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Potential Risk of Cancer in Body Organs As Result of Torak CT-Scan exposure

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breast;
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Abstract

A concise and factual abstract Computed Tomography (CT)-Scan is a radiological diagnostic tool using a computer to reconstruct data from the absorption of a particular tissue or organ that has been penetrated by X-rays to form an image (imaging). The use of scanning equipment (scan) that emits radiation has the potential to cause quite serious impacts. According to researchers from Canada, Britain, and the United States published in The Lancet Medical Journal (2012), it is stated that children who are exposed to CT-Scans can be up to three times more likely to develop blood, brain, or bone cancer later in life. It further states a potential cancer risk exists due to the ionizing radiation used in CT-Scans, especially in children who are more sensitive to radiation than adults. A chest CT-Scan is one of the most frequently performed parts of the examination because this section contains many vital organs. The analysis showed that the effective dose of the liver was 0.241 mGy, breast, and lung was 0.724 mGy. The risk of cancer in each of the liver, breast, and lung organs reaches 0.038%, 1.160%, and 1,200%. The highest cancer risk for a 1-time chest CT-Scan can occur in critical organs of the lungs.

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1 Introduction

Device CT-Scan (Computed Tomography Scan) is a tool used to diagnose diseases of the inner body to determine whether there is an abnormality. The plane CT-Scan diagnoses using ionizing radiation, especially X-rays. X-rays can shape the human body into a transparent object, making it easier to obtain information about the human body without the need for surgical operations. CT-Scan can be used for various types of examinations such as examination of the head (head), thorax (chest cavity), abdomen (abdominal cavity), and others. CT-Scan of the head and thorax is a type of examination that is widely performed compared to examinations of other parts of the body.

During the scanning process, the patient will receive radiation from the device CT-Scan, so it is necessary to calculate the amount of radiation dose using the Computed Tomography Dose Index (CTDI) method received by the patient for each examination (Tsalafoutas & Metallidis, 2011). Even the lowest radiation dose received by the patient will cause changes in the biological system and the risk of cancer acquired by sensitive organs in the patient's body. The biological effect of radiation does not only depend on the radiation dose hitting the tissue or organ, but also depends on the biological sensitivity of the tissue or organ being exposed to radiation, which is called the effective dose. The effective dose is a description of the radiation dose that is reflected from different biological sensitivities (Chuninghum, 1983; AAPM, 2011; Adler et al., 1992). So that it is necessary to estimate the radiation dose to determine the percentage of the potential cancer risk received by the patient due to the ionizing radiation emitted on the CT-Scan.

Research on calculating the radiation dose received by patients was carried out by Munir et al., (2011). This study measured the radiation dose and risk factors in the 3-Phase Whole Abdomen CT Scan, using a 64-Slice Lightspeed VCT MSCT Scan. The results showed that the organ with the largest dose equivalent was the kidney ranging from (32-140) mGy. Effective dosage accepted patients ranged from (15-64) mSv. The highest potential risk received by ICRP was 0.32% with the effective dose received by these patients was 64 mSv. Thus it is very important to research the potential risk of cancer in the body organs due to chest CT-scan radiation (Sofiana et al., 2012; Strauss & Rae, 2012; Susilo et al., 2012).

2 Materials and Methods

The research was conducted at the Radiology Installation of Sanglah Hospital Denpasar. Meanwhile, data analysis was carried out at the Biophysics and Medical Physics Laboratory at Bukit Jimbaran Campus. The tools used in this study were CT-Scan, CR (Computer Radiography), Lux meter, Humidity meter, thermometer, and patient medical records. To identify the amount of dose received by the patient, diagnostic and interventional radiology patients were grouped into 3 categories based on age, where infants (0-4 years), children (5-14 years), and adults (15 years and over). Patient identification information needed other than age group is gender and body weight (Ibrahim et al., 2018; Martina, 2016). Each type of examination requires a minimum of 10 patients for each type of examination that is rare or infrequent and 20 patients for each type of examination that is frequent or multiple. If the facility can estimate the patient workload per type of examination for each modality, then the required patient sampling size is at least 30% of the workload.

In this study, a Siemens 128 *slice* CT-Scan tool with a slice thickness of 10 mm and a voltage of 120 kVp, a tube current of 35 mA, a slice thickness of 10 mm, and a scan length of 32 cm, which functions as an X-ray producer. Computer and CT-Scan console for displaying and storing and recording the resulting images in 3-dimensional form. For a chest CT-Scan, the patient can estimate the dose using CTDI and DLP. CTDI and DLP values can generally be found on the CT-Scan console monitor screen or integrated with each patient's DICOM data system such as dose protocol reports or other features depending on the manufacturer (Shepard & Pei-Jan, 2002; Sikumbang, 2018). Patient medical record data displayed on the monitor screen or DICOM data can be recorded and tabulated. The medical record data, especially the DLP and CTDI values, were then analyzed to determine the $CTDI_{eff}$ value, and then the risk of potential cancer could be estimated with the $Risk_{eff}$ value. The statistical analysis used was ANOVA (Analysis of Variance). The results of the ANOVA test were significantly different ($P \leq 0.05$) followed by the LSD test so that a significant difference could be seen between the $Risk_{eff}$ values of each patient's organ.

3 Results and Discussions

The results of the examination of the Torak CT-Scan patient for the category of adult patients 15 years and over were 20 people at the Radiology Installation of Sanglah Hospital, Denpasar. Furthermore, the determination of the effective dose and risk of cancer (Risk effective) of each critical organ contained in the Torak X-ray is carried out, such as the liver, breasts, and lungs. As an example of the calculation, patient data was taken in the name of Dewa Ketut Sukra, with a $CTDI_{vol}$ value of 6.03 mGy and a DLP of 208.30 mGy.cm. Critical organs that can be determined the effective dose on a Torak examination such as liver with organ weight factor (w_t = 0.04), lung and breast with organ weight factor (w_t = 0.12), using the equation:

$$D_{eff} = CTDI_{vol} \times w_t$$
$$= 6{,}03 \text{ mGy} \times 0{,}04 \text{ (liver), with 1 mGy can be converted to 1 mSv}$$
$$= 0{,} 241 \text{ mSv}$$
$$= 6{,}03 \text{ mGy} \times 0{,}12 \text{ (breast dan lung)}$$
$$= 0{,}724 \text{ mSv}$$

Furthermore, it can be determined the potential risk of cancer using the equation, as follows;

$$Risk_{eff} = D_{eff} \times r_t$$
$$= 0{,}241 \text{ mSv} \times 14 \text{ (liver)}$$
$$= 3{,}38 \text{ mSv}$$
$$= 0{,}038\%$$
$$= 0{,}724 \text{ mSv} \times 160 \text{ (breast)}$$
$$= 115{,}84 \text{ mSv}$$
$$= 1{,}16\%$$
$$= 0{,}724 \text{ mSv} \times 166 \text{ (lung)}$$
$$= 120{,}18 \text{ mSv}$$
$$= 1{,}20\%$$

The details of the potential risk of cancer for each critical organ in the examination of thoracic patients are as shown in Table 1 below,

Table 1
The potential risk of cancer for critical organs in thoracic examination patients

Critical Organs	Average Effective Dose (mSv)	Potential cancer risks (%)
Liver	0,189	0,026
Breast	0,567	0,907
Lung	0,567	0,941

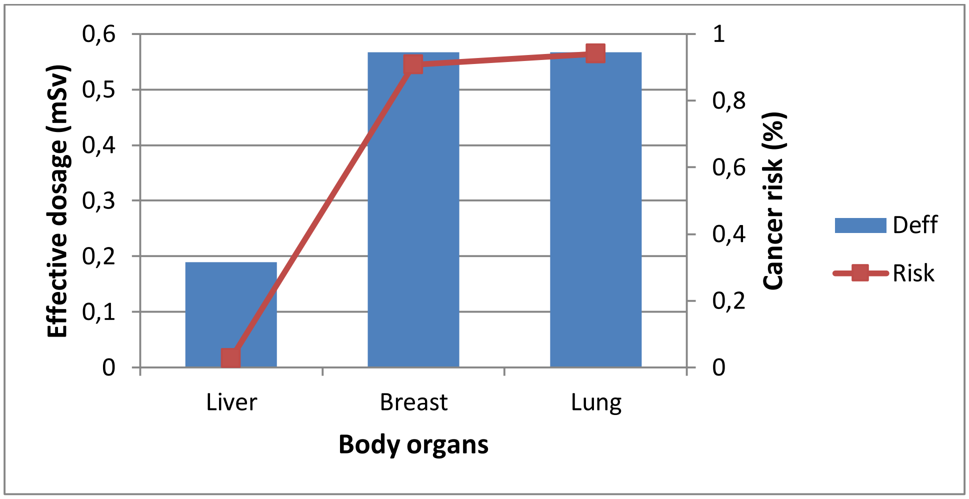

Figure 1. Effective dose and risk of cancer to organs

The effective dose for body organs on the CT-Scan examination is shown in Figure 1, that the effective dose of the lungs and breasts is very large when compared to the effective dose of the liver. This is because the weight of the liver is much smaller than that of the lungs and breasts. Another cause can also occur due to the length scan area, where the liver has a smaller scan length area when compared to the scan length area of the lungs and breasts (Silvia et al., 2013). So that the energy received by the lungs and breasts is greater than that of the liver, although the mass of the lungs and breasts is smaller than the mass of the liver. It can be understood that the radiation dose is influenced by the average energy given by ionizing radiation of dE to the material through which mass dm is passed (Chuninghum, 1983). According to Ibrahim et al. (2018), the effective dose is the radiation exposure received by the patient while undergoing a CT-Scan examination.

The results of the study for the potential risk of cancer are shown in Figure 1. It is also following the ICRP 103 literature, that the potential risk of developing cancer in a patient can be estimated by assuming an effective dose-response or dose-response relationship. The highest effective dose in the examination of the Torak CT-Scan section is on the breast and lung organs at 0.67 mSv with a potential cancer risk of 0.907% and 0.941%. Meanwhile, the smallest effective dose of the liver was around 0.189 mSv with a very low potential cancer risk, namely 0.026%. The difference in the potential risk of cancer that occurs between the lung and breast organs even though the effective dose that is received by the two organs is the same is due to the cancer risk factors possessed by each organ is different (ICRP 103, 2011). Lungs have a higher risk of cancer than breast organs. However, the results of this study indicate that the estimated potential for cancer in patients is still a small percentage (Parl, 2005; Ekbom et al., 1992; Belfiore et al., 1992). This is because the CT-Scan examination performed by the patient is only 1 time and is influenced by the relatively small current strength value with the same voltage value used for each examination, namely 120 kV (Sutapa, 2018).

4 Conclusion

Examination of the patient once on a Torak CT-Scan has caused critical organs of the liver, breasts, and lungs to receive effective doses of 0.189 mSv and 0.670 mSv, respectively, with a potential cancer risk of 0.026%, 0.907%, and 0.941%. Lungs already have a potential cancer risk of nearly 1%, but it is still lower than the ICRP 103 recommendation in 2011 of 5.5%.

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