Assessment of knowledge and awareness among radiology personnel regarding current computed tomography technology and radiation dose

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Abstract. In this paper, we evaluate the level of knowledge and awareness among 120 radiology personnel working in 7 public hospitals in Johor, Malaysia, concerning Computed Tomography (CT) technology and radiation doses based on a set of questionnaires. Subjects were divided into two groups (Medical profession (Med, n=32) and Allied health profession (AH, n=88). The questionnaires are addressed: (1) demographic data (2) relative radiation dose and (3) knowledge of current CT technology. One-third of respondents from both groups were able to estimate relative radiation dose for routine CT examinations. 68% of the allied health profession personnel knew of the Malaysia regulations entitled ‘Basic Safety Standard (BSS) 2010’, although notably 80% of them had previously attended a radiation protection course. No significant difference (p<0.05) in mean scores of CT technology knowledge detected between the two groups, with the medical professions producing a mean score of (26.7 ± 2.7) and the allied health professions a mean score of (25.2 ± 4.3). This study points to considerable variation among the respondents concerning their understanding of knowledge and awareness of risks of radiation and CT optimization techniques.

1. Introduction

Since its introduction in 1974, Computed Tomography (CT) has revolutionized the field of medicine, allowing physicians to diagnose the disease with enhanced confidence as a result of the greatly improved image resolution compared to conventional projection imaging. These advantages over other diagnostic imaging modality have made CT a preferred imaging tools among physicians and the number of CT examinations is increasing every year. CT technology has seen rapid developments in recent times, with the introduction of multi-slice CT (MSCT) in 2001 [1–3].

CT scans are recognized to be a high radiation dose modality with the concern that the doses could in some cases be clinically unjustified [4–6]. Many researchers have highlighted issues regarding choice of CT parameters and the influence on the dose to patients, the discussions narrowing down on how to optimize the dose [7–10], noting that there are many possible combinations of choice to optimize CT parameters. Radiology personnel and other users need to be knowledgeable about the various means in...
controlling radiation output of CT parameters via used tube potential, tube current, slice thickness, pitch, the detector used and etc.

Nowadays, most of modern CT equipped with automatic tube current modulation (ATCM) technology with a recommended protocols that have been setup by the manufacturer. However, the optimisation technique must also consider patient characteristics including patient’s size, age and region of scanning[9, 11, 12]. Hence, this study aimed to describe the optimization of CT procedure and to evaluate the knowledge of radiology personnel and their awareness regarding radiation dose in Johor public hospitals.

2. Methodology
A total of 120 questionnaire forms were distributed to radiology personnel in the seven Departments of Radiology, of which 10, 22, 7, and 81 were distributed to Radiologists, Medical officers, Physicists and Radiographers, respectively. The questionnaire was adapted from Foley et al. study where the level of competency among radiology personnel, both in terms of knowledge and awareness in radiation safety in CT procedures and of current CT technology was assessed [11]. After given a day to complete the form, we collected the form from each participant [13].

The questionnaires consisted of 24 questions divided into three sections. The first section provided general demographic information such as level of experience in handling CT and in the second section, the questions were related to the radiation awareness. In the third section, the formats were multiple-choice questions (MCQs) which contained 40 sets of questions regarding current CT technology. Correct responses were given a score of 1, whereas questions with incorrect or incomplete answers were given a score of 0. Before distributing the questionnaires, a pilot test study was performed, involving five persons with different backgrounds; one radiologist, one physicist and three radiographers.

The data was analyzed by using the statistical package software SPSS, version 17.0, utilizing the Student t-test with a p-value of 0.05. This value was considered significant for data validation.

3. Results

3.1. Demography
A total of 120 questionnaires were completed by all participants. These give us a response rate of 100%. The respondents were divided into two groups; Medical professions (Radiologists and Medical officers) and Allied Health professions (Physicists and Radiographers), with a total of 32 and 88 respectively. The distribution of respondents represents the current ratio of radiology personnel in the local practices. The demographic features are shown in table 1, with ‘Med’ indicating the category for Radiologists and Medical officers and ‘AH’ representing the category for Allied Health professions.
Table 1. The demographic information obtained from the questionnaire.

| General Information | Med\(^a\) n = 32(w%) | AH\(^b\) n = 88(w%) | Total, n = 120(w%) |
|---------------------|-----------------------|----------------------|-------------------|
| **Experience in handling CT (years)** | | | |
| ≤ 3                 | 13(41)                | 54(61)               | 67(56)            |
| 3 to 6              | 3(9)                  | 22(25)               | 25(21)            |
| 6 to 9              | 8(25)                 | 7(8)                 | 15(12)            |
| > 9                 | 8(25)                 | 5(6)                 | 13(11)            |
| **Confidence in altering CT parameters correctly** | | | |
| Excellent           |                       | 2(2)                 | 2(2)              |
| Good                | 5(16)                 | 15(17)               | 20(17)            |
| Moderate            | 21(66)                | 35(40)               | 56(46)            |
| Poor                | 3(9)                  | 25(28)               | 28(23)            |
| Very poor           | 3(9)                  | 11(13)               | 14(12)            |

\(^a\)Med – indicating category for radiologist and medical officer in Department of Radiology

\(^b\)AH – indicating category for radiographers in Department of Radiology

A total of 67(56%) out of the 120 respondents had a less than 3 years of experience, with an average experience of 4.5 years. A total of 98(82%) of the respondents believed that they do not know how to favourably alter the CT scan parameters in operating the scanners. As observed in table 2, two-thirds of allied health profession (68%) involved in radiology have heard about basic safety standard (BSS) 2010 regulations, although 80% of them have previously attended the associated course.

Table 2. Mean score value of radiation awareness among respondents.

| Questions | Med\(^a\) | AH\(^b\) |
|-----------|-----------|----------|
| Have you ever attended a Radiation Protection course? | 13 (42) | 70 (80) |
| Have you heard about the Basic Safety Standard (BSS 2010) Malaysia regulations under Act 304, 1985? | 16 (50) | 60 (68) |

\(^a\)Med – indicating category for radiologist and medical officer in Department of Radiology

\(^b\)AH – indicating category for radiographers in Department of Radiology

3.2. Radiation dose

Respondents were asked to choose the correct dose in the equivalent of chest X-ray (CXR) examination of radiation for some commonly requested diagnostic imaging procedures. We set the concern based on this standard scale; from 0 to 300, 301 to 500 and 501 to 800 of CXR equivalent. Of the 7 multiple choice questions (MCQs) concerned, the analysis of responses is shown in table 3. The correct estimates of equivalent dose obtained were similar between two groups which ranged from 25% to 92% for Med while for the AH the ranged was from 17% to 92%.
Table 3. Mean score in percentage concerning knowledge of dose in CXR equivalent for particular procedures.

| Type of examinations       | Med (%) | AH (%) |
|----------------------------|---------|--------|
|                            | Under estimated | Correct | Over estimated | Under estimated | Correct | Over estimated |
| CT Brain                   | 34      | 58     | 8           | 31      | 40     | 29           |
| CT Thorax                  | 8       | 25     | 67          | 16      | 26     | 58          |
| CT Abdomen                 | 58      | 25     | 17          | 69      | 23     | 8           |
| CT Lumbar spine            | 58      | 42     | 0           | 72      | 17     | 11          |
| Skull X-Ray                | 0       | 92     | 8           | 8       | 92     | 0           |
| Intravenous-urography (IVU)| 25      | 42     | 33          | 31      | 69     | 0           |
| Lumbar spine X-Ray         | 25      | 75     | 0           | 2       | 89     | 9           |

3.3. Knowledge on current CT technology

Comparative analysis of knowledge on current CT technology within the groups concerning over radiation dose and their experience is shown in table 4. Of 40 questions, the mean knowledge score of the medical professions was 26.7 ± 2.7 (ranging from 22 to 32), while the mean score for allied health professions was 25.2 ± 4.3 (ranging from 12 to 32). No significant difference was found between the scores for the two categories of the profession (p<0.05).

Table 4. Mean score for all correct responses on knowledge of CT technology.

| Profession      | n   | Mean ± SD    | Min - Max | p   |
|-----------------|-----|--------------|-----------|-----|
| Medical         | 32  | 26.7 ± 2.7   | 22 - 32   |     |
| Allied Health   | 88  | 25.2 ± 4.3   | 12 - 32   | p < 0.05 |
| Total           | 120 | 25.4 ± 4.1   | 12 - 32   |     |

4. Discussion

4.1. Radiation dose considerations

The use of CT in medicine has been rapidly growing due to advances in technology in producing high-quality images. The employing of multiple array detectors in modern CT has resulted in briefer scan-acquisition times than that for conventional single array CT units. Radiation dose from MSCT has significantly increased compared to the use of SSCT, with additional and occasionally unjustified use of this capability in clinical practice [14], an observation also made by Brix et al. in a survey of German CT clinical practice [2]. Staff who operate CT should be independently capable of deciding the radiological protocol to be used during scanning procedure to avoid excessive CT doses to patients.

In this study, the respondents rank the relative radiation dose from CT for each procedure and other routine radiological examinations (such as skull X-ray, IVU and lumbar spine). The majority have estimated correctly for the skull x-ray, both groups scoring 92%. However, both groups have underestimated the dose for CT Brain, CT Abdomen and CT Lumbar with a respective response rate of 34%, 58% and 58% for the Med and 31%, 69% and 72% for the AH profession. Although, it has been observed that 67% and 58% of Med and AH, respectively overestimated the dose for CT Thorax but in regard to non-CT procedures, two-thirds of all respondents scored correctly. Therefore, it is recommended for continuous medical education (CME) regarding CT optimization techniques and knowledge of radiation doses in CT so that further benefit to all radiology personnel thus reducing dose to patients.
4.2. CT technology considerations

In the final part of the questionnaire, respondents were asked regarding their knowledge of CT technology, particularly on use of the ATCM and noise level as well as its influence on radiation dose. Typically, lowering the CT dose by adjusting acquisition parameter, the greater will be the commensurate image noise hence degraded image quality [15]. Concerning current ATCM technology, as in table 5, 92% of both Med and AH groups are aware of the purpose of the ATCM to control the image quality and dose to patients.

| Questions                                                   | Med (w %) | AH (w %) |
|-------------------------------------------------------------|-----------|----------|
| ATCM has been shown to decrease patient dose on average      | 92        | 92       |
| ATCM is affected by centering of the patient within the gantry| 67        | 62       |
| ATCM can increase the patient dose in the pelvic region      | 58        | 42       |

In this regard, it is apparent that both groups of respondents scored within the restrictive range 40 – 50%, displaying a lack of knowledge of CT technology and ways to implement appropriate techniques in CT aimed at optimizing image quality and dose. To date, this study is considered as the first step towards enhancing our understanding of how radiology practice in CT optimization techniques is influenced by staff knowledge and awareness about CT scan.

5. Conclusion

In this study, knowledge and awareness of CT technology among radiology personnel were evaluated. The findings of this study demonstrate that most of the radiology personnel are aware of radiation dose to the patients but are not well versed in CT optimization techniques. This is due to their understanding in obtaining high-quality images and importantly commensurate control of radiation exposure. It is recommended that studies focusing on the understanding of CT image quality to be conducted in the future.

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