COLLEGE OF HEALTH SCIENCES, SCHOOL OF MEDICINE
DEPARTMENT OF INTERNAL MEDICINE,
NUCLEAR MEDICINE UNIT.

Assessment of renal scintigraphy indications and results among patients referred for renal scintigraphy at nuclear Medicine unit Istituto Nazionale Tumori IRCCS-Fondazione G Pascale Napoli, Italy.

Principal Investigator: Dr. Ziyad Abrahim (MD, Final Year NMR)

A Research Thesis to be Submitted to Addis Ababa University Post Graduate Studies in Partial Fulfillment of the Requirements for the Specialty Certificate in Clinical Nuclear Medicine

February, 2023
Addis Ababa, Ethiopia

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Approval of the Examining Board

This thesis by Dr Ziyad Abrahim is accepted in its present form by the board of examiners satisfying thesis requirement for the Specialty Certificate in Clinical Nuclear Medicine.

Title of project: Assesment of renal scintigraphy indications and results among patients referred for renal scintigraphy at nuclear Medicine unit Istituto Nazionale Tumori IRCCS-Fondazione G-Pascale Napoli, Italy.

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Acronyms

AH	Antinatal Hydronephrosis
ACE/ACEI	Angiotensin converting enzyme/inhibitor
CDC	Center For Diseases Control and Prevention.
CKD	Chronic Kidney Diseases.
CT	Computed tomography
DTPA	Diethylene triamine penta acetic acid.
DMSA	Dimercaptosuccinicacid.
DRF	Differential renal function.
DGF	Delayed graft function
DOTATOC	(DOTA0-Phe1-Tyr3) octreotide.
ERPF	Estimated renal plasma flow
IAEA	International Atomic Energy Agency.
FEDA	Fluro ethyl iminodiacetic acid.
FDG	Fluoro deoxy glucose.
GFR	Glomerular filtration rate.
HN	Hydronephrosis
IRCCS	Scientific Institute for Research, Hospitalization and Healthcare.
MAG-3	Mercaptoacetyltriglycine
MCU	Micturating cysto ureterography
MDP	Methylene diphosphonate.
MD	Medical Doctor.
MOC DEXA	“Mineralometria Ossea Computerizzata" dual-energy X-ray absorptiometry.
MINT	Ministry of Innovation and Technology.
NMP	Nuclear Medicine physician.
PET	Positron emission tomography.
PH	Postnatal Hydronephrosis
SPECT/CT	Single photon emission computerized tomography / computerized tomography.
TASH	Tikur Anbessa Specialized Hospital.
TAC	Time - activity curve

PI	Principal Investigator.
PMP	patients per million population.
SPSS	Statistical Package for Social Sciences.
UTI	Urinary tract infection
US	Ultrasound
VUR	Vesico-Urethral Reflux

Abstract

Background: Renal scintigraphy is an imaging method that uses radiopharmaceuticals to evaluate renal anatomy, physiology, and pathology. It is performed by using a variety of methods, each providing a slightly different approach to assess renal function or anatomy. These methods includes functional imaging (visual assessment of perfusion and function) and Renography (TAC representative of function).

Objective: The aim of this study was to assess renal scintigraphy, indications and result, among patients referred for renal scan at nuclear medicine unit, Istituto Nazionale Tumori IRCCS-fondazione G-Pascale from November 1, 2017 to October 31, 2022.

Methods: Hospital based retrospective cross-sectional study was conducted to assess renal scintigraphy. All patients with full records of Renal scintigraphy at nuclear medicine unit, Istituto Nazionale Tumori IRCCS-fondazione G-Pascale from November,1 2017 - October,31 2022 were used in this study. After completion of data collection and processing, data was checked for completeness, clarity and consistency. The collected data was edited, coded by microsoft Excel and entered processed and analyzed with computer using SPSS version 26 software.

Result: Out of 265 renal scintigraphy studies most of the scan 110 (41.5%) were indicated for evaluation of hydronephrosis and 91 (34.3%) were indicated for evaluation of patient with renal cancer.

Among 110 patient in whom renal scintigraphy are indicated for evaluation of hydronephrosis 83 (39%) renal unit were normal, 53 (24%) showed functional obstruction, and 38 (17%) renal unit showed anatomical obstruction.

The most common risk factor for renal disorder is renal cancer constituting 63 (23.8%) followed by renal cancer plus obesity in 34 (12.8%) of patient

Conclusion: The most common indication of renal scintigraphy in the study area was for evaluation of patients with various degrees of hydronephrosis followed by renal carcinoma, renal functional status evaluation and raised creatinine.

Keywords: Renal scintigraphy, indication, result, significance

1. Introduction

1.1. Background

Renal scan, also known as renal scintigraphy, is an imaging technique that uses radiopharmaceuticals to assess the morphology, physiology, and disease of the kidneys. The kidneys remove the various radiotracers administered to the blood and emit radiation, particularly gamma radiation, which gamma cameras can detect (Banker, H *et al*., 2021).

Renal scintigraphy encompasses four distinct methods: dynamic renal scan, which assesses renal function and perfusion, A captopril scan, which is used to diagnose renal arterial hypertension and involves the administration of captopril, A diuretic renal scan, which studies pelvic-ureteric blockage and requires the administration of diuretics on specific time, and finally a cortical renal scan, which is used to look for renal cortical abnormalities such as reno-cortical scarring (Alsabea, H, 2017).

For clinical use in renal scintigraphy, three types of radiotracers are available: those filtered by the glomerulus for estimating GFR and renal scan; those secreted by the proximal renal tubules for calculating effective renal plasma flow (ERPF); and those that adsorb in the distal tubules/cortex for assessing the renal parenchyma. These radiotracers include 99mTc-DTPA, 99mTc-MAG3, and 99mTc-DSMA, to name a few (A. T. Taylor, 2014).

A diuretic renography using renal radiotracers combined with intravenous intravenous furosemide administered 20 to 30 minutes after the isotope injection (diuretic isotopic renography) can be used to differentiate between simple collecting system dilation and true obstruction. The isotope is normally washed out of the kidney quickly, and its persistence indicates a degree of obstruction. Renography is significantly less useful in patients with poor renal function because the diuretic response to furosemide may be absent. Diuresis renography may also be used to monitor patients who have had obstruction-relieving surgery, such as pyeloplasty (Kevin P.G *et al.,* 2010).

Captopril renography detects the angiotensin-II dependence of glomerular filtration rate employing dynamic renography performed before and after administration of a single dose of captopril. In a positive test, there is a delay in the uptake, reduced peak uptake, prolonged parenchymal transit, and slow excretion of tracer. The reported accuracy of captopril renography in identifying patients with renovascular disease has been variable with reported sensitivity around 85% (range 45% to 94%) and specificity of around 93% (range 81% to 100%) (Graham, W *et al*., 2007).

Tc-99m DMSA exhibits homogeneous cortical uptake in DMSA renography and is retained by the cortical tubules for at least 6 hours. The test is simply a parenchymal imaging scan, which has been shown to be more effective than ultrasonography in children over the age of five for early diagnosis and prompt treatment of pyelonephritis. This is critical for avoiding complications like cortical scarring and the loss of renal function that comes with it (Banker, H *et al*., 2021).

1.2. Statement of the problem

The term "kidney disease" refers to a wide range of conditions affecting the function and structure of the kidneys. Even minor changes in kidney structure and function can increase the risk of mortality and complications in other organ systems, both of which are far more common than renal insufficiency (A. S. Levey & J. Coresh, 2012).

The global prevalence of chronic kidney disease (CKD) is increasing. In order to accurately stratify, devise therapeutic strategies, and predict outcomes for patients with CKD, it is critical in clinical practice to characterize the level of renal impairment precisely. (Lv, J. C & L. X. Zhang, 2019).

Kidney disease affects 2.5 million people in Italy. These illnesses span a wide range of ailments, but they are all characterized by a decline in renal function (renal failure) (Domenico *et al*., 2014).

Over the past few years, the use of radiotracers studies to nephrology and urology practice has matured to a measureable extent. Since many years ago and up until the present, renal scans have been a part of kidney examination (Werner, R *et al.,2019*).

Even though renal scintigraphy is common procedure in developed countries, as far as to our knowledge there are no so much studies done both in Italy in general and in this institution in particular regarding the indication and results of renal scintigraphy.

1.3. Significance of the study

Renal scintigraphy provides functional data such as split renal function and is useful in the early evaluation of split renal function (contribution of both kidneys to overall renal function) (Sfakianaki *et al*., 2013).

In developed countries, renal scan is a crucial component of the evaluation of kidney illnesses, although it is less common in developing countries (Volkan-Salanci, B & Erbaş, B, 2022)

Despite the regular and accessible renal scan service in the study center, no research has been conducted to provide effective communication of available data regarding the indication and result of renal scintigraphy in a statistically sound manner.

Therefore, the result of this retrospective study will provide information about the indications and results of renal scintigraphy.

2. Literature Review.

2.1 Magnitude of kidney diseases.

Chronic kidney disease(CKD) is one of the leading causes of death and disability in the twenty-first century. An estimated 1 million people per year die as a result of untreated kidney failure. People with CKD are up to 20 times more likely to die from other causes, most commonly cardiovascular disease, before developing end-stage renal disease (CDC, 2022).

The leading cause of death in the US is kidney disease. The astonishing estimate of 37 million adult Americans with renal disease is reported by the Centers for Disease Control and Prevention (CDC, 2022)

Saudi Arabia and Belgium have the highest estimated CKD prevalence among high-income countries (24%), followed by Poland (18%), Germany (17%), the United Kingdom (16%), and Singapore (16%) (Hill, N *et al*., 2016).

Norway and the Netherlands have the lowest projections, both at 5%. In the United States, the estimated prevalence is 14%, compared to 13% in Canada and Australia (Hill, N *et al*., 2016).

Chronic kidney disease (CKD) is estimated to affect 7% of people in South Asia and 8% of people in Africa, but it can reach 11% in North America and 12% in Europe, the Middle East, East Asia, and Latin America (Helio, 2019).

Chronic kidney disease (CKD) affects a sizeable portion of the Italian population, especially the elderly, according to the paper "the epidemiology of CKD in Italy: possible therapeutic approaches" that was published in 2003. Each year, more than 300 patients per million people (pmp) are estimated to receive a CKD diagnosis (Locatelli etal., 2003).

In a population of 320 participants, the assessed prevalence of chronic kidney disease (CKD) was 39 (12.2%), according to a hospital-based cross-sectional study that was conducted to assess the severity of the condition and its contributing factors among patients at Zewditu Memorial hospital and published on June 20, 2018. The prevalence of CKD increased with age, peaking in the age group of <35 years 16 (41.02%), followed by 35–41 years 8 (20.51%), 41–47 years 9 (23.07%), and >47 years 6 (15.38%) (Cheru Kore *et al*., 2018).

2.2 Indication and result of renal scintigraphy.

Renal scintigraphy is used for evaluation of renal perfusion, and function as well as renal anatomy. Additionally, it aids in the obstructive uropathy diagnosis. It can be utilized to distinguish between genuine obstruction and non-obstructive simulators that enlarge the urinary tract. It aids in the diagnosis of unilateral compensated renal hypertension. Particularly in children, DMSA cortical renal scintigraphy is helpful in identifying renal scar or acute pyelonephritis; it is more sensitive than standard ultrasonography and emits less radiation than CT scan. Renal scintigraphy is a fantastic tool for both qualitative and quantitative evaluation of the effectiveness of renal transplants (Blaufox, M, 2018).

In a study done in India which is published on march, 2002, the correlation between urinary tract infection (UTI), vesicoureteric reflux (VUR) and renal scarring was studied in 89 patients (177 renal units; 1 solitary kidney) during the period 1997–2000. There were 63 males and 26 females; ages ranged from neonates to 14 years. UTI was diagnosed on the basis of a positive urine culture, VUR was diagnosed and graded by micturating cystourethrogram (MCU), and renal scarring was assessed by technetium $^{99\,m}$Tc-dimercaptosuccinic acid (DMSA) scan. Ultrasonography (US) was done to evaluate renal tract dilatation and other structural abnormalities. A follow up DMSA scan was performed approximately 6 months after the initial scan. VUR was present in 106 of the 177 renal units in which it was studied and absent in 71 units. The majority of the VUR was grade V. Renal scars were seen in 90 of 177 renal units at presentation and in 72 of the 116 renal units studied at follow-up. Some information was lacking in 31 patients; hence, the correlation between UTI, VUR, and renal

scarring was done in 58 patients. The majority of the suspected scars at presentation were not seen at follow-up, but most of the established scars persisted. Only 2 renal units showed scars for the first time on follow-up. On US, approximately 50% of normal kidneys showed either suspicious or established scars on DMSA scan, while patients with bilateral abnormality on US showed renal scars. Renal scars were seen in 15 of 23 children without VUR, 17 of 18 with unilateral VUR, and 16 of 17 children with bilateral VUR. Thus, there is a cause-and-effect relationship between UTI and renal scarring that is worsened by VUR. DMSA scans have been shown to be the most reliable method of assessing renal scarring, and an abnormal US scan showing upper-tract dilatation or a structural abnormality may have a predictive value in the detection of renal scarring (Bhatnagar, V *et al*., 2002).

A retrospective survey was conducted at King Abdulaziz University Hospital to assess the efficacy of combining scintigraphy and sonography techniques in detection and evaluation of renal disease. A total of 96 patients with various types of kidney disease were recruited for the study. There were 53 men and 43 women. All patients underwent renal scintigraphy, and 19 of 96 (19.7%) were found to have hydronephrosis (lsubhi *et al*., 2022).

In a Survey done regarding the Use of Nuclear Renal Imaging in the United States and Published on Oct. 27, 2016, the study was generated with questions about patient populations, the most frequent clinical indications, radiopharmaceutical use, measurement techniques, the average number of completed scans, and medical centre/transplant team affiliations. The result shows that 91% of the departments use 99mTc-MAG3 more often, and the other 9% use 99mTc-DTPA more often; some department use a combination of both tracers. The clinical indications from most common to least common are renal obstruction, split renal function, renovascular hypertension, renal transplantation, spinal cord injury, urine leakage, chronic kidney disease and cancer (Archer, K. D, & Bolus, N. E, 2016).

In a Study done at Edith Wolfson Medical Center, (Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel) and published on April 2000, on the role of renal scintigraphy and unenhanced helical computerized tomography in patients with ureterolithiasis involving 30 patients admitted to the emergency room with acute flank pain, the renograms showed high-grade, unilateral obstruction in 12 patients, indeterminate scans in 5 patients and normal renogram in 13 patients (Lorberboym *et al.,* 2000).

Another Study conducted at Dokuz Eylul University Pediatric Nephrology clinic Turkey and published on 2017 aimed to determine the contribution of dynamic renal scintigraphy with ^{99m}Tc-MAG-3 to the clinical decision-making for surgery in hydronephrotic children. Files of the patients evaluated by MAG-3 scintigraphy for antenatal (AH)/postnatal (PH) hydronephrosis between 1992 and 2014 were reviewed. Gender, age, hydronephrosis (HN) grade by ultrasound (US), presence of VUR, MAG-3 result (obstructive vs. Non-obstructive), ultimate diagnosis, and need for surgery were assessed. Cases with double collecting system and neurogenic bladder were excluded from the study. All of the patients had normal serum creatinine and eGFR. There were a total of 178 patients with 218 hydronephrotic renal units (mean age 34.7 ± 52.7 months; male/ female = 121/57, AH of 62%). MAG-3 was non-obstructive in 134 and obstructive in 84 hydronephrotic renal units. MAG-3 was obstructive in 47 of 121 (39%) males and 30 of 57 (53%) females (P = 0.058, odds ratio (OR) for obstruction was 1.9 for girls). MAG-3 was obstructive in 47 of 135 (35%) units with AH and 37 of 83 (45%) units with PH (P = 0.137). In 81 units with grade 4 hydronephrosis by US (according to the society of fetal urology grading), MAG-3 was obstructive in 55 (68%), and surgery was required in 52 of 55 (95%). Surgery was required for only two (7%) of the remaining 26 units with non-obstructive dilatation (P <0.001, sensitivity 96%, specificity 89%,OR 208). Antero-posterior diameter >16.5 mm was the best cut-off level for predicting obstruction by MAG-3 (sensitivity 75.2%; specificity 71%; OR 3.8). Investigators of this study concluded that MAG-3 significantly affects clinical decision for surgery in HN, Hydronephrotic girls have more risk in terms of true obstruction and combining MAG-3 with US improves the discrimination of true obstruction during follow-up (Seçil Arslansoyu *et al*., 2017).

In research done in Kuala Lumpur Malaysia and published on January 2022, regarding the value of baseline post-transplant MAG3 renal scintigraphy in the evaluation of graft function, researchers determined the predictive value of parameters derived from MAG3 performed within 72 hours post transplant in detecting graft function. Delayed graft function (DGF) which is defined as requirement of dialysis within the first week post transplant, is chosen as a surrogate measure of graft function. All renal transplant recipients who underwent MAG3 within 72 hours post transplant from 2017 to 2019 were enrolled. Three MAG3 parameters, renogram grade, tubular injury severity score, and R20:3, were evaluated. A total of 117 patients were enrolled. The overall incidence of DGF was 16.2% with a significantly higher incidence among cadaveric graft recipients (53.6%) compared with living graft recipients (4.5%). Renogram grade ≥2, tubular injury severity score ≥4, and R20:3 > 1.31 significantly predicted DGF, $P < .05$ with higher area under the curve for R20:3 of 0.97. Grafts with parameters above the cutoffs also showed significantly worse GFR at 1- and 3-months post-transplant. On multivariate analysis, prolonged cold ischaemia time was associated with a higher risk of DGF, odds ratio 1.005 (95% confidence interval 1.003-1.007), $P < .05$. The investigator of this study concluded that baseline MAG3 accurately depicts early graft function and is also predictive of GFR at 1- and 3- months post-transplant, these baseline MAG3 scans could be particularly useful among deceased donor graft recipients owing to the higher risk of poor graft function (Ching Yeen. *et al*., 2022).

2.3. Conceptual framework.

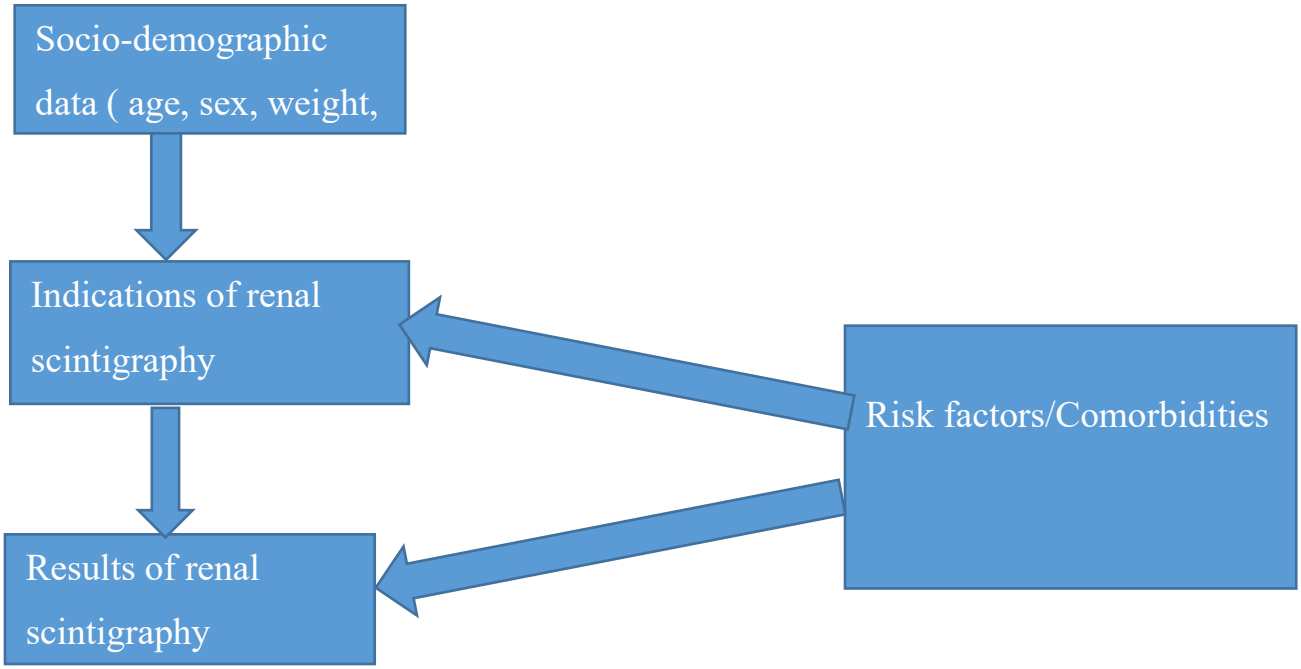

Figure 1. Conceptual frame work of assessment of renal scintigraphy indications and result, Nuclear medicine unit Pascale National Institute of cancer 2017 - 2022

3. Objectives.

3.1. General Objective.

- ✓ To assess renal Scintigraphy indications and results among patients referred for renal scan at nuclear medicine unit, Istituto Nazionale Tumori IRCCS-Fondazione G-Pascale from November 1, 2017 to October 31, 2022.

3.2. Specific Objectives.

- ✓ To determine indications of renal Scintigraphy among patients referred for renal scintigraphy at nuclear medicine unit.
- ✓ To evaluate results of renal Scintigraphy among patients referred for renal scan at nuclear medicine unit.
- ✓ To determine risk factors of renal disorder among patients referred for renal scintigraphy at nuclear medicine unit.
- ✓ To assess the correlation between dependent and independent variables.

4. Methodology.

4.1. Study Design.

A hospital-based retrospective cross-sectional study was conducted to assess renal scintigraphy indications and results among patients referred for dynamic renal scintigraphy in the past five years at the nuclear medicine unit, Istituto Nazionale Tumori (IRCCS)-Fondazione G-Pascale Napoli, Italy.

4.2 Study area and study period.

4.2.1. Study area.

The study was conducted at the Istituto Nazionale Tumori (IRCCS) Fondazione G-Pascale, Naples, Italy. Naples is the third-largest city in Italy, located in the southern region of Campania and serving as its capital. As of 2012, the population of the comune di Napoli totals around 960,000. Naples' wider metropolitan area, sometimes known as Greater Naples, has a population of approximately 4.4 million. Senator Giovanne Pascale founded the institution IRCCS in 1933. The National Cancer Institute represents the regional reference center for the diagnosis and treatment of neoplastic diseases and is recognized as a multi-specialty oncological reference center.

4.2.2. Study period.

The study (data collection) was conducted from September 12, 2022 to October 31, 2022.

4.3. Source Population.

From November 1, 2017 to October 31, 2022, all patients who underwent renal scintigraphy at the nuclear medicine unit of Istituto nazionale tumori (IRCCS-fondazione G-Pascale) were included in this study as a source population.

4.4. Study Population.

Patients who underwent a renal scan between November 1, 2017 and October 31, 2022 and met the inclusion criteria during data collection comprised the study population.

4.5. Inclusion and Exclusion criteria

4.5.1. Inclusion Criteria

All patients with full records of Renal scintigraphy at nuclear medicine unit, instituto nazionale tumori IRCCS-foundazione G-pascale from November 1, 2017- October 31, 2022.

For patients who had more than one renal scan, only the first, or baseline, renal scan was enrolled in the study.

4.5.2. Exclusion Criteria

Those patients whose renal scintigraphy have incomplete records were excluded from the study.

For patients who had more than one renal scans, the follow-up renal scan were excluded from the study.

Records of patients with single kidney are excluded from the study.

4.6. Sample Size determination and sampling technique

4.6.1. Sample size determination

Due to lack of studies and concrete information on the proportion of renal scintigraphy, the sample size for the objective was determined by taking a proportion of renal scintigraphy 50%, a margin of sampling error tolerated 5%, a confidence interval of 95%, considering incomplete records of 10%, the representative sample size was determined using single population proportion formula for cross sectional study design

$n=\frac{(z\alpha/_2)^2 p(1-p)}{d^2} = \frac{(1.96)^2 0.5(1-0.5)}{(0.05)^2} = 384$

Where p=50%

q =1 –p

d = margin of sampling error tolerated (0.05)

n = the required sample size.

Total population of the study is 740; the minimum sample size (n') was obtained by:

n'=n/ (1+n/N), Where;

n' = Corrected (minimum) sample size

n= determined sample size = 384

N=total number of renal scan performed from November,1, 2017 to October,31, 2022 = 740.

n'=n/ (1+n/N) = 384/(1+384/740) = 254+10% incomplete record, final n = 254+25.4 = 279.

4.6.2. Sampling Techniques

Proportionate Stratified Random Sampling technique was used. Number of patients whom underwent renal scan in the past five years was stratified in to five strata and sample was taken from each five strata proportional to size of each strata as follows :-

Strata 1. November 1,2017 - October 31, 2018 = 115…n= (115*279)/740= 43, k= 2

Strata 2. November 1, 2018 - October 31, 2019 = 118...n= (118*279)/740= 44, k= 2

Strata 3. November 1, 2019 - October 31, 2020 = 169..n= (169*279)/740= 64, k= 3

Strata 4. November 1, 2020 - October 31, 2021 = 169..n= (169*279)/740= 64, k= 3

Strata 5. November 1,2021 - October 31, 2022 = 169..n= (169*279)/740= 64, k= 3

n'=43+44+64+64+64= 279.

Therefore, by taking the corrected sample size calculated above and there were 10 incomplete records of renal scintigraphy indications and results, and 4 patients with single kidney are also excluded from the study. So the final sample size of this study was **279-14 = 265**.

4.7. Data Collection Instruments and Techniques

Data was collected using data collection format prepared according to patient record. Data source was secondary source i.e. Patients' medical records documented on nuclear medicine patient care software.

4.8.1. Dependent Variables

Indication and clinical significance or result of renal scintigraphy.

4.8.2. Independent Variables

Socio-demographic variables (age, sex, weight, height, BMI)
Renal function test (creatinine, GFR, SRF)
Comorbidities (hypertension, diabetes mellitus, obesity, neoplastic disorders, heart diseases).
Types procedures and types of radiopharmaceutical used.

4.9. Operational Definitions

Anatomical obstruction: Stasis of radioactive urine at pelvicalyceal system with no improvement (persistent) on post micturition or delayed image.
Difficult to evaluate the excretion phase: When the global glomerular filtration is so depressed and the excretion phase is not well characterized.
Functional obstruction: Stasis of radioactive urine at pelvicalyceal system that has improved or resolved on delayed or post micturition image.
Glomural filtration rate: The flow of plasma from the glomerulus into Bowman's space over a specified period and is the chief measure of kidney function.
Indications : In this thesis indications are the valid reason why renal scan is requested by referring physicians
Renal Scintigraphy: An image taken of a patient's kidney after the patient is given an injection of radiopharmaceutical.
Split renal function: Also called Differential renal function (DRF) is a measurement of each kidney's ability (contribution) to extract tracer from blood and therefore reflects renal function.

4.10. Data Analysis.

After completion of data collection and processing, data was checked for completeness, clarity and consistency. The collected data was edited, coded and entered in to Microsoft Excel and exported to, processed and analyzed with computer using SPSS version 26 software.

Descriptive and inferential statistics were generated and result were interpreted using numbers (prevalence), percentages, means and ranges T-test, correlations and regressions. The direction and strength of association was measured by odd ratio with 95% confidence interval.

4.11. Data Quality

Before starting data collection, data collecting format was cross matched with available information on records; then the study questions were rearranged as necessary.

Daily completeness of the data was cross checked. If incomplete, the records were reassessed again. The records that were incomplete after revision were discarded. Data have been collected by principal investigator.

4.12. Ethical Consideration

Written ethical approval and permission to conduct research was obtained from Istituto Nazionale Tumori IRCCS-Fondazione G-Pascale and the Department of internal medicine college of health science Addis Ababa university. After objective of the study was explained and permission was secured, data collection was started.

Therefore, informed consent for the study was not taken from the study subjects. The investigator made sure that the confidentiality of the information was assured in order to avoid disclosure of patient's name and health care provider related to the finding.

4.13. Dissemination Plan

After the study is completed, the results with their respective discussions, interpretations and recommendations will be prepared and disseminated to TASH, School of Medicine, the Internal Medicine Department, Nuclear Medicine Unit and radiometabolic treatment unit of Istituto Nazionale Tumori IRCCS-Fondazione G-Pascale.

4.14. Role of investigator

The investigator was responsible for topic selection, proposal development, and planning of the study. The researcher also analyzes the information, summarizes the findings, and submits them to the appropriate authorities.

5. Result.

5.1. Proportion of renal scintigraphy and Socio-demographic characteristics of the patients.

A total of 35498 exams were done in the study institution from November, 1, 2017 to October, 31, 2022, out of which 740 (2%) exam were renal scintigraphy. A 265 studies (530 renal unit) were enrolled in this study. Among the study participants who have been enrolled in the renal scans 133 (50.2%) of them were females and 132 (49.8%) were males with female to male ratio of 1:1.

The mean, standard deviation age of patients was 63.67 ± 12.23 years with a range of 17 to 87 years and most of them were in the age range of >60 years **(Table 1).**
The mean, standard deviation height of patients with renal scintigraphy records was 1.65 ± 0.09 meter with a range of 1.40 to 1.88 meter.

The mean, standard deviation weight of patients with renal scintigraphy records was 75.56 ± 17.56 kilogram with a range of 38 to 150 kilogram and by body mass index most of the patients 108 (40.8%) were overweight, the mean and standard deviation body mass index being 27.22 ± 5.82 Kg/m^2 with range of 10 to 54 Kg/m^2 **(Figure 2).**

Among 20 patients in whom renal scan was indicated for raised creatinine level, 11 (55%) patients` creatinine level was raised, it was normal in 2 (10%), in 7 (35%) of the patients (study participants) the creatinine levels were not documented.

Table 1. Sociodemographic characteristics of the patients, Nuclear medicine unit Pascale National Institute of cancer 2017 - 2022

		Frequency	Percent
Age category	17 — 30	4	1.5
	31 — 39	7	2.6
	40 — 49	15	5.7
	50 — 59	67	25.3
	> 60	172	64.9
	Total	265	100.0
Sex of the patients	Male	132	49.8
	Female	133	50.2
	Total	265	100.0

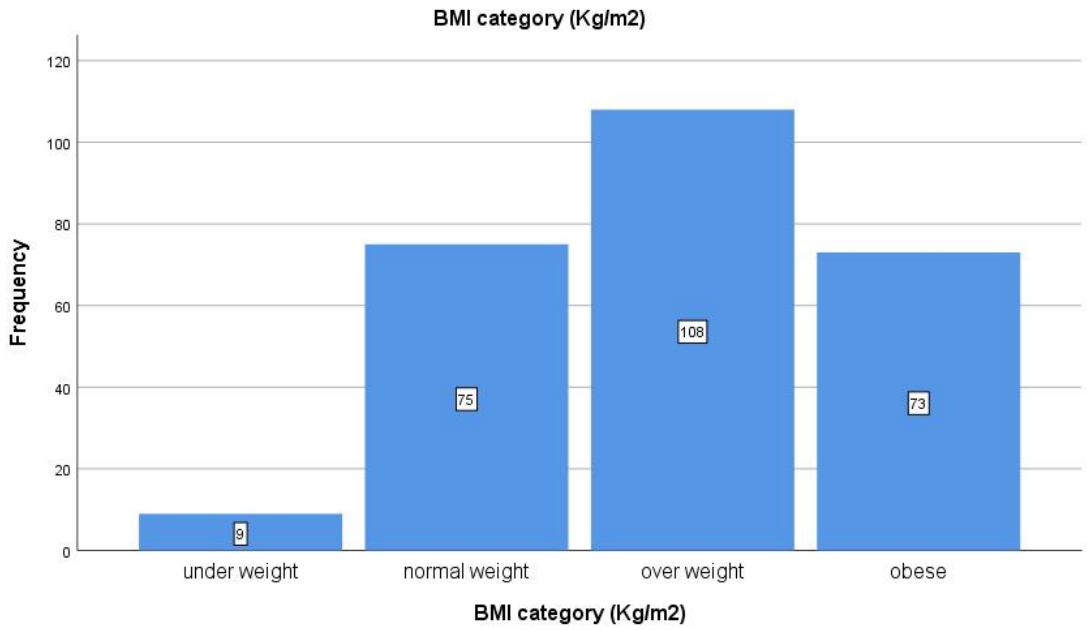

Figure 2. Body mass index of the patients, Nuclear medicine unit Pascale National Institute of cancer 2017 - 2022

5.2 Creatinine level of the patients

The serum creatinine level was raised in 32 (12.1%) patients and in 179 (67.5%) patients serum creatinine level were not documented, while it is in the normal range in 54 (20.4%), the mean and standard deviation serum creatinine level being 1.40 ± 0.80 mg/dl with a range of 0.51 to 6.00 mg/dl **(Figure 3).**

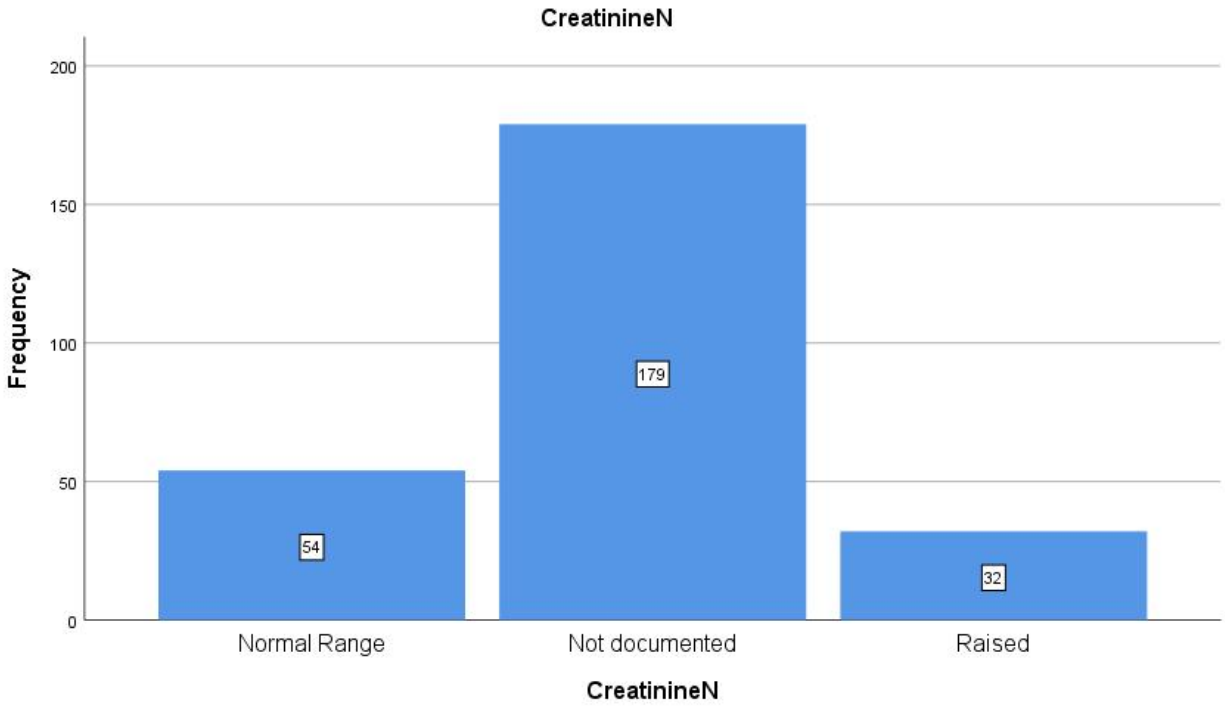

Figure 3. Creatinine level of the patients, Nuclear medicine unit Pascale National Institute of cancer 2017 - 2022

5.3 Procedures and radiopharmaceuticals used

The procedure done for almost all patients 262(98.9%) was dynamic (standard) renal scintigraphy, while diuretic renal scintigraphy has been performed only for 3 (1.1%) patients.

During standard renal scan patients were well hydrated and radiopharmaceutical bolus was injected to the patients on the imaging table, then images were acquired in dynamic scan for about 30 minutes and delayed post micturition static image was acquired if necessary. For diuretic renal scan furosemide 0.5 mg/kg was adminstered generally 15 to 20 minutes after administration of radiopharmaceutical.

During both standard and diuretic renal scintigraphy the radiopharmaceutical used was Tc-99m-DTPA.

5.4. Indications of renal scintigraphy

Among patient records with renal scintigraphy reviewed, the majority 110 (41.5%) [30 bilateral kidneys, 40 right kidneys and 40 left kidneys] were indicated for evaluation of patients with various degree of hydronephrosis. The second most common indication was for evaluation of kidney function in patient with renal cancer 91 (34%) [57 left renal cancer, 33 right renal cancer and 1 bilateral renal cancer] **(Table 2).**

Table 2. Indications of renal scintigraphy, Nuclear medicine unit Pascale National Institute of cancer 2017 - 2022

Indications of renal scintigraphy	Frequency	Percent
Bilateral hydronephrosis	30	11.3
Left hydronephrosis	40	15.1
Right hydronephrosis	40	15.1
Right renal cancer	33	12.5
Left renal cancer	57	21.5
Bilateral renal cancer	1	.4
Raised creatinine	20	7.5
Renal function (status) evaluation	41	15.5
Right kidney pyelonephritis	1	.4
Right ureteral cancer	2	.8
Total	265	100.0

5.5 Results of renal scintigraphy.

5.5.1 Global and separate estimated glomerular filtration rate.

Global (total) and separate estimated glomerular filtration rate (corrected for body surface area) that were determined by ^{99m}Tc-DTPA camera based method (gates method) was analyzed from patient records. To the knowledge of the investigator currently there are no guidelines that categorize radionuclide imaging based GFR result into normal, moderately reduced and severely reduced.

In the study institution the global GFR >75ml/min is generally taken as normal. Depending on this the mean and standard deviation total corrected GFR is 64.7 ± 21.3 ml/min with range of 6 to 125 ml/min **(Table 3).**

GFR are estimated by camera based (gates method) in all patient records and there is no measured GFR by blood sampling techinique as standard to compare it with.

There is no significant difference between male and female (p = 0.11) and among BMI group regarding mean global GFR but there is significant difference between age groups regarding mean GFR at level 0.05 (P,0.00).

There is significant correlation between GFR and age of the patients and creatinine level by 2 tailed, pearson , Bivarate correlation (p 0.01) **(Table 8).**

Table 3. Global and separate glomerular filtration rate, Nuclear medicine unit Pascale National Institute of cancer 2017 - 2022

	Global glomerular filtration rate (ml/min)	glomerular filtration rate of RIGHT kidney (ml/min)	glomerular filtration rate of LEFT kidney (ml/min)
Mean	64.738	33.305	31.471
Std. Deviation	21.3188	15.0758	16.1412
Minimum	6.0	.0	.0
Maximum	125.0	76.0	70.0

Global GFR	Frequency	Percent
normal	104	39.2
reduced	161	60.8
Total	265	100.0

5.5.2 Split renal functions.

Split renal function indicates contribution of each kidney to overall renal function.
So 530 renal unit were evaluated for each kidney contributions to global renal function and the result was categorized as normal, moderately reduced and severely reduced, as per Ransley et al 1990, 202 out of 265 (76.2%) right kidney and 188 out of 265 (70.9%) left kidneys contribution were normal **(Table 4)**.

Table 4. Split renal function of the patients, Nuclear medicine unit Pascale Institute of cancer 2017 - 2022

	Split renal function	Frequency	Percent
Split renal function of Right kidney	moderately reduced	45	17.0
	normal	202	76.2
	severely reduced	18	6.8
	Total	265	100.0
Split renal function of Left kidney	moderately reduced	49	18.5
	normal	188	70.9
	severely reduced	28	10.6
	Total	265	100.0

5.5.3 Renogram curve result.

Renogram curve report of all 530 renal units were analyzed with special consideration of the excretory phase of renogram and the result were put as in figure below. Majority of renal unit 174 of 265 (65.7%) right kidney and 173 of 265 (65.3%) left kidneys were normally excreting the injected radio-pharmaceuticals, while 30 of 265 (11.3%) right kidneys and 28 of 265 (10.6%) left kidneys showed functional partial obstruction **(Table 5).**

Among 110 patient in whom renal scintigraphy are indicated for evaluation of hydronephrosis 83 (39%) renal unit were normal, 53 (24%) showed functional obstruction, and 38 (17%) renal unit showed anatomical obstruction while 39 (17.7%) renal units were difficult to evaluate **(Table 6).**

Table 5. Renogram results of the patients, Nuclear medicine unit Pascale National Institute of cancer 2017 - 2022

		Frequency	Percent
Right renogram curve result	Functional obstruction	30	11.3
	Anatomical obstruction	26	9.8
	Normal	174	65.7
	Difficult to evaluate	26	9.8
	Non functional kidney	9	3.4
	Total	265	100.0
Left renogram curve result	Functional obstruction	28	10.6
	Anatomical obstruction	18	6.8
	Normal	173	65.3
	Difficult to evaluate	34	12.8
	Non functional kidney	12	4.5
	Total	265	100.0

Table 6. Cross tabulation of indications and renogram curve results, Nuclear medicine unit Pascale National Institute of cancer 2017 - 2022

	Right renogram curve result					
Indication of the renal scan	functional obstruction	Anatomical obstruction	Normal	Difficult to evaluate	non functional kidney	Total
bilateral hydronephrosis	12	6	10	2	0	30
left hydronephrosis	4	7	29	0	0	40
right hydronephrosis	11	9	4	15	1	40
Total	27	22	43	17	1	110

	Left renogram curve result					
Indication of the renal scan	functional obstruction	Anatomical obstruction	Normal	Difficult to evaluate	non functional kidney	Total
Bilateral hydronephrosis	14	6	6	4	0	30
left hydronephrosis	8	8	4	17	3	40
right hydronephrosis	4	2	33	1	0	40
Total	26	16	43	22	3	110

5.6 Risk factors for renal disorders.

The patient records were analyzed for commorbidities and risk factors of renal malfunctions, some of the patients have more than one risk factors and the result are as below.

The most common risk factor for renal disorder was renal cancer that involves 63 (23.8%) patients, followed by renal cancer + obesity in 34 (12.8%) of the patients. For 27 (10.2%) patients there were no risk factors documented **(Table 7)**

In literature and from basic science it is known that risk factor of renal disorder also includes hypertension, diabetes mellitus, heart disease, family history of CKD, inherited kidney disorders and past damage to the kidneys, but during data collection it is found that the these variables sometime may be not recorded in patient history, or in some of the patient record it is recorded in follow up visits that were in exclusion criteria, so those variables were removed from data collection format so that it does not give false figure.

Table 7. Risk factors of renal disorders, Nuclear medicine unit Pascale National Institute of cancer 2017 - 2022

Risk factors of renal disorders.	Frequency	Percent
multiple sclerosis	1	.4
renal artery aneurysm	1	.4
obesity + ureteral cancer	1	.4
uterine cancer + obesity	1	.4
renal infection	1	.4
bladder cancer + obesity	2	.8
intra abdominal mass + obesity	2	.8
Intra Abdominal mass	3	1.1
ectopic kidney	4	1.5
urolithiasis + obesity	4	1.5
prostate cancer + obesity	5	1.9
cervical cancer + obesity	5	1.9

	prostate cancer	7	2.6
	renal cyst	8	3.0
	uterine cancer	15	5.7
	Obesity	19	7.2
	ureteral cancer	19	7.2
	cervical cancer	21	7.9
	Urolithiasis	22	8.3
	no risk factor documented	27	10.2
	renal cancer + obesity	34	12.8
	renal cancer	63	23.8
	Total	265	100.0

Table 8. Correlation of GFR, BMI, Age and Serum creatinine of patients, Nuclear medicine unit Pascale National Institute of cancer 2017 - 2022

Correlation

		Global glomerular filtration rate (ml/min)	Age of the patient (yrs)	Plasma ceratinine level (mg/dl)	Body mass index (Kg/m2)
Global glomerular filtration rate (ml/min)	Pearson Correlation	1	-.336	-.579	.033
	Sig. (2-tailed)		.000	.000	.595
	Sum of Squares and Cross-products	119985.788	-23132.721	-919.347	1073.687
	Covariance	454.492	-87.624	-10.816	4.067
	N	265	265	86	265

6 Discussion

In this work we found that in the study population the proportion of male to female ratio was 1:1 and most of patients were in the age category of more 60 years old.
In our study, the indications and results of renal scintigraphy among patients referred for renal scintigraphy were assessed by analyzing the medical records of those patients referred for renal scintigraphy over five years time period.

Based on our study from patients' records, the common indications of renal scintigraphy in decreasing order of frequency were for evaluation of patient with various degree of hydronephrosis, renal cancer, renal function (status) evaluation (for cases like pre-operative evaluations and follow-up for patients on chemotheraphy), incidental finding of raised creatinine, renal cyst and ureteral cancer.

These results are in line with study conducted on the use of nuclear renal imaging in the United States and Published on Oct. 27, 2016, in which the indication of renal scintigraphy from the most common to the least common were renal obstruction, split renal function, renovascular hypertension, and renal transplantation (Archer, K. D & Bolus, N. E, 2016).
In this study the second most common indication of renal scintigraphy was for evaluation of patient with renal cancer; as opposed to the finding from the study conducted in United States mentioned above: this could be explained by the fact that the study institution is an oncology center.

Regarding the most frequently performed procedures and radio-pharmaceuticals used, in our study we found that almost all patients underwent standard scintigraphy dynamic renal scintigraphy and the radio-pharmaceutical used was exclusively ^{99m}Tc-DTPA.
This finding is in contrast to findings of the study regarding the use of nuclear renal imaging in the United States and published on Oct. 27, 2016 in which 91% of the departments used 99mTc-MAG3 more often, and while the rest 9% used 99mTc-DTPA.

This difference could be explained by differences in preference of radio-pharmaceutical used according to American and European guidelines as it is supported by study from Turkiye (Europe) on Comparison of ^{99m}Tc- DTPA and ^{99m}Tc- MAG3 which has shown sensitivity of DTPA perfusion pattern for diagnosing dysfunction was signifificantly greater than that for MAG3(Aktas, A., *et al,* 2006) and study from Thailand on Comparison between ^{99m}Tc- DTPA and ^{99m}Tc- MAG3 Renal Scintigraphy which concludes that ^{99m}Tc- MAG3 had superior predictiveness compared with ^{99m}Tc- DTPA (Theerakulpisut, D *et al.*, 2021)

Regarding renogram curve analysis with special consideration of the excretory phase, most of the renal units were found to be normally excreting radiopharmaceuticals, and 11% of renal unit showed partial functional obstruction, 8% of renal units showed complete anatomical obstructions, while 4% of renal units appeared to be non excreting (non functional) kidneys.

Among 110 patients in whom renal scintigraphy was indicated for evaluation of hydronephrosis, 86 (39%) renal units were normal, 53 (24%) showed functional obstruction, 38 (17%) renal units showed anatomical obstruction, 39 (18%) of them were difficult to evaluate while 4 renal units were non functional, which is in line with the study conducted at Dokuz Eylul University Pediatric Nephrology clinic Turkey and published on 2017 on the contribution of dynamic renal scintigraphy with ^{99m}Tc-MAG-3 in the clinical decision-making for surgery in hydronephrotic children, involving 178 patients (356 renal units) out of which 218 (61%) renal unit were hydronephrotic and 84 of 218 (39%) hydronephrotic renal unit showed anatomical obstruction on ^{99m}Tc-MAG-3 renal scintigraphy, this difference in figure could be from the difference in sample size and study population characteristics (Seçil Arslansoyu *et al*., 2017)

By linear regression there is significant effect of age and serum creatinine level on GFR (p-0.00). By independent sample t test there is no significant difference between male and female regarding mean global GFR (p = 0.11). By one way Anova there is significant difference between age groups regarding mean GFR at level 0.05 (P,0.00), but no significant difference among BMI group regarding the mean GFR

The most common risk factor for renal disorder was renal carcinoma (23.8%) followed by renal cancer + obesity (12.8%) and urolithiasis (8.3%) , this figures could be from the fact that the study institution is a oncologic center.

On correlational analysis between global glomerular filtration rate, body mass index, age and serum creatinine level, correlation of global glomerular filtration rate to serum creatinine level and patients age is significant at 0.01 level **(Table 8)**.

7. Strength and Limitation of the Study

7.1. Strength of the study

One of the primary strengths of this study is that the sample size (n = 256) was relatively adequate, and the sampling technique used was probability sampling technique. In addition, the use of multiple sources of information (medical registers, images, and reports of images) represented another strength of the study.

7.2. Limitation of the study

It is important to mention that this study has limitations. Since it is a retrospective study, it provides lower level of evidence compared with prospective studies and prone to selection bias.

Moreover for more than half of the patients serum creatinine level were not documented in patients records.

Variables for renal risk factor assessment like DM, Hypertension, Family history of DM and others were not documented and difficult to track and hence removed from data collection format.

8. Conclusion and recommendation

8.1. Conclusion

In conclusion, the most common indication of renal scintigraphy in the study area is for evaluation of patients with various degrees of hydronephrosis followed by renal carcinoma, renal functional status evaluation and raised creatinine.

The most common procedure performed in the study institution for renal scintigraphy was dynamic (standard) renography followed , in few patients, by diuretic renography. The only radiopharmaceutical used in the study institution for renal scan were ^{99m}Tc-DTPA and the most common risk factor for renal disorder in the study institution were renal carcinoma.

8.2. Recommendation

To the nuclear medicine unit of Pascale national institute of cancer.

Referring physician as well as reporting physicians should make sure that the patient informations is completely recorded as some of the patient records were incomplete and excluded from the study.

Renal scintigraphy is recommended in evaluation of patients with obstructive urophathies of any causes.

Use of plasma based GFR measurement is recommended to use it as an standard measurement of renal clearance and filtration function

To researchers.

Prospective studies on similar topic are recommended as prospective study solves the limitations associated with retrospective study like missing of certain parameter from patient records.

9. References

Aktaş, A., Aras, M., Colak, T., Gençoğlu, A., & Karakayali, H. (2006). Comparison of Tc-99m DTPA and Tc-99m MAG3 perfusion time-activity curves in patients with renal allograft dysfunction. Transplantation proceedings, 38(2), 449–453. https://doi.org/10.1016/j.transproceed.2006.01.006

Alsabea,H (2017) *Type of Renal Scintigraphy*. J Nucl Med Radiat Ther 8:347. doi: 10.4172/2155-9619.1000347

Andrew Taylor and Joseph V Nally (1995) *The clinical application of renal scintigraphy.* Review Article January 1995.

Archer, K. D., & Bolus, N. E. (2016) *Survey on the Use of Nuclear Renal Imaging in the United States.* Journal of nuclear medicine technology, 44(4), 223–226. https://doi.org/10.2967/jnmt.116.181339

Blaufox, M. *et al*. (2018) *The SNMMI and EANM practice guideline for renal scintigraphy in adults.* European journal of nuclear medicine and molecular imaging, 45(12), 2218–2228. https://doi.org/10.1007/s00259-018-4129-6

Banker, H., Sheffield, E. G., & Cohen, H. L. (2021) *Nuclear Renal Scan*. In StatPearls. StatPearls Publishing.

Bhatnagar. *et al.* (2002) *The role of DMSA scans in evaluation of the correlation between urinary tract infection, vesicoureteric reflux, and renal scarring.* Pediatr Surg Int 18, 128–134 . https://doi.org/10.1007/s003830100680

Centers for Disease Control and Prevention (2021) *Chronic Kidney Disease Surveillance System* Available at: https://nccd.cdc.gov/CKD (Accessed 20/08/2022)

Csaba P. Kovesdy. (2021) *Epidemiology of chronic kidney disease: an update 2022*

Claudia Marino.*et al. (*2020) *Prevalence of chronic kidney disease in the Lazio region, Italy: a classification algorithm based on health information systems*

Cheru Kore. *et al.* (2018) *The Magnitude of Chronic Kidney Disease and its Risk Factors at Zewditu Memorial Hospital, Addis Ababa, Ethiopia.*

Ching Yeen. et al. (2022) Value of Baseline Post-Transplant MAG3 Renal Scintigraphy in the Evaluation of Graft Function. Transplantation Proceedings. https://doi.org/54. 10.1016/j.transproceed.2021.12.016.

Domenico Santoroa.*et al*.(2014) *Cross-Sectional Evaluation of Kidney Function in Hospitalized Patients:Estimated GFR Versus Renal Scintigraphy* https://www.humanitas.net/health/health-a-z/kidneys-urology/*42…* *20/06/2019* (Accessed 20/08/2022)·

Graham W. Lipkin, Puchimada Uthappa, Jason Moore,Chapter 64 - Renovascular Hypertension,2007,Pages 775-791, ISBN 9780323039611, https://doi.org/10.1016/B978-0-323-03961-1.50067-2.

Hill, N. R., Fatoba, S. T., Oke, J. L., Hirst, J. A., O'Callaghan, C. A., Lasserson, D. S., & Hobbs, F. D. (2016). *Global Prevalence of Chronic Kidney Disease - A Systematic Review and Meta-Analysis. PloS one*, *11*(7), e0158765. https://doi.org/10.1371/journal.pone.0158765

lsubhi, M.H. *et al*. (2022) *A Correlation Study of the Effectiveness of Renal Scintigraphy and Sonography in the Detection and Evaluation of Renal Disorders.* Journal of Biosciences and Medicines, 10, 56-65.

Jonathan S. *et al*. (2020) *Acute Kidney Injury Caused by Obstructive Nephropathy.* Review Article 29 November 2020.

Kevin P.G. et al (2010) *Comprehensive Clinical Nephrology* (Fourth Edition), 2010

Lv, J. C., & Zhang, L. X. (2019). *Prevalence and Disease Burden of Chronic Kidney Disease. Advances in experimental medicine and biology,* 1165, 3–15. https://doi.org/10.1007/978-981-13-8871-2_1

Levey, A. S., & Coresh, J. (2012). *Chronic kidney disease. Lancet* (London, England), 379(9811), 165–180. https://doi.org/10.1016/S0140-6736(11)60178-5

Locatelli, F., Pozzoni, P., & Del Vecchio, L. (2003). *Epidemiology of chronic kidney disease in Italy: possible therapeutical approaches.* Journal of nephrology, 16(1), 1–10.

Lorberboym, M. *et al.*(2000) *The role of renal scintigraphy and unenhanced helical computerized tomography in patients with ureterolithiasis.* Eur J Nucl Med 27, 441–446 (2000). https://doi.org/10.1007/s002590050528

O'Reilly, P H, Shields, R A, & Testa, H J (. Nuclear medicine in urology and nephrology. United States.

Paweł Cichocki. *et al*. (2021) *Assessment of Renal Function Based on Dynamic Scintigraphy Parameters in the Diagnosis of Obstructive Uro/Nephropathy* 2 February 2021

Raluca Mititelu, Ovidiu Bratu. (2017) *Radionuclide Imaging. An Update on the Use of Dynamic Renal Scintigraphy.* Review Article. 4 November 2017.

Sfakianaki, E.*et al.* (2013). *Renal scintigraphy in the acute care setting. Seminars in nuclear medicine,* 43(2), 114–128. https://doi.org/10.1053/j.semnuclmed.2013.01.001

Seçil Arslansoyu. *et al.* (2017) *The Role of Dynamic Renal Scintigraphy on Clinical Decision Making in Hydronephrotic children.*2017

Taylor A. T. (2014) *Radionuclides in nephrourology, Part 2: pitfalls and diagnostic applications.* Journal of nuclear medicine : official publication, Society of Nuclear Medicine, 55(5), 786–798. https://doi.org/10.2967/jnumed.113.133454

Theerakulpisut, D., Thinkhamrop, B. & Anutrakulchai, S. Comparison between Tc-99 m DTPA and Tc-99 m MAG3 Renal Scintigraphy for Prediction of Early Adverse Outcome After Kidney Transplantation. Nucl Med Mol Imaging 55, 302–310 (2021). https://doi.org/10.1007/s13139-021-00716-4

Volkan-Salanci, B., & Erbaş, B. (2022). *Diuretic Renal Scintigraphy in Adults: Practical Aspects and Reporting.* Seminars in nuclear medicine, 52(4), 445–452. https://doi.org/10.1053/j.semnuclmed.2021.12.006

Werner, R. A., Chen, X., Lapa, C., Koshino, K., Rowe, S. P., Pomper, M. G., Javadi, M. S., & Higuchi, T. (2019). *The next era of renal radionuclide imaging: novel PET radiotracers. European journal of nuclear medicine and molecular imaging,* 46(9), 1773–1786. https://doi.org/10.1007/s00259-019-04359-8

10. Annexes.

10.1. Data collection form.

Assesment of renal Scintigraphy indications and results among patients referred for renal,scan at nuclear medicine unit, Istituto Nazionale Tumori IRCCS-Fondazione G-Pascale from November 1, 2017 to October 31, 2022.

1.Patient code: - weight:- height:- BMI:-

2.Age of the patient: -

3.Sex of the patient: - A, male B, female

4.Procedure: -

A) Dynamic renography B) Diuretic renography C) Cortical scan D) Captopril scan

5. Serum createnine level

A) normal range B) raised C) not documented

6.Radio-pharmaceutical used: -

A) Tc-99m-DTPA B) Tc-99m-MAG3 C) Tc-99m-DMSA

7.Indication: -

A) renal obstruction B) renovascular hypertension C) renal transplantation D) other

8.Result of the scan:

Global eGFR……..

Separate eGFR……

SRF…….

Renogram curve result…

9. Risk factor of renal disorder identified

A) Renal cancer

B) Intra-abdominal uro-obstructive lesions

C) Bladder cancer

D) Urolithiasis

E) others……

10.2. Ethical clearances

November 1, 2022

Protocol Title: "Assessment of Renal Scintigraphy, Indications and Results, Among Patients Referred For Renal Scintigraphy at Nuclear Medicine Unit, Instituto Nazionale Tumori IRCCS-Fondazione Pascale"

Dr. Ziyad Abrahim

Permission to conduct your research at Pascale Hospital

Istituto Nazionale Tumori IRCCS Fondazione G. Pascale has grant to you a permission to conduct the above mentioned research at Nuclear Medicine Unit, Pascale Hospital. The research proposal has no ethical issue and was approved. The Manuscript/thesis is only intended for academic purpose (Graduation thesis defense at Addis Ababa University).

The final thesis should be submitted to both Addis Ababa University and Istituto Nazionale Tumori IRCCS Fondazione G. Pascale.

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