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Journal of the Mexican Federation of Radiology and Imaging

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FULL RESEARCH ARTICLE

Knowledge of bioethical principles and elements of responsibility in radiology

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ABSTRACT

Introduction: *Radiologists' participation in diagnosis and interventional therapeutic procedures has bioethical implications and professional responsibilities. We determined the level of knowledge of bioethical principles and elements of responsibility of radiologists and residents in public and private institutions in Mexico.* **Material and Methods:** *We conducted a digital survey to assess the level of knowledge of bioethical principles (beneficence, nonmaleficence, autonomy, and justice), and elements of responsibility. A low-level score was 0 to 9 points; a medium level, 10 to 13 points; and a high level, 14 to 22 points. Responsibility elements included appropriate imaging examination, informed consent, patient protection, radiologic reporting, patient and attending physician communication, continuous education, and continuous quality improvement. A low level of knowledge was 6 to 13 points; a medium level, 14 to 16 points, and a high level, 17 to 29 points.* **Results:** *We included a total of 228 participants,104 (45.6%) radiologists and 124 (54.4%) residents. A medium level of knowledge of bioethical principles was the most frequent in 55 (52.9%) radiologists and 75 (60.5%) residents. There was no statistically significant difference between levels. Residents had higher levels of knowledge of responsibility (n = 49, 39.5%) than radiologists (n = 26, 25.0%). Radiologists had low and medium (n = 39, 37.5%) in each level; in contrast to low (n = 36, 29.0%) and medium levels (n = 39, 31.5%) in residents. There was no statistically significant difference between groups.* **Conclusion:** *A medium level of knowledge of bioethical principles and elements of responsibility in radiologists and residents of public and private institutions was found. This study is the first in Mexico that presents information about radiology specialists.*

Keywords: *Principlism. Principle-Based. Ethics. Bioethics. Elements of responsibility. Radiology.*

INTRODUCTION

Like other health professionals, radiologists focus primarily on scientific knowledge and rarely consider bioethical aspects of the physician-patient relationship[1]. The four bioethical principles of principlism in relation to patient vulnerability are autonomy, beneficence, non-maleficence, and justice[2]. Technological and scientific advances in radiology have led to a dissociation between the benefits of imaging and patients´ human rights. Bioethical dilemmas may arise when performing and interpreting images, such as placing an image over clinical information, overlooking the target, who are patients, subjecting them to various imaging examinations, often without having interviewed or examined them[3], and ethical dilemmas that are thought to arise

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Received for publication: 01-03-2023
Accepted for publication: 30-03-2023
DOI: 10.24875/JMEXFRI.M23000047

Available online: 13-07-2023
J Mex Fed Radiol Imaging. 2023;2(2):98-105
www.JMeXFRI.com

when the right choice is not clear[4]. As technological development increases, so does the risk of inappropriate use[5]. According to the World Health Organization, about 80% of medical decisions are made with imaging studies[6]. The credibility and popularity of imaging have reached a point where it is felt that no treatment can be initiated, or a patient discharged, without an imaging modality[7].

Berlin[8] points out that due to the nature of the procedures in their workplace, the radiologist has become distanced from the patient and is dedicated only to viewing images[9] leaving aside the responsibility associated with thinking over behavior in the face of bioethical dilemmas and decision-making based on technological advances[3,10,11]. Armstrong[3] described the seven basic elements of radiologists' responsibility: appropriate imaging examination, informed consent, patient protection, radiologic reporting, communication with the patient and attending physician, continuous education, and continuous quality improvement. Failure to comply with these elements of responsibility can lead to errors that affect patients[3,12].

Published studies have assessed the knowledge of bioethical principles and elements of responsibility in different medical specialties[13-15], but these have not been assessed in radiology. The radiologist has gradually and imperceptibly lost contact and communication with the patient, with a depersonalized attitude that is more scientific than focused on medical care. This study determined the level of knowledge of the bioethical principles and elements of responsibility of radiologists and residents in public and private institutions in Mexico. The theoretical basis of this study is related to the four bioethical principles that apply to radiology,[2,16] and the seven elements of radiologists´ responsibility[3].

MATERIAL AND METHODS

This cross-sectional, analytical study was conducted from April to September, 2022, in Monterrey, Nuevo Leon, Mexico. Mexican radiologists and residents of either sex, with no age limit, working in public or private institutions who agreed to participate were included. Incomplete questionnaires and physicians or residents from other specialties were not included. Informed consent was obtained. The study was approved by the Bioethics and Research Committees of the Instituto de Investigaciones in Bioetica of Monterrey, Nuevo Leon, Mexico.

Study development and variables

Radiology department heads and colleagues from hospitals were contacted electronically or by telephone in the following cities and states of Mexico: Aguascalientes, Aguascalientes; Mexicali, Baja California; Chihuahua, Chihuahua; Torreon and Saltillo, Coahuila; Guadalajara, Jalisco; Mexico City; Morelia, Michoacan; Monterrey, Nuevo Leon; Oaxaca, Oaxaca; Puebla, Puebla; Matamoros, Nuevo Laredo, and Ciudad Victoria, Tamaulipas. The aim of the study was explained, and the radiologists were invited to participate in the electronic digital survey. A digital consent form was provided, and the survey had a one-week deadline. It took approximately 20 minutes to complete.

The variables recorded were age, sex, public or private institutional affiliation (the affiliation of the radiologists who worked in both institutions was recorded in relation to the institution with the highest number of hours per day), the years of professional practice of the radiologists and the year of education of the residents. In addition, the following questions were asked: Have you ever taken a bioethics course? Would you be interested in taking a bioethics course? Do you think that updating your knowledge of bioethics would be useful in your daily practice?

Instrument to measure knowledge of bioethical principles

The instrument described by Casanova,[17] and Porra[18] was used (Supplementary material, Appendix 1). Knowledge of the bioethical principles, autonomy, beneficence, nonmaleficence, and justice was assessed. The survey included 22 multiple-choice questions that were scored by the author (GOC) as low knowledge, 0 to 9 points; medium knowledge, 10 to 13 points, and high knowledge, 14 to 22 points.

Instrument to measure knowledge of the elements of responsibility

The instrument was based on the seven elements of radiologists' responsibility previously published[3]. The author (GOC) designed a Likert-type questionnaire with 29 items (Supplementary material, Appendix 2). The author (GOC) scored a low level of knowledge of the elements of responsibility as 6 to 13 points, a medium level as 14 to 16 points, and a high level as 17 to 29 points.

Table 1. Characteristics of radiologists and residents

Description	Radiologists (n = 104)	Residents (n = 124)	Total (n = 228)
Public institutions, n (%)	52 (50.0)	119 (96.0)	171 (75.0)
Private institutions, n (%)	52 (50.0)	5 (4.0)	57 (25.0)
Age (years), mean SD ±	47.6 ± 12.97	29.1 ± 2.94	
Age groups, years, n (%)			
< 30	1 (1.0)	80 (64.5)	81 (35.5)
30 to 39	36 (34.6)	42 (33.9)	78 (34.2)
40 to 49	26 (25.0)	2 (1.6)	28 (12.3)
50 to 59	13 (12.5)	0	13 (5.7)
> 60	28 (26.9)	0	28 (12.3)
Year of Residency			
R1	NA	39 (31.5)	39 (31.5)
R2		31 (25.0)	31 (25.0)
R3		31 (25.0)	31 (25.0)
R4		23 (18.5)	23 (18.5)
Years of professional practice of radiologists, n (%)			
1 to 10	46 (44.2)	NA	46 (44.3)
11 to 20	21 (20.2)		21 (20.2)
21 to 30	20 (19.2)		20 (19.2)
31 to 40	12 (11.5)		12 (11.5)
41 to 50	4 (3.9)		4 (3.8)
> 50	1 (1.0)		1 (1.0)
Have you taken a bioethics course? Yes, n (%)	66 (63.5)	90 (72.6)	156 (68.4)
Would you be interested in taking a bioethics course? Yes, n (%)	95 (91.3)	106 (85.5)	201 (88.2)
Do you think that updating bioethics knowledge is useful in daily practice? Yes, n (%)	101 (97.1)	114 (91.9)	215 (94.3)

NA: not aplicable.

Statistical analysis

The sample size was calculated non-probabilistically using simple random sampling. Inference of proportions and comparison of two independent samples were used with a power of 80%. The calculated sample size was 96 radiologists and 96 residents. Categorical variables were described as absolute frequencies and percentages, and continuous variables as means and standard deviations. Knowledge of bioethical principles and elements of responsibility of radiologists and residents was assessed with the chi^2 test for categorical variables and Student's t-test for continuous variables. IBM-SPSS software version 25 (IBM Corp., Armonk, NY, USA) was used for data analysis.

RESULTS

Two hundred twenty-eight questionnaires from 228 participants were completed; 88 (38.6%) were women, and 140 (61.4%) were men. There were 104 (45.6%) radiologists and 124 (54.4%) residents (Table 1). Public institution participation (n = 171, 75.0%) was higher, mainly among residents (n = 119, 96.0%). The mean age of the radiologists was 47.6 ± 12.97 years and 29.1 ± 2.94 years for residents. Participation by age group was lower among radiologists under age 30 (n = 1, 1.0%), in contrast to residents where most participants were under age 30 (n = 80, 64.5%). No significant differences were found in the number of residents per school year. Radiologists between 1 and 10 years

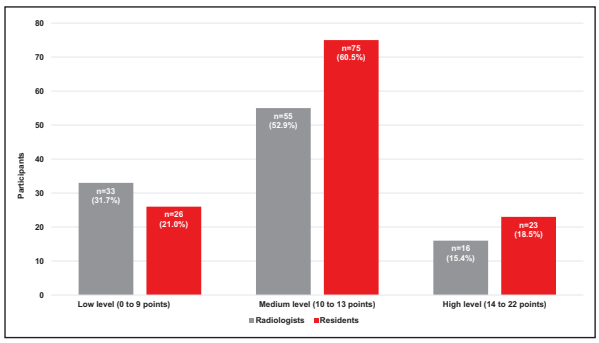

Figure 1. Level of knowledge of radiologists and residents regarding the bioethical principles. A medium level (10 to 13 points) was most common in both groups. Differences were not statistically significant.

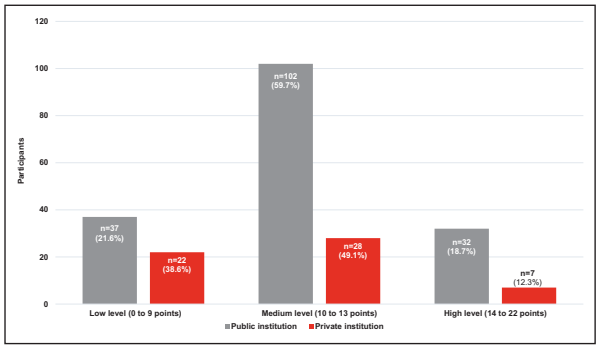

Figure 2. Level of knowledge of bioethical principles according to the type of institution. A medium level was more common among participants from public institutions. A low level was significantly more common in private institutions and a high level in public institutions ($p < 0.05$).

of professional practice after graduation from the specialty had higher participation (n = 46, 44.2%). One hundred fifty-six (68.4%) participants reported having taken a bioethics course; 201 (88.2%) would be interested in taking a bioethics course, and 215 (94.0%) of 228 felt that knowledge of bioethics would be useful in their daily practice. Participation in bioethics courses was higher among radiologists and residents of public institutions; 120 (76.5%) of 156; of these, 66 (42.3%) were radiologists, and 90 (57.7%) were residents.

Level of knowledge of bioethical principles

Figure 1 shows the level of knowledge of radiologists and residents regarding bioethical principles. A medium level (10 to 13 points) was most common in 55 (52.9%) of 104 radiologists and 75 (60.5%) of 124 residents. A high level was more common among residents (n = 23, 18.5%) than radiologists (n = 16, 15.4%). In contrast, fewer residents showed a low level (n = 26, 21.0%) than radiologists (n = 33, 31.7%). These differences were not statistically significant.

The level of knowledge of bioethical principles by type of institution is shown in Figure 2. A medium level was more common, with 102 (59.7%) of 171 participants from public institutions and 28 (49.1%) of 57 participants from private institutions. The low level was significantly more common in private institutions (n = 22, 38.6%) and the high level in public institutions (n = 32, 18.7%) ($p < 0.05$).

The level of radiologists´ knowledge of bioethical principles regarding to the number of years of professional practice was comparable among the different groups (Table 2). Regardless of the years of professional practice, a higher number of radiologists had a medium level. The differences were not statistically significant. The level of knowledge of bioethical principles among residents did not show significant differences in relation to the year of residency (Table 3). Regardless of the year of residency, a medium level of knowledge was most common. A higher proportion of residents with a high level of knowledge was observed in residency year 4 (R4) (n = 7, 30.4%), but the difference was not significant compared with the other years of residency. Figure 3 shows the relationship between the level of knowledge of bioethical principles and whether a bioethics course was taken. There were no statistically significant differences between knowledge levels.

Level of knowledge of the elements of responsibility

Figure 4 shows the level of knowledge of the elements of responsibility of radiologists and residents. A greater number of residents had a high level of knowledge (n = 49, 39.5%) compared to radiologists (n = 26, 25%). On the other hand, more radiologists had a low and medium level (n = 39, 37.5% in each level), in contrast to residents with a low (n = 36, 29.0%) and medium level (n = 39, 31.5%). The differences were not statistically significant.

No statistically significant difference was found with respect to knowledge of the elements of responsibility by type of institution, as the frequency of the different levels of knowledge by institution was very similar (Figure 5). Among radiologists, a medium level of knowledge was found to be predominant in the group with 1 to 10 years of professional practice, whereas a low level of knowledge was higher among radiologists with more than 30 years of professional practice;

Table 2. Level of radiologists' knowledge of bioethical principles regarding number of years of professional practice

Description	Years of professional practice				Total (n = 104)
	1 to 10 (n = 46)	11 to 20 (n = 21)	21 to 30 (n = 20)	> 30 (n = 17)	
Low level, n (%)	13 (28.3)	7 (33.3)	7 (35.0)	6 (35.3)	33 (31.7)
Medium level, n (%)	24 (52.1)	11 (52.4)	10 (50.0)	10 (58.8)	55 (52.9)
High level, n (%)	9 (19.6)	3 (14.3)	3 (15.0)	1 (5.9)	16 (15.4)

Table 3. Level of knowledge of bioethical principles among residents regarding year of residency

Description	Year of residency				Total (n = 124)
	R1 (n = 39)	R2 (n = 31)	R3 (n = 31)	R4 (n = 23)	
Low level, n (%)	4 (10.2)	8 (25.8)	8 (25.8)	6 (26.1)	26 (21.0)
Medium level, n (%)	29 (74.4)	16 (51.6)	20 (64.5)	10 (43.5)	75 (60.5)
High level, n (%)	6 (15.4)	7 (22.6)	3 (9.7)	7 (30.4)	23 (18.5)

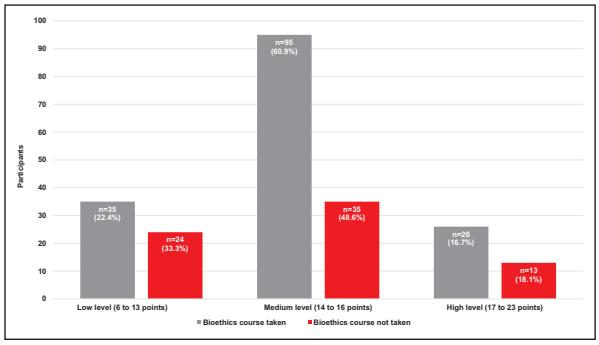

Figure 3. Relationship between the level of knowledge of bioethical principles and whether a bioethics course was taken. There were no statistically significant differences.

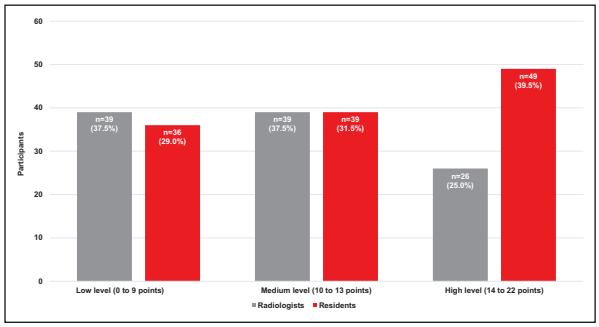

Figure 4. Level of knowledge of elements of responsibility of radiologists and residents. A greater number of residents with a high level of knowledge was observed compared with radiologists. Differences were not statistically significant.

however, the number of radiologists older than 30 was low (n = 17); therefore, this group cannot be considered a representative sample (Table 4).

Regarding the level of knowledge of the elements of responsibility among residents, participants in their first and second years (R1 and R2) achieved the highest level of knowledge of the elements of responsibility (43.6% and 45.2%, respectively) (Table 5). There was no statistically significant difference between the different years of residency and the level of knowledge about the elements of responsibility. Figure 6 shows the relationship between the level of knowledge about the elements of responsibility and whether a bioethics course was taken. No statistically significant differences were found between knowledge levels.

DISCUSSION

We found that a medium level of knowledge of bioethical principles and elements of responsibility prevails among radiologists and residents in public and private institutions in Mexico. It is recommended to support training in residency programs and continuing education courses, to achieve an optimal level of knowledge to provide dignified, fair, and respectful care for patients and to keep in mind that *"Behind an image is a person who deserves personalized care with high scientific quality"* (Figure 7).

The bioethical profile of radiology professionals requires knowledge and application of bioethical and deontological principles. Velázquez et al.[14] conducted a study to measure the bioethical knowledge of 15 general surgeons and 37 residents of the General Hospital of Mexico City. An instrument from the College of Toronto was used based on 4 clinical cases with ethical

Table 4. Level of knowledge of the elements of responsibility by years of professional practice among radiologists

Description	Years of professional practice				Total (n = 104)
	1 to 10 (n = 46)	11 to 20 (n = 21)	21 to 30 (n = 20)	>30 (n = 17)	
Low level, n (%)	14 (30.4)	7 (33.3)	9 (45.0)	9 (52.9)	39 (37.5)
Medium level, n (%)	22 (47.9)	8 (38.1)	7 (35.0)	2 (11.8)	39 (37.5)
High level, n (%)	10 (21.7)	6 (28.6)	4 (20.0)	6 (35.3)	26 (25.0)

Table 5. Level of knowledge of responsibility elements in residents by year of residency

Description	Year of residency				Total (n = 124)
	R1 (n = 39)	R2 (n = 31)	R3 (n = 31)	R4 (n = 23)	
Low level, n (%)	12 (30.8)	4 (12.9)	11 (35.5)	9 (39.2)	36 (29.0)
Medium level, n (%)	10 (25.6)	13 (41.9)	9 (29.0)	7 (30.4)	39 (31.5)
High level, n (%)	17 (43.6)	14 (45.2)	11 (35.5)	7 (30.4)	49 (39.5)

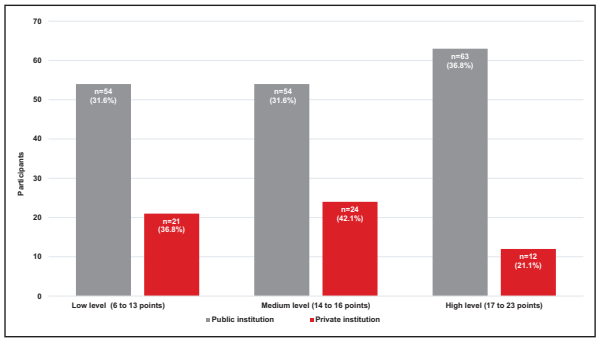

Figure 5. The elements of responsibility show a comparable frequency of the different levels of knowledge by type of institution.

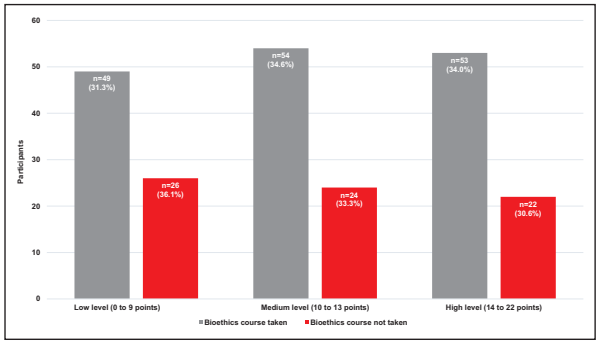

Figure 6. Relationship between the level of knowledge regarding the elements of responsibility and whether a bioethics course was taken. No statistically significant differences were found.

dilemmas related to autonomy, beneficence, and justice[15]. General surgeons performed better than residents in identifying bioethical dilemmas based on bioethical principles. Casanova et al.[17] conducted a study with 20 general surgeons, 20 internists, 16 pediatricians, and 16 obstetrician-gynecologists to determine the level of knowledge of bioethical principles. The survey included 13 questions. The level of knowledge was unsatisfactory, with a mean of 46% correct answers. Pediatricians performed better with 9 (59%) correct responses. No significant differences were found between participants regarding sex, master's or doctoral degree, or history of bioethics training. The authors believed that the better performance of the pediatricians was related to the fact that they had undergraduate studies in bioethics, unlike the other participants who had not received bioethics education during their professional training. Our study found that knowledge of bioethical principles was at a medium level among radiologists and residents. We believe that a medium level of knowledge of bioethical principles is not optimal for providing high-quality care based on bioethical principles.

Radiologists must have relevant knowledge of the elements of tasks and responsibilities to achieve optimal professional performance quality. Tachiquin Sandoval et al.[19] conducted a study in community, general, and specialty hospitals of the health services of Zacatecas, Mexico, to determine the knowledge of responsibility among 861 health professionals, including general practitioners and specialists, interns, general nurses, auxiliary nurses, and nurses from other areas; 267 were physicians. Knowledge of professional responsibility was poor (0.4%). López-Almejo et al.[13] assessed the knowledge of professional responsibility of 130 physicians specializing in orthopedics and

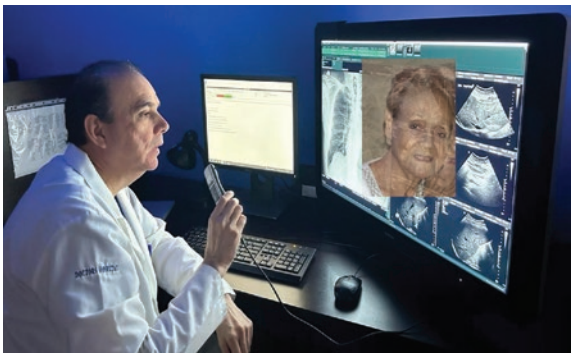

Figure 7. Behind an image, there is a person who deserves personalized care with high scientific quality.

traumatology in hospitals in Mexico City. The instrument included 15 questions on professional responsibility and the legal framework. The mean score was 5.7 (poor). Our study found a predominant medium level of knowledge of the elements of responsibility. There were no significant differences among participants who attended bioethics courses or by type of institution, years of professional practice, and year of residency. Reinforcement of responsibility elements in radiology beyond the medical-legal aspects and recognizing the patient's human rights are necessary[20].

In addition to the cognitive processes for efficient performance, radiologists need knowledge of bioethical principles and elements of responsibility to avoid errors due to ethical misconduct or irresponsibility. Hebert et al.[15] conducted a study to measure ethical sensitivity in 498 medical students in their first four years of undergraduate study at the University of Toronto, Canada. Participants evaluated four clinical cases to identify the bioethical principles of autonomy, beneficence, and justice. The authors found that ethical sensitivity decreases as they progress through the specialty. They suggested that this may result from socialization in 4th-year residency students. In our study, radiologists with fewer years of practice (1-10 years) and first- and second-year residents demonstrated better knowledge levels (medium and high) of bioethical principles and elements of responsibility. The differences were not statistically significant. It is likely that due to the increasing interest in new technologies, radiologists with more years of practice and residents of higher education levels (R3/R4) focus their attention on cognitive aspects with disinterest in patient contact.

The strengths of our study relate to the sample size and the study population, which included radiologists with different years of professional practice and residents with four years of education. The weaknesses relate to the fact that the participants were mostly from public institutions. Some radiologists may practice in public and private institutions, but this was not recorded in the survey.

CONCLUSION

Our study showed that radiologists and residents have a medium level of knowledge about bioethical principles and elements of responsibility. This research arose from an interest in promoting bioethics and deontology courses in radiologists' residency and fellowship programs to increase their knowledge level of bioethics and elements of responsibility and to provide more humane, dignified, responsible, and beneficial care for their patients.

Supplementary data

Supplementary data are available online in the Journal online (DOI: 10.24875/JMEXFRI.M23000047). These data are provided by the corresponding author and published online for the reader's benefit. The contents of supplementary data are the sole responsibility of the authors.

Acknowledgments

The authors thank Professor Ana M. Contreras-Navarro for her guidance in preparing and writing this scientific paper.

Funding

This research received no external funding.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical disclosures

Protection of Individuals. This study complied with the Declaration of Helsinki (1964) and subsequent amendments.

Confidentiality of Data. The authors declare they followed their center's protocol for sharing patient data.

Right to privacy and informed consent. Informed consent was obtained from all participants.

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