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Knowledge and attitude toward theranostics among Nuclear Medicine Technologists

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KNOWLEDGE AND ATTITUDE TOWARD THERANOSTICS AMONG NUCLEAR MEDICINE TECHNOLOGISTS

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Bachelor of Science in Nuclear Medicine Technology

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ABSTRACT

This study was conducted to determine the knowledge and attitude of nuclear medicine technologists toward theranostics. This research utilized a quantitative correlational research design. Data were gathered from 69 practicing nuclear medicine technologists, specifically those that do not perform or have theranostics procedures. The data were gathered using a self-made questionnaire and statistically treated using frequency, percentage, range, mean, standard deviation, *t*-test, ANOVA, Kruskal-Wallis *H* test, Mann-Whitney *U* test, and Spearman Rank Order Correlation.

Findings show that the majority of the respondents are male, and most are 20-30 years old. Most of the respondents have good knowledge and show a "positive attitude" toward theranostics. In general, there are no significant differences in the knowledge of the respondents about theranostics when they are grouped according to sex, years of experience and type of hospital they are currently employed in. However, there is a significant difference when grouped according to age, where the 31–40-year-old group showed a higher level of knowledge than the 20-30-year-old group possibly due to learning more about practices with theranostics. With the respondents' attitude toward theranostics, there are no significant differences when they are grouped according to age, sex, years of experience, and type of hospital they are currently employed in. The findings also show that there is a weak positive relationship between the knowledge and attitude of the respondents toward theranostics. Generally, the results show that nuclear medicine technologists have very good attitude toward and good knowledge of theranostics.

APPROVAL SHEET

This undergraduate thesis entitled, ***Knowledge and Attitude Toward Theranostics among Nuclear Medicine Technologists*** prepared and submitted by Ma. Majella Gerard A. Babia, Sophia Gaile V. Cote, Anita Juliana B. Cuy, Christian Emanuel P. Dimaandal, Isabela Louise Fuentes, and Shawn Pimentel in partial fulfillment of the requirements for the degree Bachelor of Science in Nuclear Medicine Technology, has been examined and is recommended for acceptance and approval for final oral defense.

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The Researchers

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THE PROBLEM AND ITS BACKGROUND

Background of the Study

There are different challenges in the modern management of cancer, such as cancers of the thyroid, digestive tract, renal cell, breast, prostate, gastric, liver, and malignant lymphoma. Some patients are unfit for chemotherapy because of aging and health issues according to a study by Altun and Sonkaya (2018). Chemotherapy can be weakening and life-threatening with the most common side effects such as nausea, vomiting, fatigue, loss of appetite, changes in taste, hair loss, dry mouth, and constipation (Altun & Sonkaya, 2018). For this reason, nuclear medicine has a special approach to improving patient selection, minimizing adverse effects, and improving the effectiveness of therapy called theranostics (Yordanova et al., 2017).

Nuclear medicine is a "specialized medical field within radiology that uses radioactive tracers or radiopharmaceuticals, to assess functions of the body, and structure, and help diagnose and treat diseases". The Society of Nuclear Medicine & Molecular Imaging (SNMMI, 2011) stated that "nuclear medicine is a combination of chemistry, physics, mathematics, computer technology, and medicine in using radioactivity for the diagnosis and treatment of certain diseases".

Theranostics is a relatively new term coined by John Funkhouser (1998) which means "therapeutics and diagnostics". However, looking at the clinical practice, it is being practiced for about 50 years (Levine & Krenning, 2017). Theranostics is a procedure that uses closely related radioactive drugs to identify target-positive lesions and subsequently treat them. Iodine-131 is one of the first radionuclides for diagnosing and treating thyroid cancer. These theranostics procedures have seen new additions, such as gallium-68 and lutetium-177 prostate-specific membrane antigen (PSMA) for prostate cancer and Ga-68 and Lu-177 or yttrium-90 DOTATATE

for neuroendocrine tumors (Levine & Krenning, 2017). Moreover, the theranostics technique is a well-established technology in nuclear medicine for molecular targeting. The visualization of possible targets can aid in determining whether a patient will benefit from a given treatment (Yordanova et al., 2017)

Cancer theranostics, as the name implies, is the combination of therapeutic approaches in cancer diseases and seeks to minimize the waiting time for receiving medical care, and it also appears to be essential for personalized cancer treatment and diagnostics (Chen & Wong, 2014). Moreover, cancer theranostics are used for "fundamental issues related to tumor heterogeneity, cancer progression, natural history, and radiotracer performance", further challenging the advancement of radiopharmaceutical development. The recent emergence of radiopharmaceuticals in cancer and theranostics for treatment selection and monitoring demonstrates the promising use and development of cancer radiopharmaceuticals (Chen & Wong, 2014).

Theranostics was first introduced in the country by Dr. Patricia A. Bautista-Penalosa in the year 2018 at "St. Luke's Medical Center" in Quezon City, with the goal of providing better healthcare alongside the advancement of therapeutic and diagnostic technology in nuclear medicine. The introduction of theranostics in the Philippines was partly motivated by the 122.5% increase in the annual death rate since 1990 with an average of 5.3% per year by the most common cancer among men, prostate cancer (St. Luke's Medical Center, 2018; Philippine Cancer Society). Aside from prostate cancer, an increasing rate of neuroendocrine carcinoma is also a concern.

As of January 2018, only St. Luke's Medical Center – Quezon City and St. Luke's Medical Center – Global City offer theranostics procedures in their hospitals. These hospitals are using

gallium-68 (Ga-68) and lutetium-177 (Lu-177) for Positron Emission Tomography - Computed Tomography (PET-CT) imaging and radionuclide therapy, respectively (St. Luke's Medical Center, 2018; Philippine Cancer Society). These radiopharmaceuticals are used to give alternative treatment when a patient no longer responds to any type of prostate cancer therapy and neuroendocrine carcinoma. Hospitals with theranostics also aim to minimize pain and produce long-term remission for most patients.

The objective of this study is to determine the knowledge and attitude among nuclear medicine technologists toward theranostics. In addition, the researchers wanted to know how nuclear medicine technologists will respond to its emergence in the Philippines. This includes the scrutinization of different aspects of knowledge and attitude and whether they correlate. According to Bergeron (2003) knowledge is about familiarity, awareness, and understanding that come from information that is organized and summarized in a certain area (cited in Pangil & Nasurddin, n.d.). It can also be from a collection of experiences wherein appropriate information can be acquired and retained. As developments in science and technology occur, knowledge has become an essential element of productivity such as in problem-solving and decision making. According to Haradhan Kumar Mahajan (2016), the knowledge of employees within an institution or organization must be sincere as it increases the effectiveness of one's work in the workplace. On the other hand, an attitude "refers to a set of emotions, beliefs, and behaviors toward a particular object, person, thing, or event" (Cherry, 2021). Attitudes also frequently stem from experience or upbringing, and they can have a significant impact on one's behavior. This may have an impact on a person's daily task and may be enduring, but it may also change. However, attitude may be defined in two separate frameworks which are behavioral and cognitive (Ajzen & Fishbein, 1977, as cited in Jain, 2014).

Pieces of knowledge and attitude build an individual's competence which can be used to carry out a task successfully (Lizzio & Wilson, 2004). Seeing it from one standpoint, a person's knowledge may have an impact on his or her attitude about a certain topic. Alternatively, one's attitude may also affect how a person perceives thus, influencing knowledge gains (Schrader & Lawless, 2004). The practice of theranostics needs good knowledge and attitude, which are interdependent to practice. Several factors such as sex, age, type of hospital and years of experience will affect good practice.

The objective of this research is to further appreciate theranostics in advanced healthcare technologies and earlier management of cancer. This research also aims to promote and raise awareness about theranostics among nuclear medicine technologists throughout the country. This study is being conducted to further understand that the field of nuclear medicine is continuously evolving over time, and the nuclear medicine technologist may need to adapt to a more advanced and modernized healthcare setting. With this, hospitals may provide an accurate diagnosis and better quality of therapy to the patients. Since more theranostics procedures were recently introduced in the country (Bautista, 2019), such as Ga-68 PET/CT for scans and Lu-177 for therapy, there has been no extensive research done regarding the knowledge and attitude of nuclear medicine technologists. The right motivation and proper preparation for nuclear medicine technologists are essential, thus, the results of this research are important for identifying the possibility of introducing it to more hospitals in the country. To the researchers, there are no existing research studies that focus on the knowledge and attitude of nuclear medicine technologists toward theranostics.

Statement of the Problems

This research aimed to measure the knowledge and attitude of nuclear medicine technologists toward theranostics.

Specifically, this answered the following questions:

1. What is the profile of the respondents according to age, sex, years of experience, and type of hospital currently employed in?

2. What is the knowledge of the respondents on theranostics?

3. What is the attitude of the respondents towards theranostics?

4. Are there significant differences in the knowledge of the respondents on theranostics when they are grouped according to age, sex, years of experience, and type of hospital currently employed in?

5. Are there significant differences in the attitude of the respondents towards theranostics when they are grouped according to age, sex, years of experience, and type of hospital currently employed in?

6. Is there a significant relationship between the knowledge and attitude of the respondents toward theranostics?

Hypotheses of the Study

This research study tested the following hypotheses:

1. There are no significant differences in the knowledge of the respondents on theranostics when they are grouped according to age, sex, years of experience, and type of hospital currently employed in.

2. There are no significant differences in the attitude of the respondents towards theranostics when they are grouped according to age, sex, years of experience, and type of hospital currently employed in.

3. There is no significant relationship between the knowledge and attitude of the respondents toward theranostics.

Conceptual Framework

Jana (2016) defines knowledge as "perceptions, comprehension, and understanding of an environment" or the context of a situation that guide our conduct in such a way that researchers receive the information needed. Furthermore, knowledge can be defined as a "mixture of framed experience, values, contextual information, and expert insights that acts as a foundation for evaluating and integrating new experiences and information". Knowledge is not merely a collection of facts; rather, it is a uniquely human process that cannot be reduced or recreated easily. Knowledge is closely connected to one's personality, it is connected to behavior and perception, and it is context specific, as the previous definitions demonstrate. As a result, knowledge is linked to a human ability to connect one's or others' experience with the skill and experience to apply information in decision-making, actions, and results.

According to Ajzen (1993, as cited in Issah and Braimah, 2020), an attitude is "a person's tendency to react favorably or unfavorably to an object, behavior, person, institution, event, or any discriminable aspect of the person's world". Although with varying formal definitions, most of the contemporary theorists agree that the attributes of attitude are its evaluative dimension. Attitude is also generally acknowledged as a hypothetical construct. There are essentially no restrictions on the types of responses that can be considered, aside from the need that they indicate positive or negative judgments of the object.

As cited in Ajzen (2005), Fishbein and Ajzen's study in 1975 defines that "attitudes develop according to the beliefs people hold about the object of attitude". Generally, beliefs about something are formed by a person associating it with other objects, characteristics, or events.

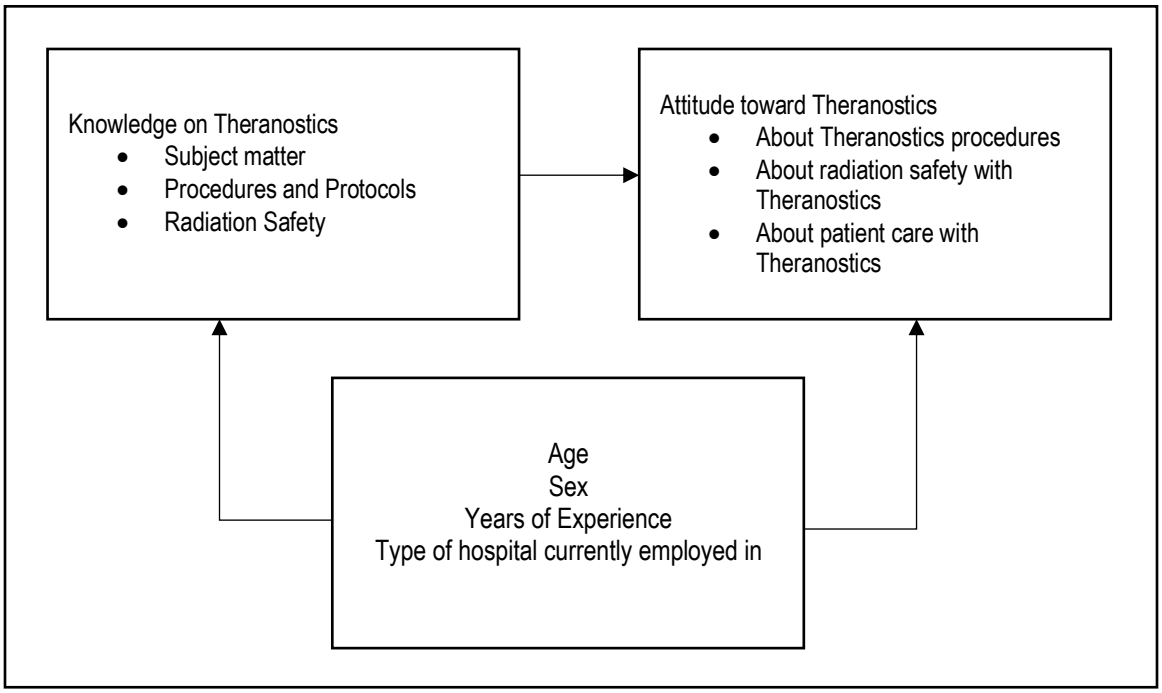

Figure 1. The paradigm of the study.

Figure 1 shows the variables of the study. This research measured the relationship between knowledge and attitude toward theranostics among nuclear medicine technologists. Moreover, this study determined the association of the demographic variables age, sex, years of experience, and type of hospital currently employed into the major variables of the study.

Scope and Limitation of the Study

This research is focused on the knowledge and attitude among selected nuclear medicine technologists in the Philippines toward theranostics.

The respondents of this research include nuclear medicine technologists in hospitals that have nuclear medicine departments and have no experience in theranostics procedures and were

willing to participate in this research. Those from hospitals that offer theranostics services were excluded to avoid data contamination.

The researchers also wanted to know the respondents' profiles which include their age (20-30 years old, 31-40 years old, 41+ years) which was arbitrarily grouped, sex (male and female), years of experience in nuclear medicine (less than 1 year, 3 years, 5 years, 10 years, and more than 10 years), and type of the hospital (government and private) they are currently employed in.

The collection of these demographic variables helped the researchers determine whether these have an effect on the nuclear medicine technologists' knowledge and attitude toward theranostics and its procedures.

The limitation of the study rests on its sample size. There is not a huge number of practicing nuclear medicine technologists throughout the country. Furthermore, the data collection process was done through an online survey which limits the response rate among the target respondents.

Chapter 2

METHODOLOGY

This section comprises the methodologies and procedures that were conducted for this study. The research design, sources of data, population and sampling, research instrument used, data gathering procedure, and statistical treatment of data are discussed in this chapter.

Research Design

A quantitative correlational research design using relationship studies was utilized for this study. Quantitative research design alludes to a “scope of techniques concerned with the orderly examination of social phenomena, utilizing statistical or numerical data”. Thus, quantitative research includes the “estimation and accepts the occurrence of the study that can be measured” (Watson, 2015). Additionally, a correlational research design is the “measurement of two or more factors to determine or estimate the extent to which the values for the factors are related or changed in an identifiable pattern” (Privitera, 2019). It measured how two or more variables are related, not to the limit where one variable causes a change to the other. A correlational research design was used in the study to determine the relationship between the knowledge and attitude of the respondents toward theranostics.

Sources of Data

Data were gathered from practicing nuclear medicine technologists from hospitals throughout the country, specifically those that do not perform or have theranostics procedures. The researchers gathered as many respondents as possible from the existing nuclear medicine facilities throughout the country. However, from this population, those practicing in hospitals that perform theranostics were excluded from the study.

Population and Sampling

The researchers utilized the purposive sampling technique to identify the respondents for the study. Purposive sampling is also known as judgment, selective, or subjective sampling. It is part of non-probability sampling wherein the researchers decide on “a sample based on their knowledge about the study” (Glen, 2021). This type of sampling method is best for this study as the researchers specifically chose nuclear medicine technologists from hospitals throughout the country to participate in the research. There are 69 respondents for this research who are nuclear medicine technologists working in hospitals and have no experience in performing theranostics.

Research Instrument

A self-made questionnaire was used for this study. The questions were formed and divided into three (3) parts. The first part consists of the respondents’ demographic information: age, sex, years of experience, and type of hospital currently employed in and the second and third parts measured the knowledge and the attitude of nuclear medicine technologists toward theranostics, respectively.

For the part of the questionnaire assessing the knowledge of the respondents, a 20-item multiple-choice questionnaire was formed, based primarily on the subject matter of theranostics, its protocols and procedures, and radiation safety.

In scoring the knowledge part, number right scoring was used for multiple-choice questions (Kurz, T., 1999). A positive value of 1 was scored for correct answers and 0 for incorrect answers (Cecilio-Fernandes, D., et al., 2017). For measuring the results of the knowledge part, a score of 0-4 is interpreted as “poor”, 5-8 as “fair”, 9-12 as “good”, 13-16 as “very good”, and 17-20 as “excellent”.

On the other hand, there are 10 questions for the assessment of the respondent's attitude toward theranostics and was in the form of a self-report, 5-point Likert scale. Answers ranged from 1-strongly disagree, 2-disagree, 3-neutral, 4-agree, and 5-strongly agree. This scale consists of a set of opinion statements that can assess the views or perspectives of the respondent, and when put together, it provides information about an attitude (DeFranzo, 2011). For verbal interpretation, the attitude is translated to "highly negative" for a mean score of 1.00-1.49, "negative" for 1.50-2.49, "neither positive nor negative" for 2.50-3.49, "positive" for 3.50-4.49, and "highly positive" for 4.50-5.00.

The design for this questionnaire is based on the study of Schrader and Lawless (2004), where they cited multiple Knowledge, Attitude, and Behavior studies (KAB) that used this type of research instrument design.

Rensis Likert developed the Likert scale in 1932 primarily for attitude measurement. A 5-point Likert scale is typically used to rate the degree to which the respondents agree or disagree with a statement. As discussed by Allen and Seaman (2007), "the use of nonparametric procedures as well as distribution-free methods (such as tabulations, frequencies, contingency tables, and chi-squared tests) are appropriate for analyzing the data from the Likert scale".

The questionnaire was validated by a nuclear medicine consultant from Cardinal Santos Medical Center, a registered medical technologist from St. Luke's Medical Center, a nuclear medicine specialist and the vice chair of the Department of Nuclear Medicine in St. Luke's Medical Center, who all have enough knowledge about theranostics.

Data Gathering Procedure

The data gathering for this research started on February 9, 2022, and ended on February 25, 2022. The researchers wrote a letter to the respondents explaining the objectives and importance of this research and ways to communicate with the researchers for further questions. This letter was signed by the researchers, noted by the thesis adviser, and endorsed by the chairman of the research and development committee before distribution.

After the approval to conduct the study, respondents were given an online survey questionnaire with the use of Google Forms through online messaging platforms (Facebook Messenger, Viber, and Telegram) and e-mail, due to the pandemic. Included in the Google Form were the letter to the respondents and the consent form. Once the respondents fully understood the nature and purpose of this study, the researchers discussed the informed consent within the Google forms, which include the nature of the study and assurance that participation will not put them at risk and their answers were used for research purposes only.

Those who gave their consent continued to answer the questionnaire while those who refused were redirected to a page thanking them for their response and time for reading about the study.

The researchers established a friendly yet professional relationship with the respondents and made sure that all information will remain highly confidential. Only the researchers are able to access all the data gathered. The data will be completely disposed of three (3) years after the completion of this research.

Statistical treatment of data

To support the analysis of the data collected from the respondents, the following statistical methods were used in this study:

Frequency. A frequency is the count of the number of times that a variable occurred (Korb, 2013). In this study, the frequency was used to determine the demographic profile of the respondents according to sex, age, years of experience, and type of hospital currently employed in. Frequency distribution was also used to determine the knowledge on theranostics in terms of its correct and wrong answers.

Percentage. One percent is one-hundredth of the total or whole and is therefore calculated by dividing the total or whole number by 100 (Statistics Canada, 2015). In this study, it was used for the profile of the respondents (age, sex, years of experience and type of hospital). It was also used in the knowledge part with each question that had correct and wrong answers and in interpreting the results of the data (Excellent, Very Good, Good, Fair, Poor).

Mean. The mean is the sum of all values divided by the total number of values which is commonly referred to as the "average" (Zulfigar Ali, 2016). This method was used in the study to determine the average respondents' knowledge and attitude toward theranostics.

Standard deviation. A method of statistical analysis to measure the spread of data around the mean is commonly used to determine the distribution of data points (Calvello, 2020). This method was used in the study to determine the average distance between the values of the data in the set and the mean according to respondents' knowledge and attitude toward theranostics.

t-test for independent means. *t*-test is an inferential statistic to determine if there is a statistical difference between two variables (Javier Fernandez, 2020). This method was used in this

study to determine the significant differences in the knowledge of the respondents toward theranostics according to sex and type of hospital they are currently employed in.

Analysis of Variance. ANOVA is a collection of statistical data and the corresponding estimation procedures and is also a test of how means differ from one another (Sullivan, 2019). This test was used to compare the respondents' knowledge according to their age and years of experience specifically in the 4th problem. Since the demographic profile of age and years of experience has more than two options, ANOVA is the perfect statistical method to use in this area.

Kruskal-Wallis *H* test. Kruskal-Wallis *H* test is a test for determining if samples come from the same population and are used to compare two or more distinct samples with identical or different samples (LaMorte, 2017). It was applied in the 5th problem of this study to simply compare the respondents' attitude towards theranostics with more than two independent variables specifically for the age and years of experience of the respondents. Kruskal-Wallis *H* test was used on attitude because this is a ranking basis Likert scale, and the two demographics namely age and years of experience because these options are a continuous variable.

Mann-Whitney *U* test. The Mann-Whitney *U* test is a non-parametric test used to compare outcomes between two independent sample groups (LaMorte, 2017). This method was used specifically at the 5th problem and was used to compare two sample means from the same population. It was also used to compare the attitude towards theranostics of the respondents according to sex and type of hospital that they are currently employed in.

Spearman Correlation. The Spearman correlation in statistics is a non-parametric alternative to Pearson's correlation, mainly for the data to follow curvilinear monotonic relationships and for ordinal data (Frost, 2021). This was utilized to determine the relationship of the knowledge and attitude of nuclear medicine technologists toward theranostics.

Chapter 3

FINDINGS OF THE STUDY

This chapter consists of the research findings and analysis of the data that were collected during the procedure. Results are discussed and summarized followed by the conclusions and recommendations that the researchers have constructed based on the results of their study.

Results and Discussion

Problem 1. What is the profile of the respondents according to age, sex, years of experience, and type of hospital currently employed in?

Table 1

Profile of the Respondents According to Age

Age	*n*	%
20-30 years old	45	65.2
31-40 years old	18	26.1
41 years old and above	6	8.7

Note. *N* = 69.

Table 1 shows the profile of the respondents according to age. Forty-five (65.2%) respondents are 20-30 years old. Eighteen (26.1%) respondents are from the range of 31-40, and the remaining six (8.7%) are 41 years old and above.

The finding shows that the majority of the respondents are 20-30 years old, which suggests that hospitals have younger nuclear medicine technologists.

Table 2

Profile of the Respondents According to Sex

Sex	*n*	%
Male	37	53.6
Female	32	46.4

Note. *N* = 69.

Table 2 shows the profile of the respondents according to sex. Out of the 69 respondents who work as nuclear medicine technologists, 37 (53.6%) are male, and 32 (46.4%) are female.

The result shows that there are more male than female technologists that responded to this study.

Table 3

Profile of the Respondents According to Years of Experience

Years of Experience	*n*	%
Less than 1 year	21	30.4
1 to 3 years	19	27.5
3 to 5 years	11	15.9
6 to 10 years	11	15.9
More than 10 years	7	10.1

Note. *N* = 69.

Table 3 shows the profile of the respondents according to years of experience in the field of nuclear medicine. Out of 69 respondents, 21 (30.4%) worked as a nuclear medicine technologist for less than one (1) year, 19 (27.5%) worked for 1 to 3 years, 11 (15.9%) for 3 to 5 years, 11 (15.9%) for 6 to 10 years, and seven (10.1%) for more than 10 years.

The finding reveals that most of the respondents have less than a year of experience in the practice of nuclear medicine technology. In contrast, the number of those having 1-3 years of experience is adjacent.

Table 4

Profile of the Respondents According to Type of Hospital

Type of Hospital	*n*	%
Government	16	23.2
Private	53	76.8

Note. *N* = 69.

The frequency distribution of the profile of respondents, as determined by the type of hospital in which the nuclear medicine technologists are currently working, is depicted in Table 4. Respondents from government hospitals account for 16 (23.2%) of the total respondents, while private hospitals account for 53 (71.8%). This shows that the majority of the respondents came from private hospitals.

Problem 2. What is the knowledge of the respondents on theranostics?

Table 5

Frequency Distribution of Knowledge on Theranostics in terms of Correct and Wrong Answers

Statement	Correct Answer		Wrong Answer	
	n	%	*n*	%
1. For adrenergic tumors, Iodine-123-metaiodobenzylguanidine (MIBG) is used for imaging.	59	85.5	10	14.5
2. For adrenergic tumors, Iodine-123-metaiodobenzylguanidine is used for imaging, diagnosis, and treatment.	33	47.8	36	52.2
3. Gallium-68 DOTATATE is used for diagnosing neuroendocrine tumors.	45	65.2	24	34.8
4. For the treatment of neuroendocrine tumors, the radiopharmaceutical used is Lutetium-177 DOTATATE.	37	53.6	32	46.4
5. The main forms of particulate radiation used for therapeutic applications are alpha particles and beta particles.	37	53.6	32	46.4
6. The radioisotope used for the treatment of intestinal neuroendocrine tumors is Lutetium-177.	38	55.1	31	44.9
7. The radioactive substance that emits two electromagnetic radiations, making simultaneous treatment and imaging possible is Lutetium-177.	21	30.4	48	69.5
8. Theranostics is a combination of diagnosis and therapeutic approaches for cancer with the purpose of reducing delays in treatment and easing patient care.	47	68.1	22	31.9
9. In preparation for RAI therapy, Levothyroxine (LT4) should be withdrawn 3-4 weeks prior to the procedure.	49	71.0	20	29.0
10. The diagnostic and therapeutic agents for hyperthyroidism or thyroid cancer are I-123 Iodide and I-131 iodide.	57	82.6	12	17.4
11. The agents Tc-99m MDP and Ra-223 Chloride are the diagnostic and therapeutic agents for the clinical indication Bone metastases from prostate cancer.	56	81.2	13	18.8
12. For metastatic prostate cancer, the theranostic radionuclide for its treatment is Lutetium-177.	30	43.5	39	56.5
13. Images can be acquired 40-90 minutes after intravenous administration of Ga-68 DOTATATE for neuroendocrine tumor cells.	39	56.5	30	43.5
14. In radionuclide therapy, the radionuclide Yttrium-90 DOTATOC is administered intravenously.	59	85.5	10	14.5
15. Lutetium-177 DOTATATE is administered to a patient through slow intravenous infusion.	45	65.2	24	34.8
16. Gallium-68 is administered to a patient through bolus injection.	32	46.4	37	53.6
17. The indication for yttrium-90 DOTATATE treatment is metastatic liver cancer.	41	59.4	28	40.6
18. The radionuclide therapy used to specifically target abnormal cells while limiting damage to surrounding healthy tissues is Lutetium-177 PSMA.	41	59.4	28	40.6
19. For the treatment of advanced prostate cancer, the radiopharmaceutical used is Lutetium-177 PSMA.	36	52.2	33	47.8
20. When using Ga-68 DOTA-peptides for imaging Gastroenteropancreatic neuroendocrine tumors (GEP-NETs), skull to mid-thigh of the patient should be imaged.	37	53.6	32	46.4

Table 5 demonstrates the frequency distribution of the respondents' knowledge on theranostics in terms of correct and wrong answers.

Based on the results, the questions that the respondents frequently answered incorrectly are those pertaining to the use or purpose of radiopharmaceuticals being specifically used for theranostics procedures which are Lu-177 and Ga-68. This may be due to the respondents not having been practicing theranostics procedures during their years of experience in nuclear medicine.

Like iodine-131 therapy, lutetium-177 is a non-invasive therapy with different patient preparations and precautions. It requires a more specific pre-treatment assessment and precise monitoring. However, unlike radioactive iodine, Lu-177 was only researched and incorporated in clinical practices in the early 2000s (Bautista, 2019). Thus, nuclear medicine technologists lack knowledge about the use of Lu-177.

Generally, the questions that the respondents answered correctly are those pertaining to more widely used and already available radiopharmaceuticals that are also applicable in theranostics procedures. According to the article of Czernin, (2020), radiologists had an easy time to adopt PET/CT by simply using FDG as a "contrast" agent. They adopted PET/CT imaging, which quickly became a major diagnostic tool in oncology. Technologists adapted to these changes as many became certified in CT in addition to nuclear medicine.

Table 6

Knowledge on Theranostics of the Respondents

Interpretation for Knowledge	*n*	%
Excellent (17-20)	9	13.0
Very Good (13-16)	24	34.8
Good (9-12)	24	34.8
Fair (5-8)	11	15.9
Poor (0-4)	1	1.4

Note. *N* = 69. *M* = 12.17 (Good), *SD* = 3.556.

Table 6 shows the knowledge of the nuclear medicine technologists when it comes to theranostics. Out of 69 respondents, nine (13%) got a score of 17-20 interpreted as “excellent”, 24 (34.8%) got a score of 13-16 and 9-12 as “very good” and “good”, respectively, 11 (15.9%) for scores 5-8 as “fair”, and one (1.4%) for 0-4 as “poor”.

Based on results, most of the respondents generally have a good knowledge on theranostics. Considering that the respondents are inexperienced with this and have not received formal training for theranostics procedures, there is already a positive response regarding their knowledge which suggests a promising outcome for its future practice in the country.

Problem 3. What is the attitude of the respondents towards theranostics?

Table 7

The Attitude of the Respondents towards Theranostics

Statements	*M*	*SD*	Min.	Max.	Response/ Interpretation
1. Theranostics is relevant to my practice setting	3.91	.870	1	5	Agree
2. The practice of theranostics is safe and should be widely used	3.81	.862	1	5	Agree
3. I will encourage a friend or relative to undergo theranostics if recommended	3.91	.658	3	5	Agree
4. If required, I will undergo theranostics procedures and treatment	3.90	.731	1	5	Agree
5. Even with the discovery of new medicine and treatments, theranostics would still be beneficial to use	3.97	.785	1	5	Agree
6. Theranostics procedures are safe and can be the first choice for treatment of certain cancers	3.67	.834	1	5	Agree
7. I feel safe about the radiation exposure with theranostics for the patient and healthcare professionals involved with the care of the patient	3.67	.741	1	5	Agree
8. I feel that I am ready to provide care for patients who will be undergoing a theranostics procedure	3.65	.855	1	5	Agree
9. I feel safe caring for patients who recently underwent radiation exposure from theranostics	3.81	.692	2	5	Agree
10. It is necessary for theranostics to be available in our institution	3.86	.827	1	5	Agree
Overall Mean	3.82	.585	2	5	Positive

Note. Interpretation and response for the attitude toward theranostics: 1.00-1.49 (highly negative / strongly disagree), 1.50-2.49 (negative / disagree), 2.50-3.49 (neither positive nor negative / neutral), 3.50-4.49 (positive/ agree), 4.50-5.00 (highly positive / strongly agree).

The attitude of the respondents when it comes to theranostics is shown in table 7.

The first statement “Theranostics is relevant to my practice setting” had a high mean (*M* = 3.91, *SD* = .870) in which the respondents answered “agree”; The same response was shown about the statement that they would encourage a friend or relative to undergo theranostics procedures when recommended (*M* = 3.91, *SD* = .862). They also answered “agree” to undergo theranostics procedures when required as well as theranostics still being beneficial even with the discovery of new treatments.

Statements 6 (*M* = 3.67, *SD* = .834), 7 (*M* = 3.67, *SD* = .741), and 8 (*M* = 3.65, *SD* = .855) are all interrelated in the sense of patient and worker safety in the practice of theranostics, in which the respondents also answered “agree”. In item 10, They also believe that it is necessary for

theranostics to be available in their institution due to their response being also “agree” (*M* = 3.86, *SD* = .827).

Statement 8 "I feel that I am ready to provide care for patients who will be undergoing a theranostics procedure" showed the lowest mean (*M* = 3.65, *SD* = .855). The researchers analyzed that this outcome of their attitude toward this statement though the answer, still being “agree”, may be attributed to insufficient availability of theranostics in the country and their inexperience in this practice.

Data show an overall mean of 3.82 (*SD* = .585) which is interpreted to be “positive”. This means that nuclear medicine technologists have a positive attitude toward theranostics.

The developing field of nuclear medicine is said to be a challenge in the future, mainly to innovations like theranostics as there are also some limitations with regard to the sensitivity and specificity of the diagnostics tools such as planar imaging, SPECT, and PET, thus having the potential to lead to the erroneous selection of patients in some instances (Gomes Marin et al., 2020).

Nuclear medicine has become significant in healthcare especially with the foundation of theranostics that has already been put in place. With this, its future in the Philippines would mean more readily available access to these new diagnostic and therapeutic procedures in line with ethical practice, and the complete trust of medical professionals (Bautista, 2019).

Problem 4. Are there significant differences in the knowledge of the respondents on theranostics when they are grouped according to age, sex, years of experience, and types of hospital currently employed in?

Hypothesis. There are no significant differences in the knowledge of the respondents on theranostics when they are grouped according to age, sex, years of experience, and type of hospital currently employed in.

Table 8

Comparison of the Knowledge on Theranostics According to Age

Age	*M*	*SD*	*F*	*p*
20-30 years old	11.42	3.500	4.225*	.019
31-40 years old	14.17	3.330		
41 years old and above	11.83	2.639		

Note. *df* = 2,66. *Significant at .05 level.

Table 8 shows the comparison of the knowledge of nuclear medicine technologists according to age. The mean value for 20-30 years old is 11.42 with a standard deviation of 3.500, 14.17 for 31-40 years old with a standard deviation of 3.330, and 11.83 for 41 years old and above with a standard deviation of 2.639. The computed *F* ratio of 4.225 and a *p*-value of .019 is significant at .05 level using 2 and 66 degrees of freedom. The null hypothesis that there is no significant difference in nuclear medicine technologists' knowledge when grouped according to age is rejected, while the alternative hypothesis of nuclear medicine technologists having a significant difference in the knowledge on theranostics when grouped according to age is accepted.

In the Scheffé post-hoc analysis, findings reveal that the significant difference in knowledge is seen between those aged 20-30 years old and 31-40 years old. Those aged 31-40 years old have a better knowledge than those aged 20-30 years old with their mean knowledge scores being 14.17 and 11.42, respectively. This indicates that older nuclear medicine technologists are more knowledgeable on theranostics, and a possible explanation may be because those belonging in this age group have attended more seminars or learned more about the practices and radiopharmaceuticals associated with theranostics. The number of older nuclear medicine technologists (41 years old and above) is limited and did not show a higher knowledge

score because of respondents belonging in this group account for only 8.7% and cannot result in a fair comparison with other age groups.

Table 9

Comparison of the Knowledge on Theranostics According to Sex

Sex	*M*	*SD*	*t*	*p*
Male	11.86	3.881	-0.774	.442
Female	12.53	3.162		

Note. *df* = 67. Not significant at .05 level.

Table 9 shows the comparison of knowledge of nuclear medicine technologists on theranostics when grouped according to sex. Male respondents have a mean of 11.86 (*SD* = 3.881), while female respondents have a mean of 12.53 (*SD* = 3.162).

The *t* ratio of -0.774 with a *p*-value of .442 is not significant at the .05 level using 67 degrees of freedom. These findings mean that nuclear medicine technologists do not differ in the knowledge on theranostics when they are grouped according to sex. The null hypothesis that there is no significant difference in the knowledge of nuclear medicine technologists on theranostics is not rejected.

Table 10

Comparison of the Knowledge on Theranostics According to Years of Experience

Years of Experience	*M*	*SD*	*F*	*p*
Less than 1 year	10.90	3.780	1.412	.240
1 to 3 years	12.47	3.878		
3 to 5 years	12.45	2.911		
6 to 10 years	13.91	3.360		
More than 10 years	12.00	2.449		

Note. *df* = 4,64. Not significant at .05 level.

The comparison of the knowledge on theranostics when it comes to years of experience is shown in Table 10. The computed *F* ratio of 1.412 with a *p*-value of .240 is not significant at the .05

level using 4 and 64 degrees of freedom. The null hypothesis that there is no significant difference in the knowledge on theranostics according to years of experience is not rejected.

These findings mean that the knowledge on theranostics does not significantly vary according to years of experience. Significant differences are observed between nuclear medicine technologists with less than a year of experience (*M* = 10.90, *SD* = 3.780), 1 to 3 years of experience (*M* = 12.47, *SD* = 3.878), 3 to 5 years of experience (*M* = 12.45, *SD* = 2.911), 6 to 10 years of experience (*M* = 13.91, *SD* = 3.360), and for more than 10 years of experience (*M* = 12.00, *SD* = 2.499). A possible explanation of these findings is that despite more nuclear medicine technologists belonging to the 20-30 years old age group, there is still no significant difference in knowledge in their years of experience as expected with older age groups because theranostics procedures have only been recently introduced in the Philippine healthcare setting.

Table 11

Comparison of the Knowledge on Theranostics According to Type of Hospital

Type of Hospital	*M*	*SD*	*t*	*p*
Government	11.25	2.295	-1.189	.239
Private	12.45	3.831		

Note. *df* = 67. Not significant at the .05 level.

Table 11 shows the comparison of the knowledge of nuclear medicine technologists on theranostics according to the type of hospital that they are currently employed in.

Nuclear medicine technologists working in government hospitals have a mean knowledge of 11.25 and a standard deviation of 2.295. Nuclear medicine technologists working in private hospitals, have a mean knowledge of 12.45 and a standard deviation of 3.831. The computed *t*-ratio with the value of -1.189 and the *p*-value resulting in .239 is not significant at the .05 level with the use of 67 degrees of freedom. The null hypothesis that there is no significant difference in the

knowledge of nuclear medicine technologists according to the type of hospital they work in is not rejected.

These findings mean that the respondents have the same level of knowledge of theranostics regardless of whether they are employed in a private or government hospital.

Problem 5. Are there any significant differences in the attitude of the respondents towards theranostics when they are grouped according to age, sex, years of experience, and type of hospital currently employed in?

Hypothesis. There are no significant differences in the attitude of the respondents towards theranostics when they are grouped according to age, sex, years of experience, and type of hospital currently employed in.

Table 12

Comparison of the Attitude Towards Theranostics of the Respondents According to Age

Age	*n*	*Mdn*	Mean Rank	*H*	*p*
20-30 years old	45	4.00	35.88	.286	.867
31-40 years old	18	3.80	33.81		
41 years old and above	6	3.75	32.00		

Note. *df* = 2. Not significant at the .05 level.

Table 12 shows the comparison of the respondents' attitude towards theranostics when they are grouped according to age. The Kruskal-Wallis *H* test (*H* = 0.286, *p* = .867) reveals that there is no significant difference in the attitude of the respondents towards theranostics when grouped according to age at a .05 level with a degree of freedom of 2. The null hypothesis that there is no significant difference in the attitude of the respondents when they are grouped according to age is not rejected.

These findings mean that the respondents have the same attitude towards theranostics regardless of their age.

Table 13

Comparison of the Attitude Towards Theranostics According to Sex

Sex	*n*	*M*	Mean Rank	*U*	*p*
Male	37	3.7	32.34	493.500	.234
Female	32	4	38.08		

Note. Not significant at the .05 level.

Table 13 shows the comparison of their attitude based on their sex. The Mann-Whitney *U* test reveal that there is no significant difference in the level of attitude toward theranostics when grouped according to sex ($U = 493.5$, $p = .234$) The null hypothesis that there is no significant difference in the comparison of the attitude to theranostics when they are grouped according to sex is not rejected. These findings mean that the participants have the same level of attitude toward theranostics regardless of their sex.

Table 14

Comparison of the Attitude Towards Theranostics of the Respondents According to Years of Experience

Years of Experience	*n*	*Mdn*	Mean Rank	*H*	*p*
Less than 1 year	21	3.6	28.81	5.156	.272
1 to 3 years	19	4	36.76		
3 to 5 years	11	4	39.50		
6 to 10 years	11	4	43.09		
More than 10 years	7	3.6	29.00		

Note. Not significant at .05 level. $df = 4$

The comparison of the attitude toward theranostics when it comes to years of experience is shown in Table 14. The Kruskal-Wallis *H* test ($H = 5.156$, $p = .272$) reveal that there is no significant difference in the attitude of nuclear medicine technologists toward theranostics when they are grouped according to years of work experience. The null hypothesis that there is no significant difference in the attitude of nuclear medicine technologists according to years of experience is not rejected. This data imply that the attitude of nuclear medicine technologists toward theranostics does not significantly differ depending on their years of work experience.

Table 15

Comparison of the Attitude Towards Theranostics According to Type of Hospital

Type of Hospital	*n*	*M*	Mean Rank	*U*	*p*
Government	16	3.55	29.50	336.000	.209
Private	53	3.9	36.66		

Note. Not significant at .05 level.

Table 15 shows the comparison of the attitudes toward theranostics of the respondents according to the type of hospital.

The Mann-Whitney *U* test reveal that there is no significant difference in the attitude of the respondents toward theranostics when the respondents are grouped according to the type of hospital, $U = 336.000$, $p = .209$. The null hypothesis that there is no significant difference in the attitude of the respondents toward theranostics when they are grouped according to the type of hospital is not rejected.

Problem 6. Is there a significant relationship between the knowledge and attitude of the respondents toward theranostics?

Hypothesis. There is no significant relationship between the knowledge and attitude of the respondents toward theranostics.

Table 16

Relationship of Knowledge and Attitude of the Respondents Toward Theranostics

Variable	*Mdn*	r_s	*p*
Knowledge	12	.350*	.003
Attitude	3.8		

Note. *Significant at .05 level.

The relationship between the knowledge and attitude of the respondents toward theranostics is shown in Table 16.

The computed r_s of .350 with a *p*-value of .003 is significant at the .05 level using 67 degrees of freedom. The null hypothesis that there is no significant relationship between the

respondents' knowledge and attitude toward theranostics is rejected. The alternative hypothesis that the respondents' knowledge is significantly correlated to the respondents' attitude toward theranostics is accepted.

These findings mean that there is a significant positive relationship between the knowledge (*Mdn* = 12) and attitude (*Mdn* = 3.8) of nuclear medicine technologists toward theranostics. This positive relationship means that when the level of knowledge increases, the level of positive attitude becomes more favorable on positive. However, data show a weak relationship (r_s = 0.350) between the two. This implies that this weak relationship may be attributed to other factors influencing their attitude and that their knowledge is not a main factor.

Moreover, the highly positive attitude of nuclear medicine technologists may be due to how they see the good opportunities that may come with the implementation of theranostics in their practice and/or they may be looking forward to applying it to their practice when offered to them.

Conclusions

Based on the findings of the study, the following conclusions are drawn:

1. The majority of the respondents are 20-30 years old, male, working as a nuclear medicine technologist for less than a year, and currently working in private hospitals.

2. The results of the study reveal that nuclear medicine technologists have "good" knowledge of theranostics.

3. Based on the results, nuclear medicine technologists' attitude towards theranostics is interpreted to be positive.

4. There is a significant difference between the respondents' knowledge of theranostics according to age. In terms of their sex, years of experience and type of hospital they are currently

employed in, the outcome shows that there are no significant differences according to these demographics.

5. There is no significant difference in their attitude towards theranostics when they are grouped according to age, sex, years of experience and type of hospital they are currently employed in.

6. There is a significance between the relationship of knowledge and attitude of the respondents toward theranostics.

Recommendations

Considering the conclusions of the study, the researchers recommend the following:

1. The inclusion of the subject “Theranostics” in the Bachelor of Science in Nuclear Medicine Technology curriculum for future nuclear medicine technologists to have a full understanding of theranostics.

2. The researchers recommend exploring if improved knowledge, through more education on theranostics for upcoming nuclear medicine technologists, will improve the attitude of nuclear medicine technologists towards theranostics.

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