A SYSTEMATIC REVIEW ON RADIOLOGY SERVICES QUALITY INDICATORS

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ABSTRACT

Introduction: Services quality in radiology department became a concern of stakeholders. Quality of the service increases the consumer and provider benefits. Those benefits include services reputation improvement, increase loyalty, improve cost-effectiveness, and reduce dose of radiation. The aim of the study is to review related scientific articles that discussed radiology services indicators and to find out the gaps among those studies.

Methods: A systematic search was performed utilising four electronic database which are, Pub-med, Science Direct, Medline and CINAHL using the keywords “radiology” and “indicators”. The included studies are those published until June of 2016, written in English, conducted on different diagnostic imaging sections and evaluated the quality of radiology services. Studies on therapeutic radiology, disease, pharmaceutical, or studies that examined technical effect of a particular equipment on a disease diagnosis were excluded.

Results: A total of 33 scientific articles were identified. Of these, only 14 studies were eligible and included. Three of them discussed on discrepancy rate indicators, while two studies measured the repetition rate. Four discussed on report turnaround time, three was on dose of radiation, and the last was discussing on indicator and uses of them.

Conclusion: Various types of indicators were used to measure quality in radiology services, mostly focussing on the process indicators. These studies indicate and emphasized on importance of quality control indicators in radiology department.

Keywords: Radiology, quality indicators, service improvement, discrepancy rate, report turnaround time, repetition rate, dose of radiation.
1.0 Introduction

Quality approach facilitates the improvement of the services in an organization through the application of indicators’ measurement. Quality was defined as a conformance to requirement, in other word, it is the measurement that leads the organization to achieve its desired outcomes (Suarez, 1992). Adoption of quality in any organization is a result of belief in the quality of management (Masejane, 2012). Belief in quality is achieved through learning, experience, practice and observing others. Moreover, quality indicators have proved their effectiveness to detect any defects or errors. These include statistical analysis that could be executed at any facility (Seljak & Zaletel, 2004). It helps the facilities to improve services and attain the desired goals. Thus, proving its benefits to all stakeholder. Those benefits include service reputation improvement, loyalty increase, cost-effectiveness, and reducing the dose of radiation exposure (Abujudeh & Bruno, 2012; McCollough et al., 2009; Weiwei, 2007).

Radiology Departments have developed their quality indicators based on different quality and radiation protection agencies such as the Joint Commission International for Quality Management and the International Atomic Energy Agency for radiation protection (CBAHI, 2015; CRCPD, 2001; IAEA, 2013). Quality indicators have become more important as far as practice in Radiology Department is concerned particularly when radiology technology evolution has succeeded in performing different tasks in a short time.

Radiology represents an integral branch of Medicine that deals with ionized radiation which helps to diagnose or treat diseases. Diagnostic imaging of radiology is the most common section that is available in all health care centres (ESR, 2010). The daily work of the Department have changed their routine work process from an analogue to a dialog format. These changes as a consequence, have affected positively the quality of service (Fridell, 2011). In contrast, there are still some issues that need to be monitored and evaluated while working with the digital system. Examples include the repetition of radiograph and discrepancy rates, reporting turnaround time and dose of ionized radiation (Hardy, Snaith, & Scally, 2013; Jabbari, Zeinali, & Rahmatnezhad, 2012). These issues cannot be managed properly and functioned effectively unless they are measured and monitored regularly and corrected accordingly by quality indicators.

In addition, the radiology services are not the same as other departments’ services provided in health care centres. In radiology, the practitioners are at high risk when dealing with ionized radiation. Therefore, the application and adherence or rather commitment to quality indicators in the radiology department can lead to providing high quality services and provide a safe environment for all stakeholders. The objective of this systematic review is to have an overview of the indicators being used in the radiology department and identify any potential areas for further improvement.

2.0 Materials and Methods

PubMed, Medline, ScienceDirect, and CINAHL electronic databases were searched comprehensively. A specific strategy was followed to identify relevant articles that meet the inclusion and exclusion criteria. These strategies began with the selection of keywords,
whereby the words “indicators”, “quality indicators” and “radiology” were utilised to identify articles related to quality indicators in radiology. The studies included are those published in English until June 2016, with appropriate research design and data collection. The studies would be only included if they were conducted in a Diagnostic Imaging Department which is one of the branches of Radiology Department. Studies conducted to evaluate the quality of service in the department were included as well. In addition, studies were included if they have assessed the repetition rate, dose of radiation, report of the turnaround time, discrepancy rate or other department quality indicators. The studies were excluded, when they were conducted on calculating population effective dose of ionized radiation, therapeutic radiology which include oncology cases and other diseases, studies on pharmaceutical element as well as those examining the different techniques of radiology equipment to diagnose a specific disease. Figure 1 shows the PRISMA chart of the article search process.

Figure 1: PRISMA flow chart of the search process
3.0 Result

A total of 349 articles were identified in the initial search. The titles and abstract of all the articles were screened, of which only 33 articles met the inclusion and exclusion criteria. The full text of those 33 articles were read thoroughly, after which, only 14 were suitable to be included in the review. The detailed description of each article are presented in Table 1. These studies are arranged by year of publication.

4.0 Discussion

This systematic review has identified and presented fourteen studies that explored varies quality indicators in Radiology Department. Ten of those studies were cross sectional while one was retrospective and three were intervention. They were conducted in different countries around the world and they explored the importance of quality indicators in diagnostic Radiology Department.

The included studies in this review have evaluated the quality indicators from a different prospective on different modalities or different Department’s sections. Department’ sections are Conventional Radiography (CON), Ultrasound (US), Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Dental Imaging (DI) and Mammography (MG) (Newton Wellesley Radiology Associates, 2015). Furthermore, the study of Hurlen et al., (2010) has conducted on the several modalities namely, CON, CT, US, MG, MRI and Interventional Radiography (IR) while the study of O’Keeffe et al., (2013) has conducted on CON, MR, US, Fluoroscopy (FS) and Nuclear Medicine (NM). The difference between the study of Osei et al., (2013) and the study Issa et al., (2015) is that, the later one did not include US since it is out of study scope and because of US doesn’t produce ionized radiation.

The studies of Hofmann et al., (2015); Minnigh & Gallet, (2009) have shared the same scope of CON, but they used different versions of modalities. The study of Hofmann et al., (2015) was conducted on direct digital radiography (DR) whereas study of Minnigh & Gallet, (2009) conducted on Computed Radiography (CR).

The Studies of Miller et al., (2003); O’Hora, (2016) conducted on IR to measure the dose of radiation while the study of Hurlen et al., (2010) included IR as one of the modalities to evaluate the RTAT. In addition, the studies of Cristofaro et al., (2007); Nitrosi et al., (2007) conducted on CON, CT, MR and US. The difference between the study of Nitrosi et al., (2007) and the study of Cristofaro et al., (2007) is the last involve of MR within their study.
Table 1: The studies that included from the systematic review

<table>
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<td>(O’Hora, 2016)</td>
<td>Retrospective</td>
<td>Interventional radiological procedures over a 2-year period in a major tertiary referral hospital were understudy to assess dose of radiation.</td>
<td>Kerma-Area Does</td>
<td>The number of 5156 interventional radiology procedures were revised. Thirteen patients documented a kerma-area product dose of 500 Gy cm² or more. 6 patients underwent percutaneous cardiac interventions and 7 had embolization of gastro-intestinal haemorrhage. Subsequent phantom studies representative of percutaneous cardiac interventions and embolization of gastro-intestinal haemorrhage procedures resulted in peak skin doses of 2.6 Gy and 1.5 Gy respectively for a PKA value of 500 Gy cm².</td>
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<td>(Hofmann et al., 2015)</td>
<td>Cross-Sectional</td>
<td>All exposed images at two direct digital laboratories at a hospital in Norway were reviewed in January, 2014. The type of examination, number of exposed images, and number of deleted images were registered. Each deleted image was separately analysed and the grounds for deleting the image were recorded.</td>
<td>Repetition Rate in Digital Radiography</td>
<td>Out of the total of 5417 exposed images, 596 were repeated, producing a repetition rate of 11%. The percentage 51.3% was repeated following existing errors. The tests with the highest percentage of deleted images were the knee, hip, and ankle, which were 20.6%, 18.5%, and 13.8% as far as order is concerned.</td>
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<td>(Issa et al., 2015)</td>
<td>Cross-Sectional</td>
<td>All residents and radiologists in the Department of Diagnostic Radiology at the American University of Beirut Medical Centre where under study from June 2011 to May 2012.</td>
<td>Discrepancy Rate</td>
<td>The overall discrepancy or rather difference rate was 1.62%. The inconsistency or rather difference rate was higher for the first and second year residents (1.62% and 1.96%) than for the third and fourth year residents (1.35% and 1.24%). It was higher for computed tomography (2.13%) than for radiographs (1.29%) and ultrasound (0.8%) (P value&lt;0.01), and higher for musculoskeletal (1.61%) than non-musculoskeletal (0.99%) radiographs (P value&lt;0.0003). Discrepancies with severity score one constituted 35.5% of the total discrepancies, those with severity scores two and three introduced 22.9% and 41.6%, as far as order is concerned.</td>
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<td>(Bodanapally, Shanmuganathan, &amp; Nutakki, 2013)</td>
<td>Intervention</td>
<td>A list of patients who underwent imaging between 12 midnight and 7 AM from 2006 and 2007 in the Department of R. Adams Cowley Shock Trauma Centre, United States of America, was evaluated.</td>
<td>Discrepancy Rate, RTAT, Length of Stay (LOS)</td>
<td>A total of 1087 and 1323 patients for the year 2006 and 2007, respectively, met selection standards Mean TRU LOS changed from 11.19 to 8.25 h (26%; P &lt; 0.001). The median or rather average decreased from 10.8 to 7.2 h (33%; P &lt; 0.001). The (Q3–Q1) indicator, used as a proxy for variance and spread, shifted from 7.36 to 5.76 h. Theoretical economic benefits from 24/7 radiology coverage were</td>
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A Study conducted in a community-based outpatient clinic setting, Alberta, Canada. Total of 10 radiologists participated as peer reviewers 2241 case being actively reported by those ten radiologists were randomly chosen during September 2009 and March 2010. The case was scored using RADPEER system.

Discrepancy Rate

Among selected cases, 1,705 (76%) were interpreted. Going through radiologists agreed with previous reports in 99.1% of evaluations. Affirmative response (score 0) was given in three cases (0.2%) and concordance (scores of 0 to 2) was assigned in 99.4%, similar to reported rates of 97.0% to 99.8%. Clinically significant discrepancies (scores of 3 or 4) were identified in 10 cases (0.6%). 88% of reviewed radiologists found the comments very much valuable, 79% found scores suitable, and 65% felt feedback was appropriate. 2/3 of the radiologists found case rounds discussing substantial differences to be extremely important.

Organ and effective doses were estimated for 94 patients who underwent computed tomography examinations. For 338 patients who had conventional radiography examinations were under study in 2012 in Kingston General Hospital, Canada.

Equivalent and Effective Dose and Entrance Surface Dose

The tube possible varieties; 57 kVp to 138 kVp relying on the test and size of patient. The entrance surface doses have an extensive variety even for the same test 0.44–10.31 mGy (abdomen) and 0.66–16.08 mGy (lumbar spine) and the conforming Active dose ranges 0.025–0.77 mSv and 0.25–0.95 mSv respectively. Active dose for grown-up abdomen-pelvic CT tests ranges 5.4–19.8 mSv with a mean of 13.6 mSv and for paediatrics ranges 2.1–5.5 mSv with a mean of 2.7 mSv. The mean active dose for chest of the adult and head CT tests are 7.9 and 1.8 mSv as far as order is concerned and for pediatrics are 1.7 and 1.1 mSv.

2,023 examinations in the pre-PACS observation week, 1,954 examinations at first and 2,191 examinations in the last post-PACS week were performed. Moreover, 6,576 examinations of in-patient cases were included and 4,493 examinations of emergency cases were also performed at the university affiliated county hospital in the Eastern Norway in 2005 from 2005 to 2007.

Reporting Turnaround Time

The RTAT Introductory reports of radiological examinations was mainly changed from 12 to 2 h then accelerated to 3 h. as far as final reports are concerned, the RTAT was initially reduced from 23 to 13 h and then gradually shifted back to 22 h. Moreover, there was statistical significant and substantial change (p<0.01) in RTAT for introductory and conclusive reports. There was an important increase (p<0.01) in RTAT from the beginning to the end post-PACS observation week for all modalities except for introductory CT. There was a substantial shift (p<0.03) in RTAT for all introductory and final emergency or rather backup reports.
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<th>Study Authors</th>
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<tr>
<td>Minnigh &amp; Gallet (2009)</td>
<td>Cross-Sectional</td>
<td>766 of patients’ images at the children’s hospital in the Midwestern United States where studies were performed in 2008. Each patient is registered under the assigned technologist identification.</td>
<td>Repetition Rate of Computed Radiography The outcome shown that 80% of the radiological tests was conducted by only 21% of the technologists or radiographers and that the technologist with the highest output had a personal repetition rate of 6.5% compared to the average of the department 7.6%.</td>
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<td>Cristofaro et al. (2007)</td>
<td>Cross-sectional</td>
<td>Activity of Imaging Diagnostic Operational Unit of the National Institute for Infectious Diseases by L. Spallanzani in Rome, Italy from 2000 to 2007 were under study.</td>
<td>Malpractice The number 209,302 were carried out (with the yearly average being 26,163), that produced a 40,604 mp-rvu (with the yearly average being 5,076). The total mp index was 0.20, whereas the overall medical mp index was 6,083. The maximum number of tests was conducted in 2001 (28,779). The highest number of Malpractice Relative value Units (MP-RVUs) was performed in 2007 (6,361 MPRVUs).</td>
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<td>Nitrosi et al. (2007)</td>
<td>Intervention</td>
<td>All radiological examinations in Diagnostic radiology of Reggio Emilia, Italy were under study from 2002 to 2004.</td>
<td>Report Turnaround time, (LOS) The department efficiency production accelerated by 12% post intervention. 60% was the improvement in TAT. Timelier patient care resulted in reduced lengths of stay also post intervention. Neurology alone experienced a 12% enhancement in average patient stay. The implementation of PACs is statistically significant (p&lt;0.05).</td>
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A Multi-institutional survey study among academic radiology departments across the United States from May to November 2002 was under study. Precisely 132 members of SCARD received electronic questionnaire copies that aimed to evaluate quality indicator in their department. Those quality indicator are patient satisfaction, referring physician and employee satisfaction, patient appointment, report turnaround time.

Radiology Indicator Uses

The response rate was 42% (55/132). Most responding hospitals were from the Midwest (18/55, 32.7%) and Northeast (20/55, 36.4%). About 58% (32/55) of the responding hospitals had more than 500 beds in operation; 50.9% (28/55) of the radiology departments conducted 200,000–400,000 tests per year. Among the 80% of departments (44/55) that observed patient contentment, only 49.1% and 45.5% evaluated referring physician and employee contentment, as far as order is concerned. The most frequently observed customer contentment indicator, patient contentment, was observed quarterly or less frequently by 70.5% (31/44) of departments; about 45.5% (20/44) had preset criteria for this indicator. MRI and CT were monitored for patient appointments access by 80% (44/55) and 72.7% (40/55) of departments, respectively; 59.1% (26/44) and 62.5% (25/40) of departments applied preset criteria to these indicators, as far as order is concerned. The reporting-time indicators monitored most frequently was RTAT (45/55, 81.8%). None of the differences in mean figures and observing rates of the indicators and the use of preset criteria to assess them by region and size of departments were substantial ($p > 0.05$).

Productivity and Financial Indicators

42% is the response rate (55 of 132 surveyed SCARD members. The mean number of output pointers used by radiology departments was 4.55 - 2.56 (SD standard deviation), while the mean number of financial pointers used was 2.89 - 1.99. Twenty-two (40%) of the 55 responding departments used productivity indicators to provide feedback to radiologists monitor, technical staff and hospital leaders members for improved productivity, but only 11 (20%) departments used these pointers to compare personnel performances against specific output criteria. The most frequent objective, of seven 13% responding departments, of using the pointers was to rise the test volume from the last year by 5%–10%.
(Miller et al., 2003) **Cross-Sectional**

2,142 cases from seven academic medical centres in New York were under study to assess the radiation dose of patients from April 1999 to January 2002. **Radiation Doses of Patients**

Data were collected on 2,142 samples of interventional radiology processes, 48 complete physics assessments, and 581 periodic consistency checks from the 12 fluoroscopic units in the research. There were wide differences or rather change in dose and statistically substantial differences in fluoroscopy time, number of images, DAP, and CD for different instances of the same procedure, depending on the nature of the lesion, its anatomic location, and the complexity of the process. For the 2,142 instances, observed CD and DAP correlate well overall ($r = 0.83$, $P < .000001$), but correlation in individual samples is humble. The same is true for the correlation between fluoroscopy time and CD ($r = 0.79$, $P < .000001$). The correlation between fluoroscopy time and DAP ($r = 0.60$, $P < .000001$) is not as good. In 6% of instances (128 of 2,142), which were mainly embolization procedures, transjugular intrahepatic portosystemic shunt (TIPS) procedures, and renal/visceral artery stent placements, CD was much more than 5 Gy.

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(Sutherland, 1970) **Cross-Sectional**

All the requests for initial x-ray examinations of the chest, abdomen, skeletal structures, skull, and for intravenous pyelography, cholecystography and cholangiography, barium enemata and barium meal examinations were assessed during a six-week period. **Discrepancy Rate**

The comprehensive occurrence of agreement or rather arrangement was 33% - 533 out of 1,604 x-ray tests. The extensive variation in agreement in various radiological tests is undoubtedly linked to the nature of pathological of disease and the boundaries of radiological methods.
The Studies of Ondategui-Parra et al., (2005); Ondategui-Parra & Erturk, (2006) are unalike the aforementioned studies. They conducted their studies to evaluate the uses of quality indicators in designated Radiology Department from the perspective point of Radiology staff. Their samples are the Radiology personnel and they used designed questionnaires.

4.1 Repetition Rate Indicator

The study of Hofmann et al., (2015) and the study of Minnigh & Gallet, (2009) conducted to examine the repetition rate. Repeat radiography is defined as the radiograph that does not provide clear body anatomy to the referring physician or radiologist. It was recommended that repetition rate should not exceed more than 5% within the Department (CRCPD, 2001; Rajani, Sajjad, Masroor, Parveen, & Naqvi, 2008). In the study of Hofmann et al., (2015) and study of Minnigh & Gallet, (2009) show that the repetition rate in the first 11% while the last 7.9% and the result exhibited that the repetition rate is higher than the international recommendation. There are several implication of high repetition rate of routine radiography when it is reported. These implication affect patients, staff and organization. For patients, it increase the waiting time and dose of radiation (Jabbari et al., 2012; Khoshinani, Khoshinani, & Heidari, 2014). For staff, it increase the workload and also the dose of radiation (Ofori, Antwi, Arthur, Yeboah, & Dzefi-Tettey, 2013). For organization, it increase the economic burden, consume equipment lifetime and lead reduce the opportunity to achieve organization goals and objectives (Al-Malki, Abulfaraj, Bhuiyan, & Kinsara, 2003; Khafaji & Hagi, 2014; Ofori et al., 2013).

4.2 Discrepancy Rate Indicator

The studies that focused on the discrepancy rate such as the studies of Issa et al., (2015); O’Keeffe et al., (2013) which their main concern was the evaluation of discrepancy rate among the staff of physicians in Radiology Department. Discrepancy in radiology reporting is defined as the interpretation of radiological images that differ from reference standards (Wu, McInnes, Blair Macdonald, Kielar, & Duigenan, 2014). It is utilized to assess the physician practice and to improve the patient’s safety. It is also a good tool for training and learning that leads to improve the services’ outcomes. Furthermore, O’Keeffe et al., (2013) have used modified RADPEER program in their study to evaluate 88 radiologists’ reports from Emergency Radiology (ER) cases and other department sections. As a contrast, the study of Issa et al., (2015) have implemented the monitoring and communication systems in their Radiology Departments to monitor the different levels of reports for the residents in Radiology Department in ER. Furthermore, in the study of Issa et al., (2015) the discrepancy score one means that they needs to recall the patient and referring physician urgently to confirm the radiology report whereas the score of two means that it is a significant discrepancy, but not as urgent as the score one. The Scores three and four indicate that the discrepancy rate does not affect the patient’s health. As a contrast, the discrepancy scoring system that was used in the study of O’Keeffe et al., (2013) was different where the score of zero indicates that it is a good report, one means that the report is approved by the evaluator and the scores 2, 3 and 4 indicate that there is an error in the report. Based on the obtained scores, the percentage of discrepancy was calculated. In addition, the study of Sutherland, (1970) is discussing the discrepancy rate, but it evaluates the difference between the
radiological report and the clinical diagnosis. It is different from the studies of Issa et al., (2015); O’Keeffe et al., (2013) which measure the discrepancy rate by the tools that have used. Additionally, the discrepancy rate should be kept low as possible as can to assure high quality of radiological services and prevent medical errors.

For the implication of high discrepancy rate, it has it effect on patient and professionals in the department. For patients, it leads different clinical diagnosis by clinician and medical errors (Cindy, Paul, Sallie, & David, 2013). For professionals, it leads to increase the workload (Cindy et al., 2013). It affect reduce the quality of the department services (Brady, Laoide, Mccarthy, & Mcdermott, 2012).

4.3 Reporting Turnaround Time Indicator

RTAT were analysed in the study of Hurlen et al., (2010); Nitrosi et al., (2007). Both of those studies evaluated RTAT before and after installing the Picture Achieve Communication System (PACS). Reporting turnaround time (RTAT) is the time between the completion of body part imaging to the time of final report sent to the referring physician (Strife et al., 2007). RTAT for emergency patient should be between twenty minutes to two hours, inpatient RTAT should be from four to eight hours while outpatient should be from four to 24 hours (CBAHI, 2015; Howell, 2015; Radisphare, 2011).

There was a significant reduction in the final report turnaround time p<0.01 while the preliminary report of turnaround time was reduced in the measurement after installing PACs. In addition, both studies which deal with RTAT evaluate the length of stay, financial benefits and the number of the radiological procedures with RTAT. The result shows the statistical significant p<0.05 in the patient’s stay and productivity after the intervention. Moreover, the study of Bodanapally et al., (2013) was conducted to evaluate RTAT after the implementation of 24/7 radiology services coverage. It revealed that there is a statistical significant of RTAT (P<0.05) and it affects LOS positively.

For the implication of high RTAT, it affects the treatment process and clinician decision which affect patient health improvement.(Lamb et al., 2015). High RTAT also affect patient flow and delays patient moving into inpatient department when it is reported in Emergency department (Towbin et al., 2013). It also reduce the services quality in department and leads to internal and external clients’ dissatisfaction (Marty, 2009).

4.4 Dose of Radiation Indicator

To maintain the issue of ionized radiation, the dose should be monitored periodically. The dose of radiation depends greatly on the body organ thickness and the type of exposure either in CON or CT. The routine radiological procedure average effective dose is (0.1mSv to 10 mSv) while CT (2-20 mSv) and interventional procedure are (5 to75 mSv) (Jr, Huda, Yoshizumi, & Mahesh, 2008). Moreover, the average of the annual exposure should not exceed more than 0.050 mSv/per person annually for gonads organ (Ragheb, 2016). Meanwhile, the maximum dose of Radiation that Radiology personnel have to be exposed to is 50 mSv/ year (Iannucci & Howerton, 2013; Sinclair, 1981).

The studies of Miller et al., (2003); O’Hora, (2016); Osei et al., (2013) conducted to evaluate the doses of radiation. The study of Osei et al., (2013) has measured the effective dose in the
human body associated with the different radiological examinations using OrgDose program while the study of Miller et al., (2003) was conducted to evaluate the cumulative dose (CD) and the dose–area–product (DAP). The study of O’Hora, (2016) was conducted to evaluate Kerma-area doses in interventional procedure. All of those studies which deal with the radiation dose measurement, the results are compared with the international standards. According to O’Hora, (2016) a kerma-area dose product of 500 Gy cm^2 alone is not that much useful indicator of potential tissue reaction for percutaneous cardiac interventions or gastrointestinal haemorrhage embolization's. Meanwhile the study of Miller et al., (2003) stated that embolization procedures, Transjugular Intrahepatic Portal Systemic Shunt (TIPS) creation, and renal/visceral artery stent placement are associated with a substantial possibility of clinically significant patient dose.

This ionized radiation has its side effect on the human body, organs and gonads when exceeded than the average limit. According to World Health Organization (WHO) excessiveness of ionized radiation more than the average or what it is permissible, may lead to skin burns and acute radiation syndrome (WHO, 2016).

Studies of Ondategui-Parra et al., (2005); Ondategui-Parra & Erturk, (2006) show the importance of other different indicators that implemented in Radiology department which was understudy and their effectiveness from the perspective point of radiology professionals’ views. In addition, another study of Cristofaro et al., (2007) was utilized RVU to evaluate the malpractice within the different facilities of the department. RVU combined with the average insurance premiums, was originated by the complex mathematical analysis by Medicare to evaluate the radiological risk.

5.0 Conclusion and recommendation

The quality of services indicators in Radiology should be a common practice among Radiology staff. Studies highlighted on the importance of those indicators to improve the Radiology quality services, safety and productivity. They also emphasized on continuous practice on the uses of those indicators in the Radiology Department on a regular basis. Informative training and education program on quality indicators should be recognized,
implemented and evaluated to achieve high quality services. For future work, it is recommended to evaluate the cost effectiveness of RADPEER of discrepancy rate. Intervention and its effectiveness were also implicitly suggested to be evaluated in different studies. Therefore, the future work should be undertaken based on the previous studies recommendations.

Declaration

The authors have no conflict of interest for declaration.

Author’s contribution

Author 1: Literature search, analysing and writing the draft. Author 2: Idea and concept, reviewing the articles and editing. Author 3: Reviewing and editing. Author 4: Reviewing and editing. Author 5: Reviewing and editing and Author 6: Reviewing and editing.

References


CRCPD. (2001). *Quality Control Recommendations for Diagnostic Radiography Volume 3*


IAEA. (2013). Radiation Quantities and Units. Retrieved from https://rpop.iaea.org/RPOP/RPoP/Content/InformationFor/HealthProfessionals/1_Radiology/QuantitiesUnits.htm


