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Latin American Countries' Regulations On Requirements Of The Installation Site, X-Ray Generating Equipment, Occupationally Exposed Worker And Radiological Protection In Dentistry

Research Article

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Abstract

The purpose of the present study is to analyze regulations of Latin American countries regarding the requirements of the installation site, X-ray generating equipment, occupationally exposed worker, and radiological protection in dentistry. AGoogle search of the Regulatory Authority´s website of each country was performed,and then the "snowball" sampling technique was carried out. The information was organized in tables according to four categories of analysis.A total of 138 regulations corresponding to 18 countries were analyzed. The regulations of Mexico, Uruguay, Dominican Republic, and Nicaragua are clear, precise, and complete because: a) they divide the requirements of the medical and dental areas, b) they detail the information they request, c) they include requirements established in the norms and recommendations of international bodies. In conclusion, in orderfor the applicant and the holder of the authorization of the installationto have a better understanding of the regulations, thesemust be clear, precise, and complete. In addition, they must contain a chapter with specific requirements for each type of X-ray generating equipment used in dentistry. Finally, they must incorporate requirements on the collaboration of the Oral and Maxillofacial Radiologist Specialist, the radiographic diagnosis, and the disposal of liquids used in the development process.

Keywords: Latin America; Government Regulation; Dentistry; Radiology.

Introduction

In the health area, X-ray generating equipment is used to expose the patient to ionizing radiation for justified diagnostic purposes [1]. Since ionizing radiation is harmful to humans [1], there are norms and recommendations of the installation site, use of X-ray generating equipment, occupationally exposed worker (OEW), and radiological protection. These are established by internationalorganizations such asInternational Atomic Energy Agency (IAEA)[2], Pan American Health Organization (PAHO) [3], and the International Commission on Radiological Protection (ICRP) [4, 5]. These international norms and recommendations can be adopted by countries in their national regulations. Additionally, a Regulatory Authority (RA) exists in each country which is defined as an "entity legally empowered to exercise regulatory control" of sources that emit ionizing radiation [5]. Therefore, the RA must ensure compliance of the national regulations that control the use and installation of X-ray generating equipment [6], as well as grant or deny the authorizationto the interested person(s).

In relation to the international recommendations, some studies have analyzed their implementation within the national regulations of Korea and Ireland [7, 8]. Regarding national regulations, the regulations of ionizing ultraviolet radiation have been analyzed in Brazil, Europe and Canada [9-11]. In South Africa [12], they mention some of the requirementsthey demand to the licensee responsible for the installation (LRI) and the OEW to acquire a license touse X-ray generating equipment. However, in the literature no studies were found that analyze the current information on national regulations of Latin American countries relating the

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requirements of the installation site, X-ray generating equipment and radiological protection in dentistry.

The purpose of the present study is to analyze regulations of Latin American countries on requirements of the installation site, X-ray generating equipment, OEW and radiological protection in dentistry.

Materials And Methods

The present study is a qualitative, diagnostic and descriptive literature review with content analysis. The information collection was carried out in two ways. First of all, a specific search was performed through the Google platform to identify the RA´s website of each Latin American country and find their national regulations. Likewise, a general internet search was carried out to identify the regulations of the Latin American countries that were not found at the RA´s website. In addition, the "snowball" sampling technique was carried out, which consisted of contacting experts on the subject of the present studyby e-mail. The experts considered were the representatives of the RAs of each country and also personal contacts Specialist in Oral and Maxillofacial Radiology (OMR) who had knowledge of the regulations of their country. A first contact was made with the experts and if no response was received, a second and last time was contacted. The OMRs that responded provided general information on regulations in their country. The RA of each Latin American country was consulted about the validity of the regulations found through the internet searches and the possible existence of additional regulations to those present on their website.

The inclusion criteria used in the present study were: a) national regulations of Latin American countries in which their official language is Spanish or Portuguese; b) national regulations on the requirements of the installation site, X-ray generating equipment, OEW and radiation protection applied to dentistry, c) national regulations that were found through the search on the Google platform regardless of its official publication date and d) national regulations sent by the experts via email. The exclusion criteria were: a) requirements of the installation site and ionizing radiation generating equipment other than X-rays, b) countries that did not specify in their regulation or that it was not possible to verify by the sampling technique, if the requirements they belong to a dental or medical installationsite and c) the national regulations that were confirmed to be repealed and/or replaced by a new regulation.

Four categories of analysis and a series of subcategories for each of them were established. These were determined through the reading of documents that establish the requirements considered as objectives of the present study, these being: a) the IAEA Safety Standards [2],b) the PAHO Recommendations [3] and c) the ICRP Recommendations [4]. The categories and subcategories of analysis are shown in Figure 1. Finally, the categories and subcategories of analysis were organized in tables, showing the results of each of the countries.

Figure 1. Categories and subcategories of analysis.

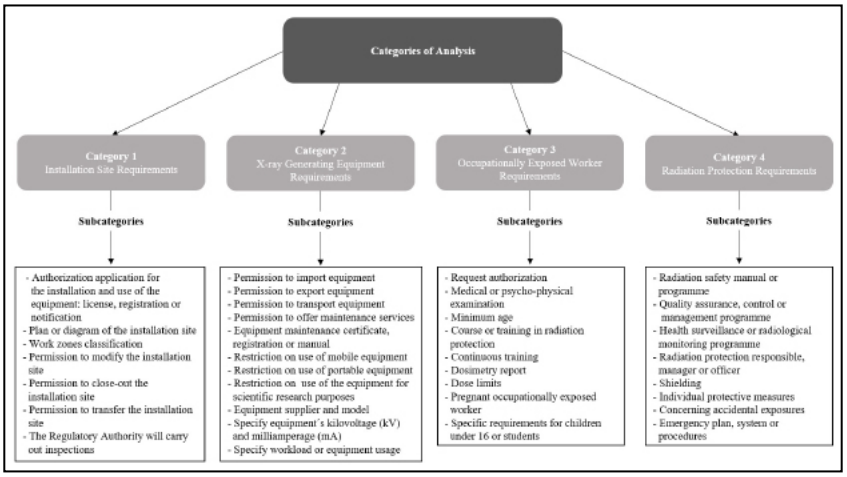

Figure 2. Analyzed and excluded countries.

Results

A total of 138 regulations corresponding to 18 Latin American countries were analyzed. Figure 2 shows the analyzed countries and excluded countries of the present study. These regulations were included in laws, decrees, norms, agreements, resolutions, and regulations. It alsowas found that the RA can be: a) the Ministry of Energy, b) the Ministry of Environment, c) the Ministry of Health, d) a dependency of the Ministries of Energy, Environment or Health, or e) an entity created specifically.

35 experts considered for the present study were contacted by email, of which 11 representatives from the following countries replied: Chile, Colombia, Costa Rica, El Salvador, Honduras, Mexico, Panama, Dominican Republic, Uruguay, Brazil and Venezuela. In this way, it was found that in Honduras and Costa Rica a new regulation is currently being developed, which is close to its publication. Similarly, it was found that Argentina and Chile, in addition to their national regulations, have specific regulations for each region of the country.

As a general result in the present study, it was found that the 18 countries analyzed establish sanctions for non-compliance with regulations. On the other hand, it was found that the websites of the RAs of Argentina [13], Costa Rica [14], and Colombia [15] have the list of people and/or companies authorized to offer technical services, such as shielding or dosimetry.

Category 1. Installation Site Requirements

Table 1 shows the installation site requirements. Regarding the requirement of authorization application for the installation and use of the equipment: license, registration or notification, some countries such as El Salvador [16], Peru [17], and the Dominican Republic [18] separate the requirements of the X-ray generating equipment used in dentistry into categories: intraoral (or conventional) and extraoral (or panoramic). These countries require a license for extraoral equipment and a registration for intraoral equipment, with the exception of El Salvador which only requires a notification for the installation of intraoral equipment.16 However, regardless of the separation of X-ray generating equipment or not into categories, it was found that when a registration is requested, the requirements are less compared to those when requesting a license. On the other hand, Colombia [19] and Guatemala [20] are the only countries that establish requirements for Cone Beam Computed Tomography (CBCT), which is also one of the equipment used in dentistry.

In addition, it was found that once the validity period of the authorization ceases, its renewal is required in almost all of the analyzed countries, except in Argentina, which on the RA´s website states that the authorization is permanent as long as it is not modified [13].

Table 1. Installation Site Requirements.

Country	Authorization application for the installation and use of the equipment: license, registration or notification	Plan or diagram of the installation site	Work zones classification	Permission to modify the installation site	Permission to close-out the installation site	Permission to transfer the installation site	The Regulatory Authority will carry out inspections
Argentina	Cadastral registry	✓	X	✓	Only needs to notify	Only needs to notify	✓
Brazil	Cadastral registry License: extraoral equipment	Only for extraoral equipment	✓	✓	✓	X	✓
Chile	License	X	X	X	✓	X	X
Colombia	License	✓	✓	✓	✓	✓	✓
Costa Rica	License	X	✓	✓	✓	✓	✓
Cuba	X	X	✓	✓	✓	✓	X
Ecuador	Registration and License	✓	✓	✓	X	Only needs to notify	✓
El Salvador	License: extraoral equipment Notification: intraoral equipment	✓	✓	✓	✓	✓	✓
Guatemala	License	X	✓	✓	✓	✓	✓
Honduras	License	✓	✓	X	X	✓	X
Mexico	License	✓	✓	✓	X	✓	✓
Nicaragua	License: extraoral equipment Registration: intraoral equipment	✓	✓	✓	Close-out license: extraoral equipment Unsuscribe: intraoral equipment	✓	✓
Panama	Registration	X	X	✓	✓	✓	✓
Paraguay	Registration	✓	✓	X	Unsuscribe	✓	✓
Peru	License: extraoral equipment Registration: intraoral equipment	X	✓	P	Close-out license: extraoral equipment	Only when it is license	✓
Dominican Republic	License: extraoral equipment Registration: intraoral equipment	✓	✓	✓	Close-out license: extraoral equipment	✓	✓
Uruguay	Registration	✓	✓	✓	Only needs to notify	X	✓
Venezuela	Registration	✓	✓	✓	X	✓	✓

✓: the country has the requirement

X: the country does not have the requirement

Other Installation Site Requirements

In Nicaragua21 it is established as a requirement to present the procedures done before the purchase of a new X-ray generating equipment. On the other hand, some countries such as Nicaragua [21], Ecuador [22], Chile [23], Costa Rica [24] and, Honduras [25] request a certificate or permit to operate the equipment. Additionally, Mexico [26] establishes that the suppliers of X-ray generating equipment must request the manufacturer or distributor abroad to certify that the equipment meets the requirements established in the national regulations.

Some countries such as Chile [23] and Mexico [26] request to present an operating permit. Venezuela [27] establishes that the interested person must present the Construction Project´s Sanitary Conformityor the Environmental Sanitary Conformity. Argentina [28] requests authorization from the National Atomic Energy Commission.

Other countries such as Argentina [28] and Paraguay [29] establish that the authorization application for the installation and use of the equipment must be an affidavit. Guatemala [30] establishes that when the permission to close-out the installation site is requested, the interested person must submit an affidavit regarding the final destination of the X-ray generating equipment. In addition, some countries establish requirements on: a) the waiting room [26, 27, 29, 31], b) the correct development of the radiographic films [31-33], c) the storage area for radiographic films [26, 27, 31, 32], d) the interpretation area [26, 31, 33],e) the toilets for patients [27, 29, 31, 34] and f) the firefighting equipment [21, 34].

Category 2. X-ray Generating Equipment Requirements

Table 2 shows the X-ray generating equipment requirements. Regarding the requirement of specify workload or equipment usage, Brazil [32] and Venezuela [33] also require to keep a record of each radiographic procedure performed. In particular, Uruguay [31] specifies that each radiographic procedure must be registered and archived for 5 years. Moreover, Mexico [26] establishes that in facilities where more than 50 radiographic procedures are performed per working day, a Quality Assurance Committee responsible for the quality assurance programme must be created. Argentina [34] is the only country that establishes that in dental installations sites with exclusive dedication for radiographic procedures, there must be an OMR.

As to the requirement of permission to offer maintenance services, the Dominican Republic [18] establishes that the interested person must present requirements such as: a) radiation safety manual, b) quality assurance programme, c) assignmentof a person responsible for protection and d) procedure manual for repair, maintenance and calibration of the equipment.

Other X-ray Generating Equipment Requirements

Brasil [32] establishes that every six months the X-ray generating equipment suppliers must notify the RA about the equipment they have sold in the country.

Specifically, Venezuela [35] establishes that radiographic examinations for theft detection purposes are considered unjustified.

Category 3. Occupationally Exposed Worker Requirements

Table 3 shows the OEW requirements. Regarding the requirement of request authorization, Colombia [37] establishes that the OEW must also request a radiological protection credential from the RA. Specifically in Cuba [38], the authorization granted to the OEW is for life. Moreover, in some countries where the OEW does not need to submit a request for authorization to do the

Table 2. X-ray Generating Equipment Requirements.

Country	Permission to import equipment	Permission to export equipment	Permission to transport equipment	Permission to offer maintenance services	Equipment maintenance certificate, registration or manual	Restriction on use of mobile equipment	Restriction on use of portable equipment	Restriction on use of the equipment for scientific research purposes	Equipment supplier and model	Specify equipment´s kilovoltage (kV) and milliamperage (mA)	Specify workload or equipment usage
Argentina	X	X	✓	X	✓	✓	✓	X	X	Only kV	✓
Brazil	P	X	✓	✓	✓	X	X	✓	✓	✓	✓
Chile	X	X	X	✓	✓	✓	X	X	X	X	X
Colombia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Costa Rica	✓	✓	✓	✓	X	✓	✓	X	✓	Only kV	X
Cuba	✓	✓	✓	X	✓	✓	✓	✓	X	X	X
Ecuador	✓	X	✓	✓	✓	✓	X	X	✓	✓	X
El Salvador	✓	✓	X	✓	✓	✓	✓	✓	✓	Intraoral equipment: kV Extraoral equipment: kV, mA	✓
Guatemala	✓	✓	✓	X	✓	✓	✓	✓	X	✓	X
Honduras	✓	✓	✓	✓	✓	X	X	✓	✓	✓	✓
Mexico	✓	✓	X	✓	✓	X	✓	X	✓	✓	✓
Nicaragua	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Panama	✓	X	✓	X	X	X	X	X	✓	✓	✓
Paraguay	✓	✓	X	✓	✓	X	X	✓	✓	✓	✓
Peru	✓	X	✓	✓	X	X	X	✓	X	X	X
Dominican Republic	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	✓
Uruguay	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	✓
Venezuela	✓	X	X	✓	✓	✓	✓	✓	X	X	✓

✓: the country has the requirement
X: the country does not have the requirement

work, it is the LRI that must guarantee that the OWE is qualified to work correctly [16, 27, 32].

Regarding the requirement of medical or psycho-physical examination, which is part of the OEW's health surveillanceprogramme, some countries such as Cuba [36] and Brazil [32] establish to carry them out not only at the beginning of their contract, but also permanently.

Regarding the requirement of course or training in radiation protection, some countries such as Peru [17], Venezuela [27] and Mexico [39] specify that the OEW must pass a written exam on radiation safety and protection applied by the RA. Colombia [37] requires a written exam only to Radiology Technicians and Technologists. Guatemala [30] requires Radiology Technicians to obtain recognition from the Civil Association of Diagnostic Radiology and Radiant Therapy of Guatemala in order to be eligible for the operator's authorization.

Regarding the requirement of continuous training, some countries establish that the LRI is in charge of facilitating this training to the OEW [26, 32, 33]. On the other hand, in Cuba [33] and Panama [40] it is required that it should be carried out by the radiation protectionresponsible, manager orofficer.

Regarding the dosimetry report requirement, the LRI must keep a record of the values indicated by the dosimeters the OEW wears [2]. Some countries such as Paraguay [29], Venezuela [35] and Cuba [36] establish that the LRI must keep the dosimetry report until the OEW has 75 years of age or 30 years after he or she ceases to work in the installation site.Moreover, Costa Rica [24] establishes suspension of the authorization for three months to the OEW that does not deliver its dosimeter for analysis for two consecutive times. On the other hand, Brazil [32] establishes that the obligation of the OEW to use a dosimeter may not be necessary in dental installationssites with intraoral equipment that have a workload of less than 4 milliamps per minute per week.Referring to the requirement of dose limits, Costa Rica [24] sanctions the OEW for exceeding the limits established in its regulation and may even cancel the OEW license in case of receiving a second call of attention. Ecuador establishes that the RA will notify the LRI when the OEW has exceeded the dose limits. Consequently, in order not to continue exceeding the dose limit, the OEW may work at the installationsite only if the working conditions are adequate [22].

Regarding the requirement for pregnant OEW, the LRI must adapt the working conditions of the pregnant OEW so that during the gestation period she is exposed as little as possibleto radiation [22, 26, 29].

Other Occupationally Exposed Worker Requirements

Ecuador [22] and Uruguay [41] establish that the LRI must present the obligations and tasks that each OEW performs during their working hours. Peru [42] establishes that the OEW enjoys a physical rest every six months in addition to their vacation period.

Category 4. Radiation Protection Requirements

Table 4 shows the radiation protection requirements. Regarding the requirement of radiation safety manual or programme, the LRI has to be in charge of its elaboration [30]. However, in Ecuador [22] the RA made an “Instructional Form for Radiation

Table 3. Occupationally Exposed Worker Requirements.

Country	Request authorization	Medical or psycho-physical examination	Minimum age	Course or training in radiation protection	Continuous training	Dosimetry report	Dose limits	Pregnant ocupationally exposed worker	Specific requirements for children under 16 or students
Argentina	✓	X	X	Course in health radiophysics	✓	✓	✓	✓	X
Brazil	X	✓	18 years old	Training	✓	✓	✓	✓	✓
Chile	✓	✓	18 years old	Course	✓	✓	✓	✓	X
Colombia	Credential	X	16-18 years old	Training	✓	✓	✓	✓	✓
Costa Rica	Registration	✓	16-18 years old	Course	X	✓	✓	✓	✓
Cuba	✓	✓	18 years old	Training	✓	✓	✓	✓	✓
Ecuador	✓	✓	18 years old	Training	✓	✓	✓	✓	✓
El Salvador	X	✓	Over 18 years old	Training	✓	✓	✓	✓	✓
Guatemala	✓	Only when the Regulatory Authority deems appropriate	18 years old	Course	X	✓	✓	✓	✓
Honduras	✓	✓	16-18 years old	Certificate that proves competence	X	✓	✓	✓	X
Mexico	Registration	✓	18 years old	Training	X	✓	✓	✓	✓
Nicaragua	✓	✓	18 years old	Training	✓	✓	✓	✓	✓
Panama	Only the radiation protection manager	X	X	Training	✓	✓	X	✓	X
Paraguay	✓	X	Over 18 years old	Course	✓	✓	✓	✓	✓
Peru	✓	✓	18 years old	Training	✓	✓	✓	✓	✓
Dominican Republic	✓	✓	16-18 years old	Certificate	✓	✓	✓	✓	✓
Uruguay	✓	X	X	Training	✓	✓	X	✓	X
Venezuela	✓	✓	18 years old	Course	✓	✓	✓	✓	✓

✓: the country has the requirement

X: the country does not have the requirement

Table 4. Radiation Protection Requirements.

Country	Radiation safety manual or programme	Quality assurance, control or management programme	Health surveillance or radiological monitoring programme	Radiation protection responsible, manager or officer	Shielding	Individual protective measures	Concerning accidental exposures	Emergency plan, system or procedures
Argentina	X	✓	X	X	✓	X	X	✓
Brazil	✓	✓	X	Manager	✓	✓	X	X
Chile	X	X	X	X	X	✓	X	X
Colombia	✓	✓	Only for extraoral equipment and oral tomograph	Officer: for extraoral equipment and oral tomograph Manager: for intraoral equipment	✓	✓	✓	Only for extraoral equipment and oral tomograph
Costa Rica	X	✓	✓	X	X	✓	X	X
Cuba	✓	✓	✓	Officer	X	✓	✓	✓
Ecuador	✓	X	X	Responsible	✓	✓	✓	X
El Salvador	✓	✓	✓	Responsible: for extraoral equipment	✓	✓	✓	✓
Guatemala	✓	✓	✓	Manager: for extraoral equipment and oral tomograph	X	✓	X	✓
Honduras	✓	✓	✓	X	X	✓	✓	✓
Mexico	✓	✓	X	X	✓	✓	X	X
Nicaragua	X	✓	✓	Officer: for extraoral equipment	✓	✓	✓	✓
Panama	✓	✓	✓	Officer: for extraoral equipment Responsible: for intraoral equipment	X	X	✓	✓
Paraguay	✓	✓	✓	Officer or responsible	✓	✓	✓	✓
Peru	X	X	✓	X	X	✓	X	X
Dominican Republic	✓	✓	✓	Manager	✓	✓	✓	✓
Uruguay	✓	✓	✓	X	✓	✓	✓	✓
Venezuela	✓	✓	✓	X	✓	✓	X	✓

P: the country has the requirement

X: the country does not have the requirement

Protection Standards" which the LRI only has to share and hand over to the OEW.

Regarding the requirement of radiation protection responsible, manager or officer,it was found that the requirements to be an officer are greater compared to those required to a responsible or manager.Additionally, Brazil [32] requires naming a responsible technician who must also meet the requirements to perform his specific task.In Paraguay [29], it is established that for dental installationssites with intraoral or extraoral X-ray generating equipment, due to justification,a responsible for radiation protection could be namedinstead of a radiation protection officer.

In reference to the requirement of individual protective measures, Uruguay [31]] specifies about the care of lead clothing.

Regarding the requirement concerning accidental exposures, Colombia [19] establishes to implement the Institutional TechnovigilanceProgramme to identify adverse events and incidents associated with the radiological practice.

Other Radiation Protection Requirements

Some countries such as Paraguay [29], Uruguay [31], Brazil [32], and Venezuela [35] establish that adequate protection must be provided to those accompanying patients. Only Mexico [26] and Dominican Republic [43] require a discard system of the liquids used in the radiographs developing process. The regulations of the other analyzed countries refer to the disposal of radioactive substances, residues, waste or materials.

El Salvador [16], Uruguay [31], Brazil [32], Venezuela [33], Cuba [36], and Colombia [37], establish that there must be an order, request or prescription for taking a radiographic to a patient.El Salvador [16] also determines that information management systems must be established to guarantee the confidentiality of patient information.

Some countries such as Argentina [13], Colombia [19], Mexico [26], and Brazil [32] establish that a radiation physicist or consultant specialized in radiation protection must calculate the shielding of the installation site. On the other hand, Uruguay [31] establishes that the protocol to be followed for each radiographic procedure must be kept alongside the equipment control console.

Discussion

The present study is the first carried out in Latin America with the objective of analyzing regulations of Latin American countries on requirements of the installationsite, X-ray generating equipment, OEW and radiological protection in dentistry.

The IAEA considers regulations to be effective only if they are properly carried out [2]. Several studies have analyzed the role of the RA in the regulation of radiation protection [6] and the application of ionizing radiation regulations in medical exposure by treating clinicians [44-46]. Regarding the analyzed regulations in the present study, the role of the RA in each country and com-

pliance with the requirements in accordance with the established regulations is unknown. However, it is possible to ensure that the analyzed regulations of Mexico, Uruguay, the Dominican Republic, Venezuela and Nicaragua are clear, precise and complete. This has been considered since these countries meet the following criteria: a) the regulations divide the requirements of the medical and dental areas, b) the requirements are explicit by detailing more information of what they request and c) the regulations include requirements established in the standards and recommendations of international bodies [2-4].

It is important to note that most of the Latin American countries´analyzed regulations do not specify the requirements for CBCT. However, some countries use the term Extraoral Equipment or Computed Tomography in their regulations [16, 26, 29], which could be interpreted as referring to CBCT. It is recommended for each country to implement specific requirements in its regulations for each type of X-ray generator equipment used in dentistry. This is due to the fact that they have different radiation dose values [47] and therefore require different management and radiological protection measures.

On the other hand, it is worth mentioning that Argentina was the only country that within its regulations requires the collaboration of an OMR [34]. Nowadays, the OMR is recognized as a specialist dentist in more than 50 countries. The OMR has the specific competencies to perform correctly with the use of X-ray generating equipment [48]. The implementation of this requirement can improve the installation and use of X-ray generating equipment, as well as radiation protection. Furthermore, it is important to note that none of the Latin American countries´ regulations analyzed refers to the mandatory radiographic interpretation in dentistry. Radiographic interpretation is essential to determine the clinical diagnosis and consequently the patient´s treatment [48]. Without a radiographic interpretation, valuable information on the patient's health condition can be missed, for this reason it is ideal to incorporate this requirement.

Also, the ICRP establishes the application of radiological and ethical protection measures during the use of X-ray generating equipment [5]. Regarding this, in the present study it was evidenced that approximately half of the Latin American countries do not establish restrictions when using mobile and/or portable equipment and neither when it is used for scientific research purposes. Therefore, it is essential that countries implement these requirements in their regulations because they could be receiving a higher dose of radiation by not taking adequate radiation protection measures.

On the other hand, the regulations of most of the Latin American countries analyzed tend to refer to the disposal of radioactive substances or materials. The IAEA defines radioactive material, substance or waste as that which has radioactivity or radionuclides [49]. In dentistry, this type of materials, substances or waste is not generated, on the contrary, a liquid waste with low-risk silver particle content is generated. To dispose of this liquid waste, it is necessary to hire an authorized company to do it [1]. In the present study, it was found that few countries require a system to dispose of liquids used in the radiographs developing process. Therefore, it is recommended that Latin American countries regulations use the correct terminology or implement this requirement.

The limitations of the present study include the access difficulty and availability of the information on regulations of the analyzed Latin American countries, due to the fact that only some of the RA representatives responded to the email sent. Also, it is unknown whether the analyzed Latin American countries implement correctly their regulations. It is suggested that new studies can investigate the compliance of regulations in Latin American countries and the work of the RA regarding the issuance and control of authorizations.

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Conclusion

It is necessary for the RA of each country to present the updated regulations on the internet to facilitate access to the information, as well as to have digital customer service to resolve any doubts that the applicant may have. On the other hand, for the authorization applicant, as well as the LRI to have a better understanding of the regulations, it is important that these are clear, precise and complete. For this to happen, the RA must orientate in norms and recommendations established by international bodies, as well as request their collaboration. In addition, it is necessary that the regulations contain a chapter with specific requirements for the dental area, differentiating them from those of the medical area. Similarly, they must differentiate the requirements for each type of X-ray generating equipment used in dentistry and establish their respective radiation protection requirements. Finally, the regulations must incorporate requirements on the collaboration of the OMR, on a mandatory radiographic interpretation and on the disposal of liquids used in the radiographsdeveloping process.

References

[1]. White SC, Pharoah MJ (2009)Oral Radiology Principles and Interpretation. (6thedn), Elsevier, Missouri.

[2]. Organismo Internacional de Energía Atómica. Protección Radiológica y Seguridad de las Fuentes de Radiación: Normas Básicas Internacionales de Seguridad. Noviembre 2016. Accessed: july 04, 2021.

[3]. Organización Panamericana de la Salud. Guía de gestión e incorporación de tecnología, radiología de propósitos generales. 2009. Accessed: july 04, 2021.

[4]. International Commission on Radiological Protection (2007) Publication 103 the 2007 recommendations of the International Commission on Radiological Protection. Ann ICRP37(22-4):1-116.

[5]. International Commission on Radiological Protection (2018)Publication 138 ethical foundations of the system of radiological protection. Ann ICRP 47(1):1-65.

[6]. Arias CF. La regulación de la protección radiológica y la función de las autoridades de salud [Regulatingradiologicalprotection and the role of healthauthorities]. RevPanam Salud Publica. 2006 Aug-Sep;20(2-3):188-97. PubMedPMID: 17202020.

[7]. Cho KW, Kim YM. Implementation of the ICRP 2007 recommendations in Korea. ApplRadiatIsot. 2009 Jul-Aug;67(7-8):1286-9. PubMedPMID: 19299151.

[8]. Lee AM, Lee MJ. Radiation safety awarenessamong medical interns: are EU guidelinesbeingimplemented? Ir J MedSci. 2017 Aug;186(3):547-553. PubMedPMID: 27844336.

[9]. Silva AA. OutdoorExposure to Solar UltravioletRadiation and Legislation in Brazil. HealthPhys. 2016 Jun;110(6):623-6. PubMedPMID: 27115230.

[10]. Görig T, Schneider S, Greinert R, Breitbart EW, Diehl K. Are tanningsalons in compliancewith German law? Anevaluationbasedon a nation-

widerepresentativesurvey. PhotodermatolPhotoimmunolPhotomed. 2018 Mar;34(2):106-111. PubMedPMID: 28875578.
[11]. Gosselin S, McWhirter JE. Assessingthecontent and comprehensiveness of provincial and territorial indoortanninglegislation in Canada. Health-PromotChronicDisPrev Can. 2019 Feb;39(2):45-55. PubMedPMID: 30767854.
[12]. Noffke CE, Snyman AM. South African legislation for radiation control in dentistry: a review. SADJ. 2007 Nov;62(10):438, 440, 442-5. PubMed PMID: 18500105.
[13]. Ministerio de Salud de Argentina. Habilitación de equipos de rx. Accessed: july 04, 2021. Available in: https://www.argentina.gob.ar/habilitacion-de-equipos-de-rx
[14]. Ministerio de Salud de Costa Rica. Prestadores de servicios autorizados en radiaciones al 14 de enero del 2020. Enero 2020.Accessed: july 04, 2021. Available in: https://www.ministeriodesalud.go.cr/index.php/informacion/radiaciones-ionizantes
[15]. Ministerio de Salud y Protección Social de Colombia. Licencias de prestación de servicios de protección radiológica y control de calidad. Diciembre 2020. Accessed: july 04, 2021. Available in: https://www.minsalud.gov.co/salud/MT/Paginas/radiaciones-ionizantes.aspx
[16]. Ministerio de Salud de El Salvador. Acuerdo no 1706-BISReglamento Especial de Protección y Seguridad Radiológica[Internet].San Salvador; 18 de octubre de 2018 [cited on july 04 of 2021]. Available in: http://www.jurisprudencia.gob.sv/DocumentosBoveda/D/2/2010-2019/2018/10/CF664.PDF
[17]. Ministerio de Energía y Minas de Perú. Decreto Supremo no 039-2008-EM Reglamento de la Ley No 28028, Ley de Regulación del Uso de Fuentes de Radiación Ionizante [Internet].Lima; 19 de julio de 2008 [cited on july 04 of 2021]. Available in: http://www.ipen.gob.pe/transparencia/regulacion/normatividad/reg_ley_28028.pdf
[18]. Comisión Nacional de Energía de República Dominicana. Resolución 1/97 Norma para la Autorización de Prácticas Asociadas al Empleo de Radiaciones Ionizantes[Internet]. Santo Domingo de Guzmán; 12 de diciembre de 1997[citedonjuly 04 of 2021]. Available in: https://www.cne.gob.do/wp-content/uploads/2015/11/norma-para-la-autorizacion-de-practicas.pdf
[19]. Ministerio de Salud y Protección Social de Colombia. Resolución no 482por la cual se Reglamenta el Uso de Equipos Generadores de Radiación Ionizante, su Control de Calidad, la Prestación de Servicios de Protección Radiológica, y se dictan otras Disposiciones[Internet].Bogotá; 22 de febrero de 2018[cited on july 04 of 2021].
[20]. Ministerio de Energía y Minas de Guatemala. Rayos x – diagnóstico dental.2020. Accessed: july 04, 2021. Available in: https://www.mem.gob.gt/que-hacemos/area-energetica/proteccion-y-seguridad-radiologica/rayos-x-diagnostico-dental/
[21]. Ministerio de Salud de Nicaragua. Guía para solicitar autorización para la práctica de radiología convencional e intervencionista. Octubre 2011. Accessed: july 04, 2021.
[22]. Comisión Ecuatoriana de Energía Atómica de Ecuador. Decreto Supremo no3640 Reglamento de Seguridad Radiológica [Internet]. Quito; 08 de agosto de 1979 [cited on july 04 of 2021].
[23]. Ministerio de Salud de Chile. Decreto 133 Aprueba Reglamento Sobre Autorizaciones para Instalaciones Radiactivas o Equipos Generadores de Radiaciones Ionizantes, Personal que se Desempeña en Ellas, u Opere tales Equipos y Otras Actividades Afines [Internet]. Santiago; 23 de agosto de 1984 [cited on july 04 of 2021].
[24]. Ministerio de Salud de Costa Rica. Decreto no 24037-SReglamento Sobre Protección Contra las Radiaciones[Internet]. San José; 08 de marzo de 1995 [cited on july 04 of 2021].
[25]. Secretaría de Energía, Recursos Naturales, Ambiente y Minas de Honduras. Acuerdo Ejecutivo no 003-2014 Reglamento de Autorizaciones para Instalaciones Radiactivas y Equipos Generadores de Radiaciones Ionizantes [Internet]. Tegucigalpa; 10 de octubrede 2014 [cited on july 04 of 2021].
[26]. Comité Consultivo Nacional de Normalización de Regulación y Fomento Sanitario de México. Norma Oficial Mexicana 229-SSA1-2002Requisitos Técnicos para las Instalaciones, Responsabilidades Sanitarias, Especificaciones Técnicas para los Equipos y Protección Radiológica en Establecimientos de Diagnóstico Médico con Rayos X [Internet]. Ciudad de México; 15 de septiembre de 2006[citedonjuly 04 of 2021].
[27]. Ministerio de Salud de Venezuela. Resolución 401Norma Sanitaria para la Autorización y el Control de las Radiaciones Ionizantes en Medicina, Odontología y Veterinaria [Internet]. Caracas; 27 de noviembre de 2006 [cited on july 04 of 2021].
[28]. Ministerio de Bienestar Social de Argentina. Decreto no 6320Reglamentación de la Ley 17.557[Internet]. Buenos Aires;30 de octubre de 1968 [cited on july 04 of 2021].
[29]. Autoridad Reguladora Radiológica y Nuclear de Paraguay. Resolución D-ARRN no26/2016 por la que se Modifica el Reglamento Básico de Protección Radiológica y Seguridad de las Fuentes de Radiación Ionizante de la Autoridad Reguladora Radiológica y Nuclear [Internet]. Asunción; 22 de septiembre de 2016[citedon july 04 of 2021].
[30]. Ministerio de Energía y Minas de Guatemala. Acuerdo Gubernativo no55-2001Reglamento de Seguridad y Protección Radiológica de la Ley para el Control, Uso y Aplicación de Radioisótopos y Radiaciones Ionizantes[Internet]. 14 de febrero de 2001 [cited on july 04 of 2021].
[31]. Autoridad Reguladora Nacional en Radioprotección de Uruguay. Norma UY 108 Seguridad Radiológica en Radiodiagnóstico Médico y Odontológico Rev. II [Internet]. Montevideo; 29 de julio de 2014 [cited on july 04 of 2021].
[32]. Ministério da Saúde, Secretária de VigilânciaSanitária da Brasil. Portaria Federal no 453 Aprova o Regulamento Técnico que Establece as Diretrizes Básicas de Proteção Radiológica em Radiodiagnóstico Médico e Odontológico [Internet]. Brasilia; 2 de junio de 1998 [cited on july 04 of 2021].
[33]. Fondo para la Normalización y Certificación de la Calidad de Venezuela. Norma Venezolana Covenin 218-1:2000 Protección Contra las Radiaciones Ionizantes Provenientes de Fuentes Externas Usadas en Medicina Parte 1: Radiodiagnóstico Médico y Odontológico (1ra Revisión) [Internet].Caracas; 28 de marzo de 2001 [cited on july 04 of 2021].
[34]. Ministerio de Salud de Argentina. Resolución 610/2004 Apruébanse las Normas de Organización y Funcionamiento de Servicios de Diagnóstico y Tratamiento por Imágenes en Establecimientos con o sin Internación [Internet]. Buenos Aires;6 de julio de 2004 [cited on july 04 of 2021].
[35]. Fondo para la Normalización y Certificación de la Calidad de Venezuela. Norma Venezolana Covenin 3496:1999Protección Radiológica Medidas de Seguridad para la Protección Contra las Radiaciones Ionizantes y las Fuentes de Radiación (Provisional) [Internet]. Caracas; 15 de septiembre de 1999 [citedonjuly 04 of 2021].
[36]. Ministerio de Ciencia, Tecnología y Medio Ambiente, y Ministerio de Salud Pública de Cuba.Resolución Conjunta CITMA- MINSAP Normas Básicas de Seguridad Radiológica [Internet].La Habana; 04 de enero de 2002 [citedonjuly 04 of 2021].
[37]. Ministerio de Salud de Colombia. Resolución no 9031 por el cual se Dictan Normas y se Establecen Procedimientos Relacionados con el Funcionamiento y Operación de Equipos de Rayos X y Otros Emisores de Radiaciones Ionizantes, y se Dictan otras Disposiciones [Internet]. Bogotá; 12 de julio de 1990 [cited on july 04 of 2021].
[38]. Ministerio de Ciencia, Tecnología y Medio Ambiente, y Ministerio de Salud Pública de Cuba.Resolución Conjunta CITMA- MINSAP Reglamento para la Selección, Capacitación y Autorización del Personal que Realiza Prácticas Asociadas al Empleo de Radiaciones Ionizantes [Internet]. La Habana; 24 de marzo de 2004 [citedonjuly 04 of 2021].
[39]. Comité Consultivo Nacional de Normalización de Regulación y Fomento Sanitario, y Comisión Nacional de Seguridad Nuclear y Salvaguardias de México. Norma Oficial Mexicana NOM-031-NUCL-2011 Requisitos para el Entrenamiento del Personal Ocupacionalmente Expuesto a Radiaciones Ionizantes [Internet]. Ciudad de México; 26 de octubre de 2011 [citedonjuly 04 of 2021].
[40]. Ministerio de Salud de Panamá. Resolución no 0026 que Reglamenta la Categorización del Personal Encargado de Protección Radiológica [Internet]. Ciudad de Panamá; 11 de enero de 2017[citedonjuly 04 of 2021].
[41]. Ministerio de Industria, Energía y Minería de Uruguay. Guía de autorización para instalaciones y actividades asociadas. Mayo 2019. Accessed: july 04, 2021.
[42]. Congreso de la República de Perú. Ley 30646Ley que Regula el Descanso Físico Adicional del Personal de la Salud por Exposición a Radiaciones Ionizantes o Sustancias Radiactivas [Internet]. Lima; 17 de agosto de 2017 [cited on july 04 of 2021].
[43]. Comisión Nacional de Energía de República Dominicana. Guía de seguridad y protección radiológica para la práctica de diagnóstico con rayos x.Accessed: july 04, 2021.Available in:
[44]. Grange S. Vital guide to radiography and radiationprotection. Vital. 2009 Dec;7(1):43-6.
[45]. Rout J, Brown J. Ionizingradiationregulations and the dental practitioner: 2. regulationsforthe use of x-rays in dentistry. Dental update. 2012 May 2;39(4):248-53.
[46]. Kiu A, Bano F, Barnes R, Khan SH. IRMER regulations: compliancerate of radiographreportingby non-radiologyclinicians. ClinRadiol. 2010 Dec;65(12):984-8. PubMedPMID: 21070902.
[47]. European Commission. Radiation protection no 172 cone beam CT for dental and maxillofacial radiology (evidence-based guidelines).2012. Accessed: july 04, 2021.Available in:
[48]. Autor et al. 2019.
[49]. IAEA Safety Glossary. Terminology used in nuclear safety and radiation protectión 2018 edition.2019. Accessed: july 04, 2021.Available in: https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1830_web.pdf