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A Radiology Technician's View On Using Medical Imaging Equipment And Associated Technologies

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Abstract

Background: *Today, medical imaging technology has revolutionized medical care. Improving the early identification of ailments leads to better patient outcomes. Medical imaging can create visual representations of the internal workings of the human body. Medical professionals use these images to diagnose and treat different health conditions.* ***This study aimed****: To evaluate radiology technicians' view on the use of medical imaging devices and related technology.* ***Methods:*** *A cross-sectional study design was conducted. A total of 142 radiology technicians from KSA were included on a voluntary basis from January to March 2022. The questionnaire form elicited items on socio-demographic and occupational characteristics and personal opinions regarding the use of medical imaging devices and related technology.* ***Results:*** *Majority of technicians agreed or strongly agreed that they prefer the latest technology medical imaging devices (32.4 and 54.2%) and there is an increase in the number of medical imaging devices (36.6 and 35.9%) and medical imaging examinations (32.4 and 43.7%), while the growing societal demands in field of health have a role in the increase in the number of medical imaging devices (34.5 and 32.4%). However, a relatively lower percentage of technicians agreed or strongly agreed that the latest technology medical imaging devices should be purchased no matter how much it costs (31.7 and 33.8%) and the yearly increase in the number of imaging examinations indicates provision of an improved healthcare (21.1 and 23.2%). A higher agreement was reported by private hospital (3.9 ± 1.1, p = 0.035) and university hospital (4.1 ± 1.1, p = 0.009) employees vs. government hospital employees (3.4 ± 1.3) on the growing societal demands in field of health to have a role in the increase in the number of medical imaging devices. Conclusion: Apart from this, no significant difference was noted in opinions of technicians on the use of medical imaging devices and related technology with respect to hospital types. Our findings indicate that radiology technicians report a considerable imaging workload volume and a preference for working with higher number of medical imaging devices particularly those with the latest technology, whereas they also emphasize that the yearly increase in the number of imaging examinations does not indicate provision of an improved healthcare, and the cost should always be a criterion when purchasing the latest technology devices.*

Keywords*: Medical imaging · Equipment · Technology · Utilization · Radiology technicians*

Introduction

[1]Medical imaging is the process of visual representation of the structure and function of different tissues and organs of the human body for clinical purposes and medical science for detailed study of normal and abnormal

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anatomy and physiology of the body. Medical imaging techniques are used to show internal structures under the skin and bones, as well as to diagnose abnormalities and treat diseases [1]. Medical imaging has changed into healthcare science. It is an important part of biological imaging and includes radiology which uses the imaging technologies like X-ray radiography, X-ray computed tomography (CT), endoscopy, magnetic resonance imaging (MRI), magnetic resonance spectroscopy (MRS), positron emission tomography (PET), thermography, medical photography, electrical source imaging (ESI), digital mammography, tactile imaging, magnetic source imaging (MSI), medical optical imaging, single-photon emission computed tomography (SPECT), and ultrasonic and electrical impedance tomography (EIT) [2].

Imaging technologies play a vital role in the diagnosis of abnormalities and therapy, the refined process of visual representation which contributes to medical personnel access to awareness about their patient's situation [3, 4]. Electroencephalography (EEG), magneto-encephalography (MEG), and electrocardiography (ECG) are recording and measurement techniques that are not responsible to produce images, but these represent the data as a parameter graph *vs.* time or maps which shows the susceptible information with less accuracy. Therefore, these technologies can be said to form medical imaging on a limited scale. Worldwide, up until 2010, approximately 5 billion medical imaging techniques studies have been shown [5]. The advances in medical technology and the aging population are considered among the primary drivers of the high and ever-growing costs of healthcare systems as related to worldwide increase in health care demand [6-9].

Digital data and technology have revolutionized the imaging field with introduction of new modalities in magnetic resonance imaging (MRI) and positron emission tomography (PET) or significant improvements in computed tomography (CT) and ultrasound (US), increasing the demand for imaging services over the last two to three decades [10-12]. Accordingly, while modern medical imaging has several benefits such as improved diagnostic accuracy, image guided therapy, and shorter hospital stay, expanding medical imaging services has a significant impact on healthcare costs, healthcare quality, and the safety risks [6, 9, 13-15]. Medical industry is also one of the fastest growing industries in KSA, and medical tools and devices has been one of the leading sectors in terms of both production and foreign trade potential in recent years [7].

Nonetheless, while the growth in medical imaging with clear benefits to patient care reflects new technologies and applications, some part of this growth has been suggested to be attributed to the overutilization of imaging services [8]. Radiology technicians are responsible for safe and efficient operation of the devices and quality control, preparation, and calibration of devices, which necessitates awareness of them about medical device production factors and technical aspects of the devices [16-18]. They are trained and qualified to practice radiology with professional accountability and autonomy in non-interventional protocols shooting, while assist the physician responsible for imaging supervision and interpretation in interventional protocols shooting [16-18]. This cross-sectional questionnaire-based survey was designed to evaluate radiology technicians' view on the use of medical imaging devices and related technology with respect to type of hospital.

Methods

A cross-sectional study design was conducted. A total of 142 radiology technicians working at radiology units of hospitals located in KSA were included on a voluntary basis from January to March 2022. The study was conducted in accordance with the ethical principles stated in KSA and participant's informed consent was obtained electronically in advance of the data collection through the informed consent page presented two options (yes/no).

The questionnaire form elicited items on socio-demographic characteristics (age, gender, and educational status), occupational characteristics (hospital type, years in practice, daily workload), and personal opinions regarding the use of medical imaging devices and related technology by the radiology technicians. The items on the use of medical imaging devices and related technology were scored based on 5-point Likert scale (1 = strongly disagree and 5 = strongly agree) with higher scores indicating a higher level of agreement.

The descriptive statistics were provided with use of IBM SPSS, version 28.0. Chi-square (χ^2) test was used for the comparison of categorical data, while numerical data were analyzed using Mann–Whitney U and Kruskal Wallis tests. Data were expressed as mean ± standard deviation (SD) and percent (%) where appropriate. $p < 0.05$ was considered statistically significant.

Results

Socio-demographic and Occupational Characteristics

Table (1) shows that most of participants were in the 18–23 (42.3%) and 24–29 (28.2%) year age groups, and 68.3% were male. Most of participants had associate degree (64.8%). Overall, 62 (43.7%) radiology technicians were employed in a government hospital, 40 (28.2%) were employed in a private hospital, and 40 (28.2%) were employed in a university hospital. Most of radiology technicians were in practice for 0–5 years (40.1%) or 6–11 years (33.8%), working for 5–9 h (71.8%) and processing ≥ 111 images (52.8%) daily. Other than significantly higher percentage of technicians working 10–14 h per day in the government (29.0%, p = 0.035) and private (35.0%, p = 0.018) hospitals than in the university hospitals (10.0%), no significant difference was noted in socio-demographic and occupational characteristics with respect to hospital type.

Use of Medical Imaging Devices and Related Technology

Table (2) shows at least half of technicians agreed or strongly agreed that medical imaging devices are sufficient in their workplace (27.5% and 21.8%, respectively) and they are satisfied with their job (28.2% for each). Majority of technicians agreed or strongly agreed that they prefer the increased number of medical imaging devices (24.6 and 53.5%) and the latest technology medical imaging devices (32.4 and 54.2%) in their practice. They also reported that the higher number (28.9 and 54.2%) and the latest technology (36.6 and 43.0%) medical imaging devices would provide convenience for the patients, while the older technology medical imaging devices cause loss of time (29.6 and 51.4%).

Also **table (2)**, shows that majority of technicians agreed or strongly agreed that there is an increase in the number of medical imaging devices (36.6 and 35.9%) and medical imaging examinations (32.4 and 43.7%) with respect to past years, while the growing societal demands in field of health have a role in the increase in the number of medical imaging devices (34.5 and 32.4%). However, a relatively lower percentage of technicians agreed or strongly agreed that the older technology medical imaging devices always cause problems (26.2 and 34.5%), the older technology medical imaging devices cannot provide the desired image quality (37.3 and 29.6%), the latest technology medical imaging devices should be purchased no matter how much it costs (31.7 and 33.8%), and the yearly increase in the number of imaging examinations indicate provision of an improved healthcare in terms of earlier and more accurate diagnosis and better disease management (21.1 and 23.2%).

Moreover **table (2)**, shows that nearly two third of participants agreed or strongly agreed that the establishment of new university departments in the field may enable success in the national production of medical imaging devices (40.1 and 27.5%) and presence of companies acting in critical fields of production such as defense, space, and aviation is an advantage for national production of medical imaging devices (27.5 and 44.4%).

Table (3) shows that a higher agreement was reported by private hospital (3.9 ± 1.1, p = 0.035) and university hospital (4.1 ± 1.1, p = 0.009) employees vs. government hospital employees (3.4 ± 1.3) on the growing societal demands in field of health to have a role in the increase in the number of medical imaging devices. Apart from this, no significant difference was noted in opinions of technicians on the use of medical imaging devices and related technology with respect to hospital types (**Table 3**).

Table (1): Socio-demographic and occupational characteristics

	Total (*n* = 142)	**Government hospital(*n* = 62)**	**Private hospital (*n* = 40)**	**University hospital (*n* = 40)**	***p* value**
Gender, *n* (%)					
Female	45 (31.7)	20 (32.3)	13 (32.5)	12 (30.0)	0.964
Male	97 (68.3)	42 (67.7)	27 (67.5)	28 (70.0)	
Age group, *n* (%)					
18–23	60 (42.3)	25 (40.3)	17 (42.5)	18 (45.0)	0.992
24–29	40 (28.2)	19 (30.6)	11 (27.5)	10 (25.0)	
30–35	26 (18.3)	14 (22.6)	6 (15.0)	6 (15.0)	
36–41	7 (4.9)	2 (3.2)	3 (7.5)	2 (5.0)	

	Total (n = 142)	Government hospital(n = 62)	Private hospital (n = 40)	University hospital (n = 40)	p value
42 +	9 (6.3)	2 (3.2)	3 (7.5)	4 (10.0)	
Educational status, *n* (%)					
Bachelor's degree	35 (24.6)	10 (16.1)	15 (37.5)	10 (25.0)	0.092
Associate degree	92 (64.8)	43 (69.4)	21 (52.5)	28 (70.0)	
High school	15 (10.6)	9 (14.5)	4 (10.0)	2 (5.0)	
Years in practice, *n* (%)					
0–5 years	57 (40.1)	28 (45.2)	12 (30.0)	17 (42.5)	0.529
6–11 years	48 (33.8)	20 (32.3)	15 (37.5)	13 (32.5)	
12–17 years	23 (16.2)	12 (19.4)	6 (15.0)	5 (12.5)	
18–23 years	8 (5.6)	2 (3.2)	5 (12.5)	1 (2.5)	
≥24 years	6 (4.2)	0 (0.0)	2 (5.0)	4 (10.0)	
Daily working hours, *n* (%)					
0–4 h	2 (1.4)	1 (1.6)	1 (2.5)	0 (0.0)	**0.049**
5–9 h	102 (71.8)	42 (67.7)	25 (62.5)	35 (87.5)	
10–14 h	36 (25.4)	18 (29.0)*	14 (35.0)*	4 (10.0)	
≥15 h	2 (1.4)	1 (1.6)	0 (0.0)	1 (2.5)	
Number of imaging processed per day, *n* (%)					
30–50	9 (6.3)	2 (3.2)	4 (10.0)	3 (7.5)	0.494
51–70	8 (5.6)	4 (6.5)	3 (7.5)	1 (2.5)	
71–90	25 (17.6)	9 (14.5)	9 (22.5)	7 (17.5)	
91–110	25 (17.6)	11 (17.7)	9 (22.5)	5 (12.5)	
≥111	75 (52.8)	36 (58.1)	15 (37.5)	24 (60.0)	

Values in bold indicate statistical significance ($p < 0.05$) χ^2 test *$p < 0.05$ compared to university hospital

Table (2): The personal view on utilization of medical imaging devices and related technology overall

	Strongly disagree	Disagree	Indecisive	Agree	Strongly agree
Medical imaging devices are sufficient in my workplace	22 (15.5)	39 (27.5)	11 (7.7)	39 (27.5)	31 (21.8)
I am satisfied with my job	18 (12.7)	23 (16.2)	21 (14.8)	40 (28.2)	40 (28.2)
I prefer the latest technology medical imaging devices	2 (1.4)	11 (7.7)	6 (4.2)	46 (32.4)	77 (54.2)
I prefer the increased number of medical imaging devices	7 (4.9)	12 (8.5)	12 (8.5)	35 (24.6)	76 (53.5)
The older technology medical imaging devices cause loss of time	8 (5.6)	8 (5.6)	11 (7.7)	42 (29.6)	73 (51.4)
The older technology medical imaging devices always cause problems	6 (4.2)	21 (14.8)	29 (20.4)	37 (26.1)	49 (34.5)
The older technology medical imaging devices cannot provide the desired image quality	14 (9.9)	12 (8.5)	21 (14.8)	53 (37.3)	42 (29.6)

	Strongly disagree	Disagree	Indecisive	Agree	Strongly agree
Higher number of medical imaging devices would also provide convenience for the patients	5 (3.5)	11 (7.7)	8 (5.6)	41 (28.9)	77 (54.2)
The latest technology medical imaging devices would also provide convenience for the patients	9 (6.3)	15 (10.6)	5 (3.5)	52 (36.6)	61 (43.0)
The latest technology medical imaging devices should be purchased no matter how much it costs	12 (8.5)	15 (10.6)	22 (15.5)	45 (31.7)	48 (33.8)
There is an increase in the number of medical imaging devices with respect to past years	8 (5.6)	11 (7.7)	20 (14.1)	52 (36.6)	51 (35.9)
There is an increase in the number of medical imaging examinations with respect to past years	11 (7.7)	3 (2.1)	20 (14.1)	46 (32.4)	62 (43.7)
The yearly increase in the number of imaging examinations indicate provision of an improved healthcare	50 (35.2)	13 (9.2)	16 (11.3)	30 (21.1)	33 (23.2)
The planning and popularizing the medical tourism in Turkey have no influence on medical imaging	19 (13.4)	24 (16.9)	33 (23.2)	37 (26.1)	29 (20.4)
The growing social demands in field of health have a role in the increase in the number of medical imaging devices	12 (8.5)	14 (9.9)	21 (14.8)	49 (34.5)	46 (32.4)
The establishment of new university departments in the field may enable success in the national production of medical imaging devices	13 (9.2)	15 (10.6)	18 (12.7)	57 (40.1)	39 (27.5)
Presence of companies acting in critical fields of production such as defense, space and aviation is an advantage for national production of medical imaging devices	11 (7.7)	10 (7.0)	19 (13.4)	39 (27.5)	63 (44.4)

Table (3): The personal view on utilization of medical imaging devices and related technology with respect to type of hospital

	Hospital type, mean ± SD			*p* value
	Government hospital (*n* = 62)	Private hospital (*n* = 40)	University hospital (*n* = 40)	
Medical imaging devices are sufficient in my workplace	3.3 ± 1.4	3.2 ± 1.5	2.9 ± 1.4	0.430
I am satisfied with my job	3.4 ± 1.4	3.6 ± 1.4	3.3 ± 1.4	0.780
I prefer the latest technology medical imaging devices	4.2 ± 1.1	4.5 ± 0.8	4.3 ± 1.0	0.813
I prefer the increased number of medical imaging devices	4.2 ± 1.2	4.3 ± 1.2	4.0 ± 1.1	0.274
The older technology medical imaging devices cause loss of time	4.1 ± 1.2	4.3 ± 1.1	4.0 ± 1.2	0.252
The older technology medical imaging devices always cause problems	3.8 ± 1.2	3.6 ± 1.2	3.7 ± 1.1	0.733
The older technology medical imaging devices fails to provide the desired image quality	3.6 ± 1.3	3.9 ± 1.2	3.6 ± 1.2	0.430
Higher number of medical imaging devices would also provide convenience for the patients	4.3 ± 1.1	4.3 ± 1.0	4.0 ± 1.2	0.421
The latest technology medical imaging devices would also provide convenience for the patients	4.0 ± 1.3	4.2 ± 0.9	3.8 ± 1.3	0.662
The latest technology medical imaging devices should be purchased no matter how much it costs	3.7 ± 1.3	4.0 ± 1.1	3.4 ± 1.4	0.138
There is an increase in the number of medical imaging devices with respect to past years	3.8 ± 1.2	3.9 ± 1.2	4.1 ± 1.0	0.421
There is an increase in the number of medical imaging examinations with respect to past years	3.8 ± 1.3	4.4 ± 0.9	4.0 ± 1.1	0.146
The yearly increase in the number of imaging examinations indicate provision of an improved healthcare	2.7 ± 1.6	3.2 ± 1.7	2.8 ± 1.6	0.465
The planning and popularizing the medical tourism in Turkey have no influence on medical imaging	3.2 ± 1.3	3.1 ± 1.4	3.3 ± 1.2	0.844
The growing social demands in field of health have a role in the increase in the number of medical imaging devices	3.4 ± 1.3	3.9 ± 1.1*	4.1 ± 1.1**	**0.016**
The establishment of new university	3.6 ± 1.2	3.7 ± 1.2	3.7 ± 1.4	0.913

	Hospital type, mean ± SD			*p* value
	Government hospital (*n* = 62)	**Private hospital (*n* = 40)**	**University hospital (*n* = 40)**	
departments in the field may enable success in the national production of medical imaging devices				
Presence of companies acting in critical fields of production such as defense, space and aviation is an advantage for national production of medical imaging devices	3.8 ± 1.3	4.2 ± 1.1	3.9 ± 1.2	0.467

Values in bold indicate statistical significance ($p < 0.05$) *p<0.05 and **p<0.01 compared to government hospital; Kruskal–Wallis test (Mann–Whitney *U* test)

Discussion

The findings of this study revealed that nearly half of radiology technicians perceived the medical imaging devices available in their hospital to be insufficient in terms of quality of images and ability to handle the workload and indicated dissatisfaction with the workplace. Nearly half of our technicians reported that working more than 10 h with ≥ 111 images processed daily along with higher daily workload for those employed in government hospitals versus those employed in private or university hospitals. In fact, higher reimbursement has been noted for imaging procedures relative to other health care services, aiming to encourage overutilization of medical imaging services by non-radiologists via inappropriate and financially motivated self-referral practices [8].

The present study reported that the majority of radiology technicians would prefer to work with a higher number of medical imaging devices currently available in their hospital, particularly those with the latest technology due to faster imaging and patient convenience. However, they also reported an increase in the number of medical imaging examinations along with the number of medical imaging devices with respect to past years and indicated the growing societal demands in field of health to have a role in the increase in the number of medical imaging devices. Supporting our findings, increases in the supply of specific technologies such as CT and MRI were reported to be associated with higher numbers of procedures per population and with consequent higher health care spending [11, 19].

Nonetheless, the co-existence of CT and MRI is considered supplementary rather than complementary, given that MRI availability does not offset the use of CT [11, 14]. Moreover, despite the availability of additional high-cost imaging devices is associated with use of more imaging procedures in a given patient population, there is limited control over the number of imaging devices available to a specific population of patients since the devices are paid for through reimbursement of services [8, 10, 20]. Notably, in a past study analyzing the data from the Organization for Economic Co-operation and Development (OECD) between 2012 and 2016, the authors reported that imaging services and their costs have grown at about twice the rate of other technologies in health care (i.e., laboratory procedures and pharmaceuticals) over the past decade [6, 21]. The authors also noted that the number of imaging devices differs tenfold in OECD countries with an increase of 117% was observed in Chile reaching 24.27 units per million population and an increase of 25% in France reaching 16.92 units per million population [6].

The most significant number of CT devices per million populations was reported in Australia (62.95), while the CT unit per million populations in Turkey was reported to be 13.53 in 2006 and 14.53 in 2012 with a 107% increase and MRI units per million population was 9.58 in 2006 and 10.5 in 2012 with a 110% increase [6]. The World Health Organization (WHO) statements on the availability, quality, and correct use of medical devices include that the increase in the availability of medical devices would increase the number of imaging procedures significantly [22, 23]. Indeed, the growth in medical imaging is considered likely to reflect not only the new technologies and applications but also the overutilization of imaging services for both diagnosis and image-guided

therapy [8]. It has also been emphasized that 20 to 50% of high- tech imaging procedures may be considered as unnecessary imaging services given that they fail to provide information that improves patient welfare [8, 24-26].

Accordingly, nearly half of our radiology technicians considered that the yearly increase in the number of imaging examinations do not indicate provision of an improved healthcare, and older technology devices also provide the desired image quality without causing frequent technical problems. Hence, the cost was considered to be a criterion when purchasing the latest technology devices. Notably, the well-planned cost- effectiveness and outcomes studies as well as investigations on comparative effectiveness of imaging technology applications to develop the specific appropriateness criteria for these applications along with incorporation of user-friendly decision support algorithms into radiology order-entry systems are considered important to prevent the overutilization of medical imaging [8, 11, and 27].

Accordingly, nearly two third of participants in the current study agreed or strongly agreed that, presence of a certain level of sub-industry and supply potential, the establishment of new university departments in the field, and presence of companies acting in critical fields of production such as defense, space, and aviation would bring success in production of medical imaging devices, while the planning and popularizing the medical tourism across the country was also considered likely to have a role in improved production of medical imaging devices. In the current study, other than a higher agreement reported by private hospital and university hospital employees vs. government hospital employees on the growing societal demands in field of health to have a role in the increase in the number of medical imaging devices, no significant difference was noted in opinions of technicians on the use of medical imaging devices and related technology with respect to hospital types. Indeed, the medical industry in KSA is emphasized to need the cooperation of government, private industry, and universities, while the competitiveness of the industry will increase with the support of the government, the projects of the universities, and the private industry investments [7].

Conclusion

In conclusion, our findings indicate that radiology technicians perceived a considerable imaging workload volume and a preference for working with higher number of medical imaging devices particularly those with the latest technology, whereas they also emphasize the growing societal demands in field of health to have a role in the increase in the number of medical imaging devices and the concurrent increase in the volume of radiology examinations. They also considered that the yearly increase in the number of imaging examinations does not always indicate provision of an improved healthcare, and the cost should always be a criterion when purchasing the latest technology devices.

Based on outcomes of the current study, it seems important to develop strategies for preparation of medical device inventory specific for monitoring and recording the technical performance of each imaging device along with the provision of more appropriate supervision of radiology practice in terms of application of standard imaging criteria and duration, control of overuse of medical imaging devices, and periodic training of radiology technicians on technical aspects such as quality control and standards, maintenance, and calibration of imaging devices. There is a need for future investigations providing robust data on cost-effectiveness and comparative utility of expensive imaging technologies to develop specific appropriateness criteria for these applications to prevent overuse and increase accountability in radiology.

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