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Preliminary Review of Local Diagnostic Reference Level (DRLS) for Government Healthcare Dental Centres in Abu Dhabi

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ABSTRACT

Radiological examinations and studies are used in the medical field. Radiographs play an important role in today's medicine, especially for dental diagnosis. Ionizing radiation is well known for being used in dental imaging. According to the as low as reasonably achievable (ALARA) concept for radiation protection, dentists must expose patients to the least amount of radiation while providing appropriate imaging quality. Dental radiology's technological development began after 1919, when adequate electrical insulation made intraoral imaging techniques safe to perform. In the 1960s, panoramic dental imaging began to be made available to the public, whereas computed tomography has been used since the 1970s. Therefore, establishing diagnostic reference levels (DRLs) is one method to ensure a healthcare provider's optimal performance when using ionizing radiation procedures.

1. Introduction

Ionizing radiation exposure in dental radiology contributes to about 2.5 % of the effective dose received during medical procedures. The typical adult effective dose for intraoral radiographs is 0.005 mSv, for panoramic radiographs is 0.01 mSv and for dental computed tomography is 0.011 - 1.073 mSv [1].

Its widespread use is largely due to the fact that it is a low-cost diagnostic tool that permits treatment planning and image-guided operations. According to the European guidelines for radiation safety in dental radiology, between 96 and 449 dental radiological exams were done for every 1,000 people in the European Union countries that have provided this information. There are a lot of experts who practice these kinds of procedures, and many dental exams use ionizing radiation. Due to this, patients who are exposed to a certain dose of ionizing radiation during these imaging examinations need to be protected from radiation.

Many countries have conducted national surveys on medical and dental radiography. Among these instances, the United Kingdom has continuously reported national DRLs through a series of five-yearly assessments of the National Patient Dose Database maintained by the Radiation

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Protection Division (RPD) of the Health Protection Agency (HPA) [2].

All the articles studied, reported specific DRL values, having the third quartile value of doses measured. Then the values were compared with the literature with guidelines or, as in the study by [3] with previous studies from the same country. This shows the importance of national DRL facilities everywhere [3,4].

On the other hand in 2015, medical physicists from Abu Dhabi and Dubai in the UAE published a study to explore paediatric and adult doses in several dental radiology modalities. It was a part of the technical projects structured by the International Atomic Energy Agency (IAEA) in the UAE to evaluate and monitor patients' radiation doses. This study's review focussed on two types of dental radiology examinations: intra-oral dental and panoramic orthopantomography (OPG) dental. There were 122 intra-Oral and 16 Panoramic OPG dental units that participated in this survey. In the previous UAE dental radiology dosimetry examination, 85 digital units and 16 Panoramic OPG machines were used. The findings of this review study were deemed preliminary for UAE DRLs. These findings suggested that dose levels in the UAE were similar to those reported in the literature. In the UAE, research is being conducted to evaluate additional doses for digital intraoral and OPG machines [5].

Most EU nations have not yet created national DRLs for dental radiology as indicated in the introduction to the European Commission Guidelines for Radiation Protection in Dental Radiology. This systematic review addressed 13 original research publications on local or national DRLs in dental radiology for the EU and other countries. The majority of these researches concentrate on intraoral and panoramic dental imaging, with only a handful focusing on cone beam computed tomography (CBCT) imaging. This shows that there is still a need for additional research in this area. Most studies established or amended DRLs at the national level and compared them to literature and similar studies undertaken in other countries. Only one study is the product of local DRL institutions with the purpose of optimizing protocol. DRLs are generally set for adults in this collection of publications, with only four exceptions for young patients, who require special consideration in terms of dose optimization [3].

All articles studied the specified DRL values, i.e., the third quarter measured doses from their data. The values were then compared with literature with guidelines or, as in the study by [3] with previous studies from the same country. This indicate the significance of national DRLs everywhere, and the most read articles about them are listed in the Table 1 [4].

Table 1
Study of DRLs by different researchers

Author	Country	Sample	Technology	Radiography type	Units of measurement
Alcaraz *et al.,* [4]	Spain	16175 official reports, gathered between 2002 and 2009	DR, CR, film-screen	Intraoral	ESD
Alcaraz *et al.,* [4]	Spain	34143 official reports gathered between 1997 and 2014	DR, CR, film-screen	Intraoral	ESD
Christofides *et al.,* [4]	Cyprus	20 machines	Film-screen	Intraoral	DAP

Federal Authority for Nuclear Regulation (FANR), which was established to be the regulatory authority for the nuclear sector in the United Arab Emirates by virtue of Federal Decree Law No. 6 of 2009 in September 2009 regarding the peaceful uses of nuclear energy; Protects the Emirates, its workers and the environment by implementing nuclear regulatory programs in the areas of safety, security, radiation protection and guarantees, which achieve the main objectives of licensing and inspection in accordance with international best practices. FANR has made it a requirement for all health institutions that use radiation and has not yet completed compiling their DRL records in the Al Ain and Abu Dhabi regions. It is important that healthcare organizations work consistently and collaboratively to optimize patient protection [21].

The DRLs are an important part of optimizing patient protection. DRLs are defined as "a level used in medical imaging to indicate whether, in routine conditions, the dose to the patient or the quantity of Radioactive Material administered in a specified radiological procedure is unusually high or low for that procedure" in FANR Regulation 24 on basic safety standards for facilities and activities involving ionizing radiation other than nuclear facilities (version 1). DRLs are determined after consultation with health responsible authorities and related professional organizations and are based on surveys or published values appropriate to the state's circumstances. These DRLs are adjusted to the patient's age, the organ or area of the body being investigated and the clinical indication, allowing doses to be optimized for the clinical aims of the test.

2. Design of Dental Radiography Facilities

The radiation protection considerations of a planned new installation of dental X-ray machines (including the expected use of hand-held units) must be thoroughly assessed by the employer in cooperation with a qualified RPO. This will allow any building works to take all these factors into consideration and avoid additional expenses and delays from having to make changes at a later point. It should also guarantee that the required engineering controls and design features are in place from the outset. Additionally, whenever existing X-ray equipment is relocated or substantially altered or whenever the design, layout or working conditions of a room changes, an RPO must be contacted. Although they will be in a good position to provide a first opinion, it is not suitable to rely only on the advice of the firm delivering or installing the X-ray machine [6].

2.1 Design Considerations

A summary of the key issues is given below:

i. The radiographic workloads to be used for calculation purposes should be the maximum foreseeable in the long term.
ii. Dental X-ray equipment should be installed in a room or area from which all persons whose presence is unnecessary can be readily excluded while X-rays are being produced.
iii. This room or area should not be used for other work or as a passageway whilst radiography is in progress.
iv. Either the room should be large enough to allow the operator to stand at a safe distance from the X-ray set and well away from the direction of any intra oral primary X-ray beams, or a protected area should be provided for the operator inside the room (this does not apply to hand-held X-ray equipment).
v. The shielding requirements for the walls, doors and other boundaries of the room should be determined on a case-by-case basis, taking into account the use and occupancy of areas adjacent to the room regardless of their distance from the X-ray tube head and patient – this is particularly important for dental CBCT equipment where the radiation output per examination may be significantly higher than for other types of dental X-ray equipment.

vi. The exposure switch and mains on/off switch (or emergency stop) should be clearly labelled and installed at, or as close as possible to the operator’s position; It should not be necessary for the operator to pass through the intra oral X-ray beam or approach the X-ray tube head to reach the on/off switch in the event of an accident.
vii. The equipment should be selected, installed and used in such a way that any potential inadvertent or unauthorized use can be prevented (e.g., by means of a key switch on the control panel, ensuring that ‘wireless’ exposure switches are kept under the constant care of the operator, use of a PIN or password to lock the exposure controls or installing the exposure switch inside a wall mounted lockable box).
viii. The operator must be provided with a means of observing the patient throughout the exposure, from his or her normal position – options may include a suitably positioned mirror, a shielded viewing panel or a camera and TV screen if the operator stands outside a shielded door or behind a shielded barrier (The College of General Dentistry, 2020).

3. Classification of X-rays in Dental Settings

There are mainly two types of dental X-rays: intraoral and extraoral. Intraoral means that the X-ray film is inside the mouth, while extraoral means that it is outside the mouth. Most dental X-rays are intraoral X-rays, which are taken inside the mouth. These X-rays show a lot of detail and let your dentist find cavities, check the health of the tooth root and bone around the tooth, see how your teeth are coming in and keep an eye on the overall health of your teeth and jawline. Extraoral X-rays show the teeth, but the jaw and skull are the key things they look at. Because these X-rays don't show as much detail as intraoral X-rays, they can't be used to find holes or problems with individual teeth. Extraoral X-rays are used to look for impacted teeth, track the growth and development of the jaws in relation to the teeth and find potential problems between the teeth and jaws and the temporomandibular joint (TMJ). Temporomandibular disorders (TMDs) are a group of more than 30 conditions that cause pain and dysfunction in the jaw joint and muscles that control jaw movement. “TMDs” refers to the disorders, and “TMJ” refers only to the temporomandibular joint itself. People have two TMJs; one on each side of the jaw.) or other bones of the face [6].

3.1 Types of Dental X-Ray Machines

a. Intra-Oral Radiography: An X-ray film is kept in the mouth to capture the X-ray picture, which comprises all the specific details about teeth arrangement, root canal infection and identifying caries. Categories of intra-oral X-ray images are:

i. Periapical images. It provides information of root and surrounding bone areas containing three to four teeth in the single X-ray image.
ii. Bitewing images. It generally helps in detecting the information of upper and lower tooth arrangements, and an X-ray beam shows the dentist how these teeth are arranged with one another and how to spot a cavity between teeth. Bitewing X-rays may also be used to ensure that a crown is fitted correctly (a tooth-enclosing cap) or tooth restoration is done accurately. It can also detect rotting or damaged fillings.
iii. Occlusal images. Occlusal X-rays provide insight into the mouth’s base, revealing the upper or lower jaw’s bite. They place a strong emphasis on children’s tooth development and placement. Extra-oral radiography. An X-ray picture is taken from outside the mouth to capture the entire skull and jaws region. Extra-oral X-rays are classified into many types.

b. Panoramic X-rays. X-rays are full-sized and capture the overall tooth structure. Also, the pictures provide information about the skull and jaw. These images are mainly used to examine fractures, trauma, jaws diseases, pathological lesions and evaluate the impacted teeth.

c. Cephalometric X-rays. Also known as caph X-ray depicts the jaw’s whole part, including the entire side of the head. It is employed in both dentistry and medicine for diagnosis and clinical preparation purposes.

d. Sialogram. It uses a substance that is infused into the salivary glands to make them visible on X-ray film. Doctors may recommend this check to ensure problems with the salivary glands, such as infections or Sjogren’s syndrome signs (a symptom condition identified by sore mouth and eyes; this condition may cause tooth decay).

e. Computed Tomography (CT). It is an imaging technique that gives insights into 3D internal structures. This kind of visualization is used to identify maladies such as cysts, cancers and fractures in the face’s bones.

f. Cone-beam Computed Tomography (CBCT). It generates precise and high-quality pictures. CBCT is an X-ray type that generates 3D visions of dental formations, soft tissues, nerves and bones. It helps in guiding the tooth implants and finding cysts and tumefaction in the mouth. It can also find issues in the gum areas, roots and jaws structures. CBCT is identical to standard dental CT in several respects [7].

3.2 Physics of Dental X-Rays Machine

The tooth is a low-attenuation static item that places relatively little demand on X-ray generation when radiographed directly (Figure 1). The image receptor is positioned in the mouth and exposed to external radiation. An intraoral examination is a standard, affordable approach, with bitewing examinations being the most frequent. When a full set of teeth needs to be radiographed, both the image receptor and the X-ray source must be located outside of the patient. The X-ray beam must also pass through the patient's head, which necessitates a powerful X-ray generator and intricate motion control for the X-ray tube and image receptor. The intraoral examination and this process, known as OPG, yield 2D images that are typically acquired on film but are increasingly being captured in electronic format. Specially designed CT machines, most recently including CBCT have been created for specific situations where dental diagnosis requires 3D information [8]. A narrow beam of X-ray is generated by an X-ray machine. This beam travels throughout the body and gets images of our teeth and jaws on special film or digital sensors inside the mouth (intraoral X-rays) or on film or sensors outside the mouth (extra-oral X-rays) [1].

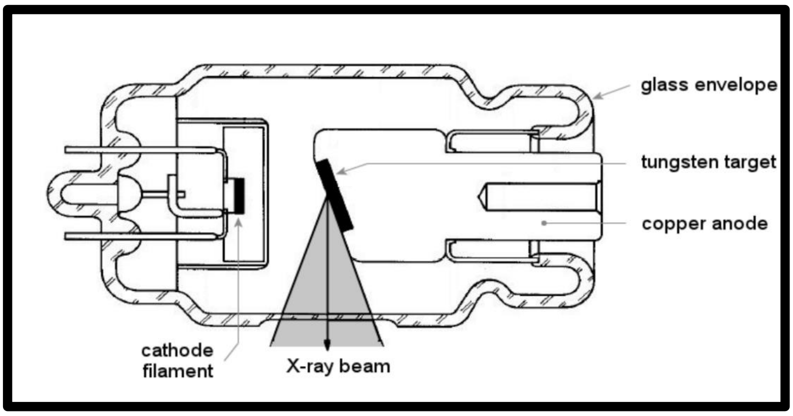

Fig. 1. Dental X-ray tube with a stationary anode

3.2.1 Intraoral radiography

The intraoral X-ray tube is a small, effective device with a stationary target that uses a very low tube current (a few milliamperes) to operate. The X-ray generator usually is very simple, frequently having a constant tube voltage and tube current, and only allows output adjustments by changes in exposure time. The stability of the tube head and the beam collimation are two major issues with this technology. The focus-to-patient surface distance (FSD) must meet international standards, which call for 200 mm. The use of a collimating attachment, which also confines the beam to the area of the mouth being radiographed, ensures this [9].

3.2.2 OPG

An OPG (panoramic X-ray) image is produced by complex equipment as the X-ray tube and image receptor assembly rotate horizontally around the patient's head. Importantly, the image receptor travels within the assembly as well, behind a lead aperture. The technology combines both the tomography and more crucially, the panoramic photography principles. Consider the panoramic camera used in photography to demonstrate this approach. In this case, an acquisition aperture was utilized to expose an image plate, which is then positioned behind the aperture slit to capture the image of a 'panorama' while the camera slowly rotates to scan a scene. Similarly, as the tube rotates around the rear of the head, a narrow vertical fan beam of X-rays acquires a panoramic image of the teeth. To capture the image, the image receptor is moved behind the aperture at the same time. This imaging scenario is non-isotropic, with normal projection radiography principles providing vertical magnification. The horizontal magnification is regulated by the image receptor's speed behind the acquisition slit and its relationship to the projected picture of the teeth. This is modified, however, so that the resulting image has equal magnification in both directions [9].

3.2.3 Dental dosimetry

The dosimetry of dental examinations is a topic of significant interest due to the high frequency of these radiographic treatments. In IAEA Technical Reports Series No. 457 provide comprehensive coverage of the pertinent principles and measuring techniques employed in the field of dosimetry. Nevertheless, it is vital to engage in a discourse pertaining to the scale and potential ramifications of those dosages. Significant discrepancies in recorded doses across different X-ray facilities have been observed. A recent study conducted in Europe revealed that the mean incidence air kerma (IAK) for an intraoral bitewing projection ranged from 1 to 2 mGy, accompanied by a comparable measurement of kerma area product (KAP) ranging from 20 to 40 mGy-cm2. It is anticipated that the dose would be considerably higher in facilities employing slower films. The data obtained through OPG exams, as well as from various sources in Europe, revealed a range of KAP values spanning from 40 to 150 mGy-cm2. However, determining the population-effective dose is challenging due to the intricate arrangement of important organs. In general, the mandible is surrounded by a limited number of radiosensitive organs. An exception can be observed in the case of the thyroid gland. Nevertheless, it is not advisable for well-collimated X-ray equipment to directly expose this organ to radiation. However, it is likely that the organ will still get a significant amount of dispersed radiation. Additional organs that are vulnerable to radiation exposure include the red bone marrow located in the jaw. Furthermore, it is important to consider the role of the brain in this context. The salivary glands, which are exposed to significant levels of radiation, should also be considered. The International Commission on Radiological Protection (ICRP) 103 has incorporated them as an additional organ in the computation of the effective dose.

Estimations of the effective dose for OPG examinations have been conducted. The average value of approximately 7 µSv was derived from the previous weighting factors established by the ICRP in its publications. The estimation of weighting factors based on ICRP 103 has been subjected to varying assessments. In the field of dentistry, there is a need for augmentating the effective dosage within the range of 50 to 400 %. Due to the utilization of a large field of view (FOV), CBCT units exhibit significantly greater effective doses compared to OPG. The estimated dose for a complete FOV ranges from 60 to 550 µSv, which is notably lower than the effective doses associated with traditional head CT, approximately 2 mSv [9].

There are several different types of X-ray equipment used in dental radiology. The results of numerous studies using various dosimeters show that the CBCT dosage is significantly higher than that of other devices, which is why CBCT use should be restricted to the patient's requirements. Reducing the ionizing danger of medical radiation is one of the dentist's primary duties. In CBCT, it is advised to use a lead apron, restrict the FOV and shield the thyroid measures that must be taken to lower the dosage of exposure. The "ALARA" principle is being followed with the usage of certain systems, according to the results of all the research employing different dosimeters that were described above. Thus, it is crucial to inform patients and dentists alike about the application of this evolutionary system and its minimal impact on the quality of life [10].

4. Framework for Radiation Protection in Dental Radiology

IAEA published safety report series No. 108, entitled Radiation Protection in Dental Radiology, with the goal to provide guidance for complying with the requirements for radiation protection and safety in the use of ionizing radiation in dental radiology. This safety report has been developed for dentists, dental specialists, other dental professionals, referring medical practitioners (e.g., physicians, dentists), medical radiation technologists (e.g., radiographers), medical physicists, radiation protection specialists, manufacturers and regulatory bodies. In addition to these professional organizations, patients and the public may find publication a useful source of information [11].

This safety report includes guidelines for the justification of medical exposure, the appropriateness of dental radiological procedures and the optimization of radiation protection and safety for patients, carers, as well as for dental staff, with special attention paid to children and pregnant women. It also provides guidelines for dental radiological equipment, including considerations of quality assurance, dosimetry and operation [12].

5. Biological Effect of Ionizing Radiation

There are two main biological effects of radiation: Stochastic effects, which refer to the potential for future tissue and body damage and; Tissue reactions (deterministic effects) with a more immediate supra-threshold dose-related severity. Somatic stochastic effects refer to the possibility of cancer and derive their name from the random (stochastic) nature of the radiation-matter interaction. In addition to somatic effects, ionizing radiation has the potential to produce genetic effects (also known as "hereditary anomalies"). Such effects have not been observed in humans, despite their documentation in non-human organisms. It is conceivable for somatic stochastic effects to occur in dental radiology. It is believed that there is no dose threshold for the occurrence of stochastic effects (the 'linear, non-threshold theory'). Theoretically, a single DNA mutation could result in carcinogenic effect. However, it is essential to realize that even if many cells undergo mutations, cancer will not result. In reality, cellular repair mechanisms significantly diminish this likelihood.

However, the probability of stochastic effects is deemed to be proportional to the administered dose regardless of how small the dose may be. The probability of stochastic effects occurring is assumed to be additive and proportional to the dose, whereas the severity of cancer is independent of the dose administered. When a dose exceeds a particular threshold, tissue reactions occur. The formation of cataracts, hair loss and skin injuries are examples of tissue reactions. Rather than their likelihood of occurring, tissue reactions are proportional to the dose administered to the tissue. In dental radiology, tissue reactions are extremely unlikely to occur outside of specific circumstances, such as accidents caused by equipment failure or human error, or conceivably cataracts. These formation owes to exposure to high doses. The effects of radiation on a developing foetus is dependent on the gestational age and the amount of radiation absorbed. Radiation hazards are greatest during organogenesis and the early fetal period, decrease slightly during the second trimester and reach their lowest point during the third trimester.

In the first two weeks after conception, relatively high exposure is most likely to result in failure to implant or an undetectable miscarriage; malformations are unlikely or extremely rare. During the period of major organogenesis, beginning in the third week after conception, doses above a certain threshold may cause tissue reactions (e.g., mental retardation, organ malformation), particularly in the organs under development at the time of exposure, with the developing central nervous system being most radiosensitive between weeks 8 and 15. This threshold is higher than what is typically reached in diagnostic X-ray imaging procedures [12].

Many studies investigating formation and cytotoxicity markers have been conducted, but these studies have limitations due to the use of bio-monitoring assays that are not sensitive enough to detect changes at low doses and a statistical analysis approach that does not account for confounding factors. Overall, the scientific literature on the possible biological implications of dental X-rays is limited and there is no strong indication of health impacts based on decades of research on low dose ionizing radiation (10 mGy). Studies involving higher doses of radiation (e.g., skull radiographs, sinus radiographs or head CT) and significant work with Japanese atomic bomb survivors have found no evidence of an elevated cancer risk below 0.1 Gy [13].

6. Radiation Dose in Dental Settings

For radiation protection purposes, special dosimetric quantities have been developed. As recommended by the International Commission on Radiation Units and Measurements (ICRU) and the ICRP and used in IAEA publications, the following are the basic quantities used for radiation protection:

a. Absorbed Dose, D, with unit gray (Gy); a physical non-stochastic quantity is defined simply as the ratio in Eq. (1):

$$D = \frac{d\,\varepsilon}{d\,m} \tag{1}$$

where, dℇ is the expected value of the energy transferred to matter of mass, dm, by any ionizing radiation. The absorption dose is measured in the same units as the kerma, namely joules per kilogram (J/kg) or gray (Gy). Because of the penetrating nature of ionizing radiation, when a large volume is irradiated, radiation from other regions, often quite far from the volume of concern, can impart energy to the matter in that volume. Because the absorbed dose comprises all contributions that impart energy in the volume of interest, it is difficult to establish a relationship between the absorbed dose and the fluence of the incident radiation. Indeed, knowing the radiation fluence in the volume of interest, including scattered radiation, is required for calculating the absorbed dose [9].

It’s measured in terms of absorbed dosage multiplied by a multiplier that varies depending on the kind of radiation. For example, a 0.1 Gy absorbed dosage of α radiation is more hazardous than a 0.1 Gy received dose of β or γ radiation. It was used to expose the damage caused in biological systems by various kinds of radiation [10].

b. Kerma, K and Collision Kerma

The physical, non-stochastic quantity kerma (K) is related to the energy transferred from uncharged particles to matter. Kerma is the acronym for kinetic energy released per unit mass. It is defined as in Eq. (2):

$$K = \frac{\mathrm{d}\,\varepsilon_{\mathrm{tr}}}{\mathrm{d\,m}} \tag{2}$$

where, the quantity dℇ$_{tr}$ is the expectation value of the energy transferred from indirectly ionizing radiation to charged particles in the elemental volume dV of mass dm. The SI unit of kerma is joules per kilogram (J/kg), which is given the special name gray (Gy). There are some important remarks about Kerma:

i Kerma may be defined in any material, so it is important that the material is declared when a value of kerma is presented.
ii Kerma is defined for indirectly ionizing radiation uncharged particles such as photons and neutrons and is related to the first step of transfer of energy from these particles to matter, in which uncharged particles transmit kinetic energy to secondary charged particles.
iii The kinetic energy transferred to the secondary particles is not necessarily spent in the volume (dV) where they were liberated. The kerma definition is constrained to the energy the secondary particles receive now of liberation [9].

The energy transferred from indirectly ionizing radiation to charged particles may be spent in two ways which are (i) Collisions resulting in ionizations and (ii) Conversion to photons.

Accordingly, the kerma can be divided into two parts:

$$K = K_{col} + K_{rad} \tag{3}$$

The collision kerma (K_{col}) is related to that part of the kinetic energy of the secondary charged particles that is spent in collisions, resulting in ionization and excitation of atoms in matter. In terms of the quantities defined before, collision kerma is obtained from the expectation value of the net energy transferred by Eq. (4):

$$K_{col} = \frac{d\varepsilon_{tr}^{net}}{dm} \tag{4}$$

The radiative kerma (K_{rad}) is related to that portion of the initial kinetic energy of the secondary charged particles that is converted into photon energy. It is simpler to define radiative kerma as the difference as in Eq. (5):

$$K_{rad} = K - K_{col} \tag{5}$$

The division of kerma in those two components is more didactic than conceptual. It helps the understanding of the relationship between kerma and absorbed dose [9]. Kerma and absorbed dose have the same units and are both associated with the measurement of radiation-matter interaction. In addition to the primary distinction that kerma is employed to measure a radiation field while absorbed dose is employed to quantify the consequences of radiation, it is imperative to underscore several noteworthy aspects within their respective definitions. One notable distinction is in the significance of the volume of interest with respect to these values. In the case of kerma, it denotes the location where energy is transferred from uncharged particles to charged particles. Conversely, in absorbed dose, the volume of interest pertains to the region where the kinetic energy of charged particles is expended. In the case of kerma, the calculation solely incorporates the energy transfer resulting from interactions involving uncharged particles inside the specified volume. Conversely, absorbed dosage encompasses the whole energy deposited within the specified volume. Hence, the contribution of charged particles entering the specified region of interest is limited to the absorbed dose, whereas kerma remains unaffected. Furthermore, within the designated region, photons have the ability to release charged particles, which may subsequently exit the region and carry a portion of their kinetic energy with them. The energy is encompassed under the concept of kerma; nonetheless, it does not contribute towards the absorbed dose. Significant disparities in absorbed dose and kerma are primarily observed at material interfaces due to variations in ionization density and scattering characteristics of the materials involved. The alterations in kerma observed at the boundaries exhibit a discrete, incremental pattern, which is proportionally scaled by the values of the mass energy transfer coefficient. Conversely, the modifications in absorbed dosage manifest a progressive progression, encompassing a region with dimensions that are comparable to the ranges of secondary particles. In the field of radiology, the term "kerma" refers to the quantity of radiation energy absorbed in a material per unit [14].

a. **Effective Dose:** The tissue-weighted total of the equivalent dosages in all the body’s designated tissues and organs is the effective dosage, E, which is measured in sievert (Sv).
b. **Equivalent Dose**: It’s measured in terms of absorbed dosage multiplied by a multiplier that varies depending on the kind of radiation. For example, a 0.1 Gy absorbed dosage of α radiation is more

hazardous than a 0.1 Gy received dose of β or γ radiation. The equivalent dose is used to expose the damage caused in biological systems by various kinds of radiation. The sievert, Sv, is the SI unit of dosage. The equivalent dosage rate is measured in microsieverts per second (mSv/s) or microsieverts per hour (mSv/h) [15-19].

7. Specific Quantities for Patient Dose Estimation

It is very important to have a way of figuring out a patient's dose that is clear, accurate and easy to use. In oral radiology, imaging can be done with different kinds of X-ray machines. Each of these methods works in a different way and makes images in a different way. So, different dosimetric numbers must be used to measure the amount of medicine given to a patient. Table 2 gives the overview of specific quantities [20].

Table 2
Overview of specific quantities for patient estimation in dental radiology

Dose quantity	Modality	Symbol	Common Abbreviation	Unit
Incident air kerma	Intraoral radiography	K_i	IAK	mGy
Entrance surface air kerma	Intraoral radiography	K_e	ESAK, ESD	mGy
Air kerma-area product	Panoramic radiography, cephalometric radiography, cone beam computed tomography	P_{KA}	KAP, DAP	mGy.cm^2
Air kerma-length product	Computed tomography, Panoramic radiography	P_{KL}	DLP	MGy.MM
CT air kerma index	Computed tomography, cone beam computed tomography	C	CTDI	mGy

8. Conclusions

The identification and establishment of reference levels serve as a tool for monitoring the practice to protect the patients. It will enable FANR and the health sector regulators in each Emirate in the UAE to address discrepancies in doses for a given examination in a specific set of patients and promote practice changes.

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