How Worrying Is the Impact of COVID-19 Pandemic on the Population Radiation Risk from Increased Number of CT-Scans?

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More than a decade before the COVID-19 crisis, it was reported that the rapid growth in ionizing radiation-based imaging procedures had caused a significant increase in the collective dose by more than 700% and an increase in the annual per-capita dose by almost 600%, as estimated by the US NCRP [1, 2]. Scientist around the globe discussed that such a rapid growth could be associated with significant effect on public health. Most of the exponential growth of cardiovascular computed tomography (CT) scan and nuclear Imaging, which require larger radiation doses than traditional X-ray imaging. Brenner and Hall in their review article published in the New England Journal of Medicine reported that CT scans increased from ~3 million in 1980 to an estimated 62 million in 2006 (20.67 x growth in 26 years) [3]. While imaging technological advances such as adaptive, statistical, iterative image reconstruction techniques have been linked to a significant radiation dose reduction [4], reports show that in countries such as the US most of the increased exposures were due to CT scans and nuclear medicine imaging which need much larger radiation doses compared to those of traditional X-ray imaging procedures.

The radiation dose in CT scans vary greatly due to protocols [5]. Today, regardless of the low individual risk, there is a growing concern about the cancer risk at population level from CT scans [6-8]. Performing a low-dose chest CT instead of a routine chest CT protocol is suggested for patients with suspected or confirmed COVID-19 [9]. It is widely accepted that when a CT scan is clinically justified, its benefits always outweigh its potential risks. However, even for a justified CT, keeping radiation doses as low as reasonably achievable (the so-called ALARA principle) should be a priority [10, 11]. Regarding CT scans, it has been reported that even radiation doses ranging 5-125 mSv can lead to a small but statistically significant increase in the risk of cancer [12]. It has been estimated that CT scans with cumulative doses of ~50 mGy in children might almost triple the leukemia risk and doses of about 60 mGy might triple the brain cancer risk [10].

After the COVID-19 pandemic, due to key advantages such as high sensitivity and rapid access, chest computed tomography (CT) were widely utilized as the main imaging modality for diagnosis, prognostic assessment, and evaluation of the complication of COVID-19. The widespread use of CT-scan as a popular screening tool during the pandemic is the radiation risk, particularly when severely symptomatic COVID-19 patients needed multiple chest CT-scans during the course of their disease. Considering the popularity of CT-scans for diagnosis of COVID-19, there is a debate over the role of CT-scans in increasing the cancer risk [13]. In a study conducted in Shiraz University of Medical Sciences, the impact of COVID-19 on radiation risk from medical imaging was evaluated through a retrospective review of the chest CT-scans performed during different stages of the COVID-19 pandemic in five major teaching hospitals in Shiraz, Iran (January, 2020-September, 2022). Given this consideration, the frequencies of CT-Scans in different hospitals were compared with those of the pre-COVID-19 period (January, 2018-December, 2019). In some cases, the findings were alarming. During one of the COVID-19 peaks, we observed a huge increase in the number of CT scans performed between July 7, 2021 and September 7, 2021. During this period, the

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number of CT scans showed a 200-300% increase compared to that of the same months in 2018. For example, in Namazi hospital as the largest teaching hospital affiliated with Shiraz University of Medical Sciences, the number of CT scans reached from 367 in Aug 2018 to 5388 in Aug 2021 (1468% growth). It is worth noting that the daily number of COVID cases in Iran had been increased from 10,598 on June 9, 2021 to 39,174 cases on Aug 18, 2021.

While the lifetime risk of dying of a cancer linked to CT-scans depends on key factors such as but not limited to age, gender, and the irradiated organs, the overall risk is very low. The likelihood of getting a fatal cancer from a CT scan is estimated to be about 1 in 2,000. Although this risk in a single patient is negligible, when a crisis such as the COVID-19 pandemic significantly increases the number of CT-scans, the number of cancer cases in the whole population would be remarkable. Based on 111.6 million adult participants from 3 continents (Asia, Europe and America), Cao et al. showed in their meta-analysis an inordinately increase (598% increase) in adults cancer risks from CT scans [14]. The cancer risk was associated with both the radiation dose and CT-sites [14]. Given this consideration, the increase in the lifetime risk of dying of a cancer linked to CT-scans in Shiraz is estimated by our team and will be discussed in another publication.

Authors' Contribution

F. Taleinejad and M. Haghani was involved in data collection and writing the manuscript. SMJ. Mortazavi contributed with the ideation and revising the manuscript. L. Sihver contributed with ideation, editing, revising and submitting the final version of the manuscript. All authors approved the final version of the manuscript.

Conflict of Interest

None

References

1. Mettler FA Jr, Thomadsen BR, Bhargavan M, Gilley DB, Gray JE, Lipoti JA, et al. Medical radiation exposure in the U.S. in 2006: preliminary results. *Health Phys.* 2008;**95**(5):502-7. doi: 10.1097/01.HP.0000326333.42287.a2. PubMed PMID: 18849682.
2. Gerber TC, Kantor B, McCollough CH. Radiation dose and safety in cardiac computed tomography. *Cardiol Clin.* 2009;**27**(4):665-77. doi: 10.1016/j.ccl.2009.06.006. PubMed PMID: 19766923. PubMed PMCID: PMC2749002.
3. Brenner DJ, Hall EJ. Computed tomography--an increasing source of radiation exposure. *N Engl J Med.* 2007;**357**(22):2277-84. doi: 10.1056/NEJMra072149. PubMed PMID: 18046031.
4. Kwon H, Cho J, Oh J, Kim D, Cho J, Kim S, et al. The adaptive statistical iterative reconstruction-V technique for radiation dose reduction in abdominal CT: comparison with the adaptive statistical iterative reconstruction technique. *Br J Radiol.* 2015;**88**(1054):20150463. doi: 10.1259/bjr.20150463. PubMed PMID: 26234823. PubMed PMCID: PMC4730981.
5. Smith-Bindman R, Wang Y, Chu P, Chung R, Einstein AJ, Balcombe J, et al. International variation in radiation dose for computed tomography examinations: prospective cohort study. *BMJ.* 2019;**364**:k4931. doi: 10.1136/bmj.k4931. PubMed PMID: 30602590. PubMed PMCID: PMC6314083.
6. Shah KH, Slovis BH, Runde D, Godbout B, Newman DH, Lee J. Radiation exposure among patients with the highest CT scan utilization in the emergency department. *Emerg Radiol.* 2013;**20**(6):485-91. doi: 10.1007/s10140-013-1142-8. PubMed PMID: 23852432.
7. Power SP, Moloney F, Twomey M, James K, O'Connor OJ, Maher MM. Computed tomography and patient risk: Facts, perceptions and uncertainties. *World J Radiol.* 2016;**8**(12):902-15. doi: 10.4329/wjr.v8.i12.902. PubMed PMID: 28070242. PubMed PMCID: PMC5183924.
8. Yu L, Liu X, Leng S, Kofler JM, Ramirez-Giraldo JC, Qu M, et al. Radiation dose reduction in computed tomography: techniques and future perspective. *Imaging Med.* 2009;**1**(1):65-84. doi: 10.2217/iim.09.5. PubMed PMID: 22308169. PubMed PMCID: PMC3271708.
9. Zhou Y, Zheng Y, Wen Y, Dai X, Liu W, Gong Q, et al. Radiation dose levels in chest computed tomography scans of coronavirus disease 2019 pneumonia: A survey of 2119 patients in Chongqing, southwest China. *Medicine (Baltimore).* 2021;**100**(31):e26692. doi: 10.1097/MD.0000000000026692. PubMed PMID: 34397803. PubMed PMCID: PMC8341287.
10. Pearce MS, Salotti JA, Little MP, McHugh K, Lee C, Kim KP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. *Lancet.* 2012;**380**(9840):499-505. doi: 10.1016/S0140-6736(12)60815-0. PubMed PMID: 22681860. PubMed PMCID: PMC3418594.
11. McCollough CH, Primak AN, Braun N, Kofler J, Yu L, Christner J. Strategies for reducing radiation dose in CT. *Radiol Clin North Am.* 2009;**47**(1):27-40. doi: 10.1016/j.rcl.2008.10.006. PubMed PMID: 19195532. PubMed PMCID: PMC2743386.
12. CADTH. Radiation Emissions from Computed Tomography: A Review of the Risk of Cancer and Guidelines. CADTH Rapid Response Reports; Ottawa (ON): Canadian Agency for Drugs and Technologies in Health; 2014.
13. Garg M, Prabhakar N, Bhalla AS. Cancer risk of CT scan in COVID-19: Resolving the dilemma. *Indian J Med Res.* 2021;**153**(5&6):568-71. doi: 10.4103/ijmr.ijmr_1476_21. PubMed PMID: 34596597. PubMed PMCID: PMC8555607.
14. Cao CF, Ma KL, Shan H, Liu TF, Zhao SQ, Wan Y, et al. CT Scans and Cancer Risks: A Systematic Review and Dose-response Meta-analysis. *BMC Cancer.* 2022;**22**(1):1238. doi: 10.1186/s12885-022-10310-2. PubMed PMID: 36451138. PubMed PMCID: PMC9710150.

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