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Usage of auto mA: deviation index adjustment on computed radiography of chest

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ABSTRACT

Background

In the digital imaging system, exposure index provides radiographers with useful feedback about the exposure received by the image receptor. An under-exposure or over-exposure image will produce the wrong exposure index, while the correct exposure will provide an appropriate exposure index. The high demand for radiographs of the thorax in Premier bintaro Hospital makes the concern more especially for adjusting the exposure index that must be carried out to be able to stay within recommended range so as to reduce detector exposure received that indirectly have an impact on decreasing patient dose.

Methods

This paper was made to determine the deviation index (DI) values of exposure produced on thorax radiography by applying automatic current (mA) in Premier Bintaro Hospital. This paper is prepared with literature review, observation, and documentation.

Results

From observations on 10 patients with Thorax PA examination using AEC was proven to be able to produce an exposure index with DI still in the range of ± 3. The variation in DI values shown values far from the red label (out of range). This is a good indication in terms of exposure received, especially avoiding over exposure that will increase the dose received by the patient.Using a range of kVp of 80-100 kVp is very appropriate to do more combined with the use of current automatic mA. A high kVp value is used to ensure the high energy photons can be detected by the receptor / plate so that the determination of AEC will be more accurate in accordance with the EI target to be achieved.

Conclusion

Application of automatic current (mA) can assist in adjusting the value of DI values which are assessed on the magnitude of the exposure index produced compared to the target exposure index that has been determined as the standard.

Keywords: *Automatic mA, Deviation Index, Exposure Index, Premier Bintaro Hospital.*

INTRODUCTION

In digital imaging systems, an exposure index give feedback that is useful to indicate the exposure received by receptors image. Under-exposure or over-exposure images will produce the wrong exposure index, while the correct exposure will

give the appropriate exposure index. The indicator is different values depending on the vendor that gives the radiographer an indication of the accuracy of their exposure settings for a particular image. The exposure indicator has many different names. The names include S-number, REG, IgM, ExI and Exposure index (EI) [1]. For Carestream products used at Premier Bintaro Hospital, the exposure index is defined as a numerical value calculated from the average code value of the image data areas used by the image processing algorithm to calculate the original tone-scale. This has a logarithmic relationship with the incident air-kerma at the detector [2, 3]. On Carestream machine, it is recommended to read between 1700 and 1900 for all examinations. The high demand for chest radiographs both for screening, pre surgery, up to the diagnosis of thorax pathology causes this type of examination to the first rank with the highest percentage compared to other examinations. Thus, the exposure index adjustment must be made to stay within the recommended range. One of the methods used at Premier Bintaro Hospital is to use Automatic tube current techniques (mA). The current strength in the exposure factor plays an important role in the amount of intensity of the radiation produced. The use of this technique is expected to maintain the value of the resulting exposure index within the recommended value range so as to produce a good quality image.

METHOD

This paper was made to determine the value of the exposure index produced on the chest radiograph by applying the radiological current strength (mA) of Premier Bintaro Hospital. This paper was prepared with a literature review, observation and documentation at the Premier Bintaro Hospital.

RESULT

Each radiology imaging manufacturer has its own method of providing information on the value of exposure indicators. This can be confusing for radiographers who have many vendors in their facilities. There is an exposure index standard for digital X-Ray imaging systems. Developed simultaneously by the International Electrotechnical Commission (IEC) and the American Association of Physicians in Medicine (AAPM), in collaboration with digital radiographic system manufacturers, the exposure index has been implemented as an international standard. This is known as the IEC exposure index [4]. The Carestream system can be configured by a radiographer to display the Carestream EI, IEC EI, or both [5, 6].

The IEC exposure index is a unique form for the type of receptor used and for the tests performed. Three default Target Exposure Index (TEI) values are loaded into the system. These three values represent the default EI Target for inspection using Bucky, Non-Bucky and paediatric. After exposure, IEC EI will be displayed, followed by the Deviation Index (DI).

The Deviation Index quantifies the difference between the actual EI and the EI Target, and feedback this allows the radiographer to track and adjust its exposures [7, 8]. When the actual EI is equal to the EI Target, the DI will be equal to 0. A positive or negative DI indicates the number of exposures greater or lower than the EI target. That doesn't always mean that an image needs to be remade. If the deviation is greater than +3, the exposure index is displayed in red to indicate high / low exposure which may need further review.

Table 1. Deviation Index Classification along with the meaning of the exposure.

Deviation Index	% of Target
3	~100% too high
2	~58% too high
1	~26% too high
0	**Correct**
-1	~21% too low
-2	~37% too low
-3	~50% too low

The DI's diagram below describes how to use the Deviation Index. In the example in the Chest radiography, the DI value is 1.06. In Table 1 you will see that DI of 1 means that the resulting exposure is ~ 26% higher than the EI Target. The initial DI is 1.06, so it can be estimated that DI is slightly higher than that percentage, maybe close to 30%. Even though the resulting image may be good enough, this can be an indicator for the radiographer to reduce the exposure factor when the next examination is carried out so that it can reduce the patient dose while still obtaining an image with acceptable quality [9].

Application of AEC on chest radiography at Premier Bintaro Hospital, from observations of 10 Thorax PA patients using AEC proved to be able to produce exposure index with DI still in the range of ± 3. In table 2 can be seen the value of DI at each examination.

Table 2. Exposure Indicator Value in Chest X-Ray Patients With the application of auto mA

Pasien	***Exposur Index***	***Deviation Index***
1	1.607	-0,96
2	1.654	-0,71
3	1.612	-0,93
4	1.626	-1,05
5	1.652	-0,33
6	1.751	-0,15
7	1.485	-1,89
8	1.867	1,87
9	1.854	2,12
10	1.846	1,26

From the table above, we can see variations in the DI value which are shown to have values that are far from the red label (above ± 3). This is a good indication in terms of exposure that may be received, especially avoiding over exposure which will increase the dose received by the patient (if it exceeds the scale of 3). But in practice, it is rarely found a DI value of 0 or in the sense that the actual EI matches the target EI. This is influenced by several factors such as the kVp used, the sensitivity of the detector, the distance (FFD, OFD), to the intrinsic factor of the patient's associated anatomies.

At Premier Bintaro Hospital, thorax examination uses tube voltages in range of 80-100 kVp. This is very appropriate to do especially combined with using an automatic tube current (mA). High kVp values are used to ensure high energy photons can be detected by the receptor / imaging plate so that the determination of AEC (mAs) will be more accurate in accordance with the target EI to be achieved [6]. Thus, the resulting DI will be able to approach 0 (EI actually approaches the target EI). However, the use of automatic mA cannot be done in non-integrated Bucky, consequently there will be changes in the value of DI even reach the red label due to the use of an inappropriate exposure factor.

As comparison data, table 3 shows the exposure index value along with DI without using automatic tube current (mA) which results in DI values that are on the red label.

Table 3. Exposure Indicator Value in Chest X-Ray Patients Without the application of auto mA

Patient	***Exposure Index***	***Deviation Index***
1	1.092	-6,64
2	950	-8,38
3	2.283	6,55
4	2.090	4,35
5	1.186	-5,99
6	2.030	-3,97
7	2.125	-3,29
8	987	-8,82

9	2.329	6,72
10	1,002	-4,32

From table 3 it can be seen that the DI value entered into the red label can be negative or positive. A negative red label value means the exposure value lower than the target set exposure, especially below the value of -3 means the exposure received by 50% lower than the target exposure. Although in terms of dosage the patient will experience a decrease, but it will affect the results of the radiograph, because with insufficient exposure it will have an impact of excessive noise on every pixel in the resulting image.

In inverse proportion to the results of the DI value entered into the red label with a negative value, a positive red label indicates the exposure detected by the receptor / imaging plate is greater than a scale of 3 when compared to the specified target Exposure. This means that the exposure received is 100% higher than the target exposure. In this case the resulting image is clearly better than the under-exposure, but this has an impact on the exposure received by the patient also to be higher than expected [10]. As a material for study and evaluation, the DI value can be used to produce an optimal image with sufficient exposure without disturbing the quality of the image.

CONCLUSION

The application of Automatic tube current (mA) in the Chest radiography examination at Premier Bintaro Hospital can assist in adjusting the value of the deviation index (DI) which is assessed at the size of the examination exposure index produced compared to the target exposure index determined as a standard.

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