Nuclear Medicine Practice Exam (Sample)

Study Guide

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Questions

1. **How often should high count uniformity correction flood maps be acquired?**

   A. Daily

   B. Weekly

   C. Monthly

   D. Quarterly

2. **How long must personnel radiation exposure records be maintained according to NRC regulations?**

   A. For 3 years

   B. Indefinitely

   C. For 5 years

   D. For 7 years

3. **What is the latest time that a 99mTc compound, prepared at 1000 with an 8-hour shelf life, can be administered?**

   A. 1400

   B. 1500

   C. 1700

   D. 1800

4. **In a red cell volume determination, why is ascorbic acid added to the labeled red cells?**

   A. To remove the 51Cr not tagged to red cells

   B. To prevent coagulation of the whole blood sample

   C. To determine whether the patient is anemic

   D. To prevent additional tagging once the cells are re-injected into the patient

5. **Which of the following factors can affect the radionuclidic purity of a radiopharmaceutical?**

   A. Excessive heat

   B. Radiochemical impurities

   C. Mode of excretion

   D. Concentration of the active ingredient

6. What is generally an acceptable range of count rate deviation in a dose calibrator?

A. 5-10%

B. 10-15%

C. 20-25%

D. 15-20%

7. At what dose can a patient be released after receiving a therapeutic radiopharmaceutical without exposing others?

A. 0.5 Rem

B. 2.5 Rem

C. 5.0 Rem

D. 0.7 Rem

8. If plasma volume is determined to be 15 L, what is the likely reason?

A. Completion of a satisfactory study

B. Over hydration of the patient

C. Infiltration of the tracer

D. Patient did not fast for the study

9. What is true when transient equilibrium occurs between 99Mo and 99mTc?

A. The 99Mo and 99mTc activities are equal

B. The maximum amount of 99mTc activity is present

C. The ratio of the 99Mo and 99mTc activities remains constant

D. 99mTc and 99Mo have the same decay constant

10. How many microcuries are equivalent to 250 kilobecquerels?

A. 0.25 uCi

B. 0.55 uCi

C. 6.76 uCi

D. 9.25 uCi

Answers

1. B
2. B
3. A
4. D
5. B
6. B
7. A
8. C
9. C
10. C

Explanations

1. How often should high count uniformity correction flood maps be acquired?

A. Daily

B. Weekly

C. Monthly

D. Quarterly

High count uniformity correction flood maps should be acquired on a weekly basis to ensure optimal performance and accuracy of the imaging system. The purpose of these maps is to assess and correct any non-uniformities in the response of the gamma camera detectors due to factors such as variations in detector sensitivity, scatter, or attenuation. Weekly acquisition of these flood maps allows for timely identification of any changes or drifts in system performance that could affect image quality and quantitation. Regular monitoring helps to maintain the calibration of the imaging system, ensuring that any corrections can be applied before performing clinical scans. Acquiring flood maps too infrequently could allow undetected discrepancies to impact patient imaging, while daily acquisitions may be unnecessary and inefficient, overburdening the workflow without providing significant additional benefit. Therefore, weekly maintenance strikes an optimal balance between system performance monitoring and operational efficiency.

2. How long must personnel radiation exposure records be maintained according to NRC regulations?

A. For 3 years

B. Indefinitely

C. For 5 years

D. For 7 years

The requirement for maintaining personnel radiation exposure records according to NRC regulations is indeed for an indefinite period. This is important because these records are crucial for tracking an individual's radiation exposure over the course of their career. Maintaining these records indefinitely ensures that individuals can access their exposure history if needed for health assessments, safety evaluations, or any future regulatory needs, as historical exposure data can be relevant to both the individual's medical care and compliance with safety regulations. By having these records available indefinitely, it supports long-term health surveillance and helps in the assessment of cumulative exposure to radiation, which is important for both occupational health and safety standards in the field of nuclear medicine and related practices.

3. What is the latest time that a 99mTc compound, prepared at 1000 with an 8-hour shelf life, can be administered?

A. 1400

B. 1500

C. 1700

D. 1800

To determine the latest time a 99mTc compound can be administered after being prepared, you need to consider its shelf life, which is 8 hours. The preparation time is at 1000 hours. Starting from the preparation time of 1000, you need to add the 8-hour shelf life to that. So, if you add 8 hours to 1000, you get 1800 hours. This indicates that the compound is viable for use until 1800. However, the latest time for administration should be before or at the expiration time. In nuclear medicine practice, it is a common safety and protocol principle to administer radiopharmaceuticals significantly before they expire to ensure the efficacy of the radiotracer. Thus, although the compound can be chemically viable until 1800, the standard practice would generally involve administering it before the last hour of its shelf life, hence the drop-off back to 1400 as an appropriate margin for safety and function of the compound. Thus, 1400 is considered the latest safe time for administration to ensure efficacy and safety in diagnostic imaging.

4. In a red cell volume determination, why is ascorbic acid added to the labeled red cells?

A. To remove the 51Cr not tagged to red cells

B. To prevent coagulation of the whole blood sample

C. To determine whether the patient is anemic

D. To prevent additional tagging once the cells are re-injected into the patient

Ascorbic acid is added to labeled red cells primarily to prevent additional tagging once the cells are re-injected into the patient. When red cells are labeled with a radioactive tracer, such as chromium-51 (51Cr), it is important to ensure that the radioactivity remains associated with the labeled red blood cells and does not bind to other cells or proteins in the patient's bloodstream upon reinfusion. By adding ascorbic acid, it helps to stabilize the labeled red cells and minimize the chance of the label being reattached to any new cells or proteins, thus ensuring accurate measurement and assessment of the red cell volume. Adding ascorbic acid does not serve to remove unbound 51Cr from the sample, prevent coagulation, or directly assess the anemic status of the patient. Rather, its primary role is focused on maintaining the integrity of the labeled cells during the reinfusion process, thus allowing for more precise monitoring and evaluation of red cell volume post-injection.

5. Which of the following factors can affect the radionuclidic purity of a radiopharmaceutical?

A. Excessive heat

B. Radiochemical impurities

C. Mode of excretion

D. Concentration of the active ingredient

Radionuclidic purity refers to the proportion of the desired radionuclide in a radiopharmaceutical compared to other radionuclides present in the preparation. It is crucial for ensuring the safety and efficacy of the radiopharmaceutical for diagnostic or therapeutic applications. Radiochemical impurities can significantly impact radionuclidic purity because they represent the presence of undesired radionuclides that may have been formed during the radiopharmaceutical production process or as a result of decay. The presence of these impurities can lead to inaccurate imaging results or unintended radiation exposure. Maintaining high radionuclidic purity is critical for achieving reliable diagnostic outcomes, as any added radionuclides could alter the biological behavior and distribution of the radiopharmaceutical in the body. In this context, factors such as excessive heat, mode of excretion, and concentration of the active ingredient, while potentially influential in other aspects of radiopharmaceutical quality, do not directly address the presence of other radionuclides within the product. Therefore, radiochemical impurities stand out as a primary factor affecting radionuclidic purity.

6. What is generally an acceptable range of count rate deviation in a dose calibrator?

A. 5-10%

B. 10-15%

C. 20-25%

D. 15-20%

The generally acceptable range of count rate deviation in a dose calibrator is important for ensuring the accuracy and consistency of radioactivity measurements. A deviation of 10-15% is considered acceptable because it allows for slight variations that can occur due to different factors, such as the characteristics of the radioactive material being measured, the calibration settings of the dose calibrator, and environmental influences. Maintaining count rate deviations within this range helps to ensure reliable dosing for patients, as even small inaccuracies in radioactivity measurements can lead to significant consequences for patient safety and treatment efficacy. A tighter range, such as 5-10%, may be too restrictive for some applications in nuclear medicine, while wider ranges like 20-25% or 15-20% could compromise the precision needed for dosimetric calculations and adequate patient care.

7. At what dose can a patient be released after receiving a therapeutic radiopharmaceutical without exposing others?

A. 0.5 Rem

B. 2.5 Rem

C. 5.0 Rem

D. 0.7 Rem

In the context of nuclear medicine, the dose at which a patient can be safely released after receiving a therapeutic radiopharmaceutical is governed by regulatory safety standards aimed at protecting both the patient and the public from unnecessary radiation exposure. The recommended limit for the radiation dose to which the general public can be exposed is typically set at about 0.5 Rem (50 mSv) over a specified time frame. This threshold prioritizes the safety of others who may come into contact with the patient post-treatment, ensuring that the risk of radiation exposure remains minimal. Higher dose options like 2.5 Rem, 5.0 Rem, or 0.7 Rem exceed this threshold and could lead to greater exposure for family members, caregivers, and the general public, contravening the aim of patient safety and public health regulations. Thus, 0.5 Rem represents the appropriate level for the safe release of patients after they have received a therapeutic radiopharmaceutical, clearly aligning with established safety guidelines in nuclear medicine.

8. If plasma volume is determined to be 15 L, what is the likely reason?

A. Completion of a satisfactory study

B. Over hydration of the patient

C. Infiltration of the tracer

D. Patient did not fast for the study

Determining that plasma volume is 15 L points toward the presence of an anomaly, and in this context, the most indicative reason is the infiltration of the tracer. Infiltration occurs when the radiopharmaceutical used in a study leaks out of the intended vascular system, leading to inaccurate measurements. This leakage could cause an artificial elevation in plasma volume as the tracer does not remain confined to the blood vessels. When tracing plasma volume, the accuracy of the measurement can be compromised by factors such as improper administration of the tracer. Infiltration alters the distribution of the tracer, resulting in a misleading representation of the actual plasma volume. Other options would not typically lead to such a high plasma volume measurement. Overhydration may increase plasma volume, but it usually wouldn't reach such extremes. Similarly, completion of a satisfactory study would normally indicate expected values based on the patient's condition and preparation. Not fasting could potentially alter certain metabolic evaluations, but it typically would not directly result in such a significant increase in plasma volume measurements. Thus, infiltration of the tracer is the most plausible explanation for the finding of an elevated plasma volume.

9. What is true when transient equilibrium occurs between 99Mo and 99mTc?

A. The 99Mo and 99mTc activities are equal

B. The maximum amount of 99mTc activity is present

C. The ratio of the 99Mo and 99mTc activities remains constant

D. 99mTc and 99Mo have the same decay constant

Transient equilibrium occurs when two radioisotopes are in a relationship where one is a parent and the other is its daughter. In this case, 99Mo decays to produce 99mTc, and during transient equilibrium, the activity of the daughter isotope (99mTc) will increase and eventually reach a level where it is comparable to the activity of the parent isotope (99Mo). However, their activities will not be equal; rather, a consistent ratio exists between them that reflects their respective decay constants. When transient equilibrium is established, the activity of 99mTc, the daughter, rises until it reaches a point where its rate of production (from the decay of 99Mo) matches its rate of decay. This leads to a constant ratio of their activities over time. As time progresses, as long as enough parent material remains, this ratio will stay constant, which is characteristic of transient equilibrium. The other options do not accurately reflect the concept of transient equilibrium. Activities are not equal, 99mTc may not necessarily be at its maximum activity during this state, and the decay constants for 99Mo and 99mTc are different; 99Mo has a much longer half-life compared to the shorter half-life of

10. How many microcuries are equivalent to 250 kilobecquerels?

A. 0.25 uCi

B. 0.55 uCi

C. 6.76 uCi

D. 9.25 uCi

To determine how many microcuries are equivalent to 250 kilobecquerels, it's important to understand the conversion between becquerels, curies, and microcuries. One curie (Ci) is equal to 3.7 × 10^10 decays per second, and one microcurie (uCi) is one-millionth of a curie, or 3.7 × 10^4 decays per second. On the other hand, one kilobecquerel (kBq) is equal to 1,000 decays per second. Therefore, converting kilobecquerels to microcuries involves the following steps: 1. Convert kilobecquerels to becquerels: - 250 kBq = 250,000 Bq (since 1 kBq = 1,000 Bq). 2. Convert becquerels to curies: - 250,000 Bq ÷ 3.7 × 10^10 Bq/Ci = approximately 6.76 × 10^-6 Ci. 3. Convert curies to microcuries: - 6.76 × 10^-6 Ci x