but should be assessed at the earliest within 1 week of symptoms[13], MRI imaging should be considered which is rather time consuming compared to CT, yet non-radioactive and robust investigation. MRI can also be used as a follow up investigation for patients with medical history of stroke.

For conditions such as Acute Rhinosinusitisand Renal calculi which can be diagnosed based on the clinical presentation or non-radiological investigation (blood, urine examination for renal calculi) imaging techniques shouldn't be resorted. However, in case of severe disease, immunocompromised state, or suspected complications CT imaging is advised according to some guidelines [14].This study shows Rhinosinusitis along with Renal calculi are the reason for 12% of all the CT imaging (6% rhinosinusitis and 6% kidney/ureter/bladder stones). It was observed that CT imaging was advised irrespective of the severity of the disease, which again results to unnecessary radiation exposure.

There are 2 types of effects on radiation exposure:cumulative and stochastic. Cumulative effects are usually observed due to radiotherapy which involve high radiation exposure in short period, whereas stochastic effects are observed in cases of low dose exposure for long period of time as seen in radio diagnostic techniques. CT scans, chest X-rays, and mammograms, for example, may be done at long intervals over a period of many years and over time, the radiation for these serial studies accumulates, although it may cause less immediately noticeable changes, but there may be unseen effects in the long run [15].A cohort study done by Mark S Pearceet alstates that CT scans in children to deliver cumulative doses of about 50 mGy might almost triple the risk of leukemia and doses of about 60 mGy might triple the risk of brain cancer, which in the 10 years after the first scan for patients younger than 10 years, one excess case of leukemia and one excess case of brain tumor per 10,000 head CT scans is estimated to occur [16].An article on "Radiation risk from medical imaging" compares imaging radiation to atomic bomb radiations, it says the atomic bomb release radiation all at once, whereas doses from medical imaging are smaller and spread over time. Given the many scans performed over the last several years, unless we change our current practices,a reasonable estimate of excess lifetime cancers would be in the hundreds of thousands[17].Therefore advises, radiation from the imaging modalities should be kept as low as possible and non-ionizing alternative imaging should be considered wherever appropriate [18].

Conclusion:-

Advent of imaging modalities such as X- ray and CT is a benchmark for diagnosing medical conditions which are seldom seen through the naked eye, yet comes with a price a radiation exposure. Hospital authorities must be responsible toprepare strict guidelines and frequent workshops should be conducted for health professionals to acquaint them with the updated guidelines, for recommending radiation involved imaging to maintain a cost-benefit balance, where the benefit is the diagnostic advantage and the cost being the radiation exposure. It is also advisable to resort to non-ionizing radiations such as MRI and Ultrasound especially for children and adults wherever possible. Timely conduction of clinical audits helps to supervene the health care providers to stick to the guidelines.

References:-

1. Iwamoto KS, Norman A, Kagan AR, Wollin M, Olch A, Bellotti J, Ingram M, Skillen RG. The CT scanner as a therapy machine. Radiother Oncol. 1990 Dec;19(4):337-43. doi: 10.1016/0167-8140(90)90034-t. PMID: 2126635.
2. https://www.rcr.ac.uk/posts/statement-use-ct-chest-screen-covid-19-pre-operative-patients-30-april-2020
3. E M Huybens, MD, M P A Bus, MD PhD, R A Massaad, MD, L Wijers, MD, J A Voet, MD, N M Delfos, MD, M Feltz, MD, K A Heemstra, MD PhD, S M P Koch, MD PhD, Screening with HRCT chest and PCR testing for COVID-19 in asymptomatic patients undergoing a surgical or diagnostic procedure, British Journal of Surgery, Volume 107, Issue 10, September 2020, Pages e384–e385, https://doi.org/10.1002/bjs.11822
4. Vikesh A, Sanjay KY, Dhananjaya S Pre-operative CT Chest as a screening tool for COVID-19: An appraisal of current evidence https://doi.org/10.1002/bjs.12039
5. Knol WG, Thuijs DJFM, Odink AE, Maurovich-Horvat P, de Jong PA, Krestin GP, Bogers AJJC, Budde RPJ. Preoperative Chest Computed Tomography Screening for Coronavirus Disease 2019 in Asymptomatic Patients Undergoing Cardiac Surgery. Semin Thorac Cardiovasc Surg. 2021 Summer;33(2):417-424. doi: 10.1053/j.semtcvs.2020.09.027. Epub 2020 Oct 17. PMID: 32979478; PMCID: PMC7567660.
6. Huybens EM, Bus MPA, Massaad RA, Wijers L, van der Voet JA, Delfos NM, van der Feltz M, Heemstra KA, Koch SMP. What is the Preferred Screening Tool for COVID-19 in Asymptomatic Patients Undergoing a Surgical or Diagnostic Procedure? World J Surg. 2020 Oct;44(10):3199-3206. doi: 10.1007/s00268-020-05722-9. Epub 2020 Aug 13. PMID: 32794035; PMCID: PMC7426008
7. Kim H., Hong H., Yoon S.H. Diagnostic performance of CT and reverse transcriptase-polymerase chain reaction for coronavirus disease 2019: A meta-analysis. Radiology. 2020;296:E145–E155.
8. https://www.mohfw.gov.in/pdf/ClinicalGuidanceforManagementofAdultCovid19Patientsupdatedason17thJanuary2022.pdf
9. Alimohammadi H, Zareh Shahamati S, Karkhaneh Yousefi A, Safarpour Lima B. Potentially inappropriate brain CT-scan requesting in the emergency department: A retrospective study in patients with neurologic complaints. Acta Biomed. 2021 Nov 3;92(5):e2021302. doi: 10.23750/abm.v92i5.10209. PMID: 34738589; PMCID: PMC8689298.
10. Traumatic Brain Injury: Imaging Patterns and ComplicationsAndrew D. Schweitzer, Sumit N. Niogi, Christopher T. Whitlow, and A. John Tsiouris RadioGraphics 2019 39:6, 1571-1595https://doi.org/10.1148/rg.2019190076
11. Shobeirian F, Ghomi Z, Soleimani R, Mirshahi R, Sanei Taheri M. Overuse of brain CT scan for evaluating mild head trauma in adults. Emerg Radiol. 2021 Apr;28(2):251-257. doi: 10.1007/s10140-020-01846-6. Epub 2020 Aug 25. PMID: 32844320.
12. Asad Mohammad, Rafael Ortiz, Ravikanth Vydyula, Bushra Mina Stroke Code Overuse or Misuse - A Need for Structured Support Systems DOI: 10.1097/01.ccm.0000439573.95760.80
13. https://main.mohfw.gov.in/sites/default/files/Guidelines%20for%20Prevention%20and%20Managment%20of%20Stroke.pdf
14. Meltzer EO, Hamilos DL. Rhinorhinosinusitis diagnosis and management for the clinician: a synopsis of recent consensus guidelines. Mayo Clin Proc. 2011 May;86(5):427-43. doi: 10.4065/mcp.2010.0392. Epub 2011 Apr 13. PMID: 21490181; PMCID: PMC3084646.
15. Chen JX, Kachniarz B, Gilani S, Shin JJ. Risk of malignancy associated with head and neck CT in children: a systematic review. Otolaryngol Head Neck Surg. 2014 Oct;151(4):554-66. doi: 10.1177/0194599814542588. Epub 2014 Jul 22. PMID: 25052516; PMCID: PMC4470427.
16. Pearce MS, Salotti JA, Little MP, McHugh K, Lee C, Kim KP, Howe NL, Ronckers CM, Rajaraman P, Sir Craft AW, Parker L, Berrington de González A. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. Lancet. 2012 Aug 4;380(9840):499-505. doi: 10.1016/S0140-6736(12)60815-0. Epub 2012 Jun 7. PMID: 22681860; PMCID: PMC3418594.
17. https://www.nytimes.com/2014/01/31/opinion/we-are-giving-ourselves-cancer.html
18. https://www.health.harvard.edu/cancer/radiation-risk-from-medical-imaging.