

An Evaluation of Gastric Emptying Scintigraphy Protocols in Health Care Institutions When Compared with the Society of Nuclear Medicine and Molecular Imaging Procedure Guidelines

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This study aimed to analyze the compliance of health care institutions with the Society of Nuclear Medicine and Molecular Imaging (SNMMI) procedure guidelines for gastric emptying scintigraphy (GES). **Methods:** A 19-question survey on demographics and the GES protocol was conducted using a Google form. The demographic questions covered position, number of technologists in the department, location, type of health care institution, and number of GES studies per month. The protocol questions included patient preparation, meal preparation, withholding of scheduled medications, radiopharmaceutical type, and radiopharmaceutical dose. The survey was sent to 7 nuclear medicine Facebook groups and a list of clinical affiliates provided by the Indiana University School of Medicine Nuclear Medicine Program. Descriptive statistics were compiled for most questions. A Fisher exact test with a significance level of 0.05 was used to compare the type of health care institution with compliance with the SNMMI GES protocol regarding radiolabeling time, meal preparation, and meal components, as well as to compare the type of health care institution with the number of GES studies performed per institution. **Results:** In total, 240 people responded to the survey. Most were nonsupervisory nuclear medicine technologists (72%) in nonacademic institutions (72%) and groups with 4 or more technologists (62%). Of the respondents, 72% followed the SNMMI guideline of adding the radiopharmaceutical before cooking, but only 37% followed the meal component guideline. There was no significant association between the type of institution or the number of GES studies and compliance with radiolabeling time or with meal preparation or components. Most respondents asked patients to withhold medications per SNMMI guidelines and used the recommended radiopharmaceutical (^{99m}Tc-sulfur colloid, 95%) at the recommended dose (18.5–37 MBq, 84%). **Conclusion:** Although most respondents followed most aspects of the SNMMI guidelines for GES, more than half did not use the recommended meal of liquid egg whites. Compliance did not vary between academic and nonacademic institutions or between groups performing a large or a small number of GES studies.

Key Words: gastric emptying scintigraphy; SNMMI; egg whites; compliance

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Gastric emptying scintigraphy (GES) is a diagnostic test to assess gastric motor function (1). GES was first developed in 1966, using “a standard breakfast of ordinary food” labeled with ⁵¹Cr (2). The radiolabeling of the meal allowed quantitative measurement of radioactivity in the stomach at specific time points and the percentage remaining of the meal, often allowing for diagnosis and treatment (3). Since then, there have been trials of which radiopharmaceutical and meal components are best used to obtain accurate results (3).

In 2013, the Society of Nuclear Medicine and Molecular Imaging (SNMMI) published a procedure guideline for adult solid-meal GES (4). The standardized meal recommended by the SNMMI protocol includes 118 mL (4 oz) of liquid egg whites, 2 slices of toasted bread, 30 g of jam or jelly, and 120 mL of water (4). The ^{99m}Tc-SC is added to the liquid egg whites, stirred, and then cooked in a microwave oven or skillet until the egg whites reach the consistency of an omelet (4). Oatmeal may be radiolabeled with ^{99m}Tc-SC as an alternative for patients with an albumin allergy, but radiolabeling efficiency has been shown to be much lower with oatmeal, causing inaccurate reference values (5). Research on alternative meals results in a lack of standardization and inconsistent results (5).

To achieve optimal radiolabeling efficiency and reproducible outcomes, the liquid egg whites must be cooked together with the ^{99m}Tc-sulfur colloid (SC) (1) because ^{99m}Tc-SC binds to the egg white protein as it becomes denatured during the cooking process (6). Thus, the egg whites must be cooked with the ^{99m}Tc-SC for the procedure to be considered a solid-meal GES. The study will be regarded as a liquid GES and provide exponentially different results if the egg whites are not cooked with the ^{99m}Tc-SC.

Health care institutions that have established their own protocols for GES may need to adhere to the guidelines set by the SNMMI (4). If the standardized meal and preparation for solid GES are not followed (1), published reference values are inaccurate and cannot be used, making it difficult to compare results between different health care institutions that use different meals or imaging protocols (4). Standardization of the GES protocol eliminates this problem and also

TABLE 1
Survey Questions

Category	Question
Demographic	1. What is your position?
	2. How many technologists work in your department (all positions: as needed, part-time, full-time)?
	3. Is your institution outside Indiana?
	4. If you answered yes to previous question, in which state/country is your institution?
	5. What type of facility is your institution?
	6. On average, how many GES studies are ordered/performed per month?
Patient preparation	7. Which pharmaceuticals must patients stop using before GES (check all that apply)?
	8. What is withholding time for pharmaceuticals listed in previous question?
Meal components and preparation	9. Are serum glucose levels tested before patients undergo GES?
	10. What protocol is used for patients who have albumin/egg allergy?
	11. What is used to radiolabel GES meal?
	12. Please list anything else that is part of meal (toast, jelly, butter, salt pepper, milk, etc.).
Imaging protocol	13. Is GES meal radiolabeled before or after cooking?
	14. Which radiopharmaceutical is used for GES?
	15. What dose range is used for GES?
	16. Are patients required to eat their GES meal within a time limit?
	17. What are the imaging interval times and total examination time (e.g., images at 1, 2, and 4 h and total time of 4 h)?
	18. Are patients allowed to drink water or fluids during intervals between imaging?
	19. What imaging views are required?

allows the patient's progress to be tracked over time (7). The primary objective of this study was to analyze health care institutions' compliance with SNMMI procedure guidelines for GES.

MATERIALS AND METHODS

Institutional Review Board approval for this prospective study was sought, and the study was deemed exempt from the requirement for written informed consent.

A survey of 19 questions was created using a Google form, made available for 4 wk on 7 different nuclear medicine technologist Facebook (Meta) groups, and emailed to 10 nuclear medicine technologist supervisors whose names were provided by the Nuclear Medicine Program of the Indiana University School of Medicine. All participants were notified that the survey would be anonymous and conducted exclusively for research and educational purposes. Demographics, patient preparation, and meal preparation were the topics of the survey (Table 1). The demographic questions included the position of the respondent, the number of technologists in the department, the location and type of facility (nonacademic, Veterans Administration/military, academic, outpatient), and the number of GES studies performed per month. The patient preparation questions included which medications were withheld before the examination and for what duration. The meal preparation questions included the meal chosen for the GES study, the alternatives for patients with an albumin or egg allergy, any additional meal components, the radiopharmaceutical and dose, and the eating time limit.

Descriptive statistics were compiled for most questions: a Fisher exact test with a significance level of 0.05 was used to compare

the type of health care institution with compliance with the SNMMI GES protocol regarding radiolabeling time and meal preparation/components, as well as to compare the type of health care institution with the number of GES studies performed per month. A *P* value of less than 0.05 allowed rejection of the null hypothesis that GES protocols in health care institutions comply with SNMMI procedure guidelines. The alternate hypothesis was that GES protocols in health care institutions are not compliant with SNMMI procedure guidelines.

RESULTS

Table 2 summarizes demographics. Hospitals with no academic affiliation were the most common type of health care institution (57.0%), and nuclear medicine technologists were the most common type of position (72%). Most respondents were in nuclear medicine departments that had 4 or more technologists (62.0%). Health care institutions performed an average of 9.5 GES studies monthly (range, 0–60) (Table 2).

Of the 240 respondents, 218 were from the United States; the remaining 22 were from Canada, Pakistan, Australia, Croatia, the United Kingdom, Kosovo, and Ethiopia. The most represented states were Texas, Florida, and Indiana (Fig. 1).

Only 37% of health care institutions follow the SNMMI consensus meal guidelines (Fig. 2). Those that do not comply with the guidelines use ingredients such as whole eggs, grits, macaroni and cheese, sausage, and oatmeal for their main radiolabeling meal.

TABLE 2
Summary of Demographic Data ($n = 240$) such as Institution Type, Position Type, and Number of Technologists in Department

Variable	Category	Frequency (n)	%
Institution type	Hospital (nonacademic)	137	57.0
	Academic	66	27.5
	Veterans Administration/military	8	3.3
	Outpatient	22	9.1
	Other	7	2.9
Position type	NMT	173	74.1
	Supervisor NMT	56	24
	Nuclear medicine physician	3	1.3
	NMT program director	1	0.4
	PET/CT technologist	2	0.8
	NMT instructor	1	0.4
	Student	3	1.3
	Other	1	0.4
Number of staff in department	1	18	7.5
	2	18	7.5
	3	55	22.9
	≥ 4	149	62.0

NMT = nuclear medicine technologist.
GES monthly volume has mean of 9.58, median of 7.5, and range of 0–60.

Additionally, 4.5% of health care institutions use fatty or high-caloric drinks such as Ensure (Abbott Laboratories) or Boost (Nestlé) for their main meal. Around 14.5% of health care institutions use ingredients not recommended in the guidelines, including butter, saltine crackers, and—instead of water—juice or milk. Furthermore, 5% of health care institutions do not require patients to finish consuming the radiolabeled meal within 10 min.

Figures 3 and 4 compare how many survey participants follow the SNMMI guidelines for medication withholding and radiopharmaceutical doses; 174 of 240 participants (72.5%) withhold the pharmaceuticals listed in Table 3, whereas 66 (27.5%) do not. Forty-seven of 240 respondents

(19.5%) require patients to withhold the pharmaceuticals for 2 d before the procedure, whereas 193 (80.4%) do not.

As shown in Figure 4, 95% of participants radiolabel using ^{99m}Tc -SC, and 83.7% use the recommended dose range (18.5–37 MBq). Five percent of participants use other radiopharmaceuticals for radiolabeling (^{111}In -diethylenetriamine pentaacetic acid or ^{99m}Tc -macroaggregated albumin), and 16.3% use doses outside the recommended range (all >37 MBq).

The survey was completed by 240 participants. Table 4 shows a Fisher exact test on the relational data between the demographics, such as the type of health care institution and compliance with the SNMMI GES protocol regarding when the meal was radiolabeled. Forty-three responses (17.9%) did not apply to this Fisher exact test. The P value was 0.39, making the results not statistically significant. From the statistical analysis, since the P value is larger than

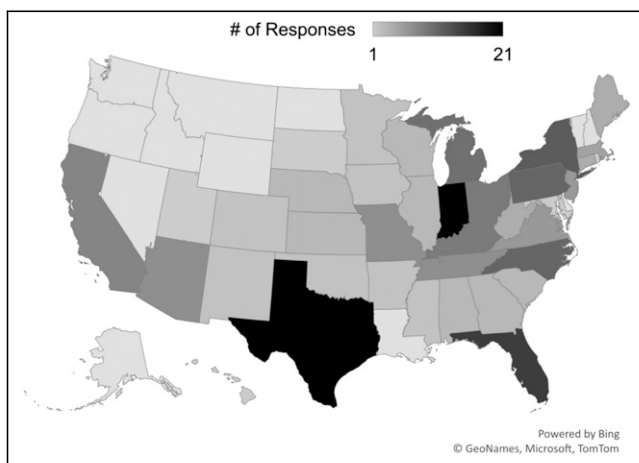


FIGURE 1. Map of participant locations in United States.

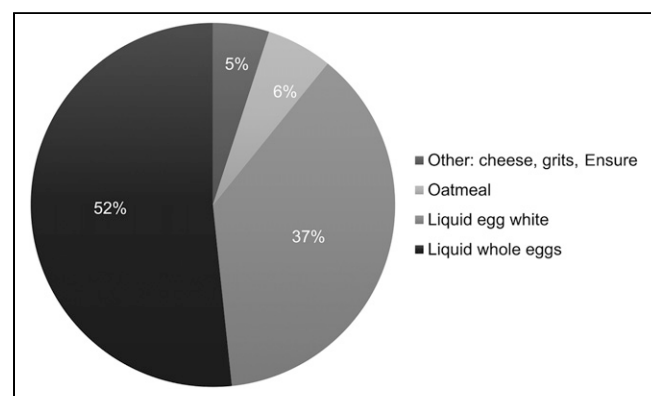


FIGURE 2. Frequency of radiolabeled meal component.

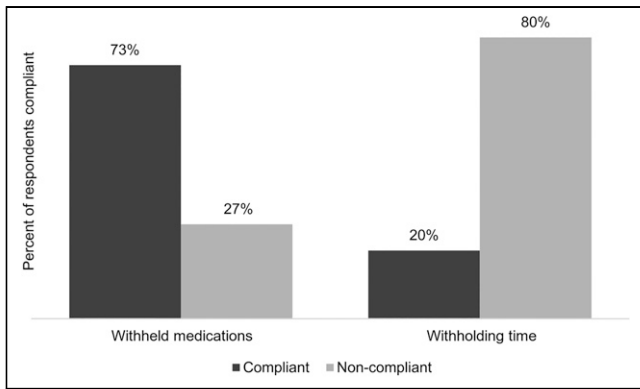


FIGURE 3. Compliance with pharmaceutical and withholding time.

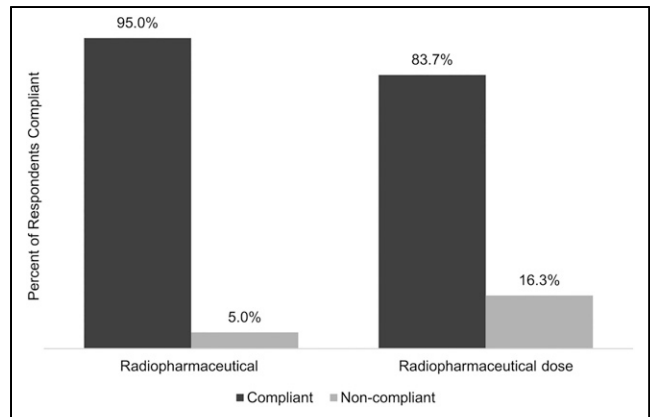


FIGURE 4. Compliance with radiopharmaceutical and dose.

the significance level of 0.05, we fail to reject the null hypothesis. This indicates that there is no significant difference in radiolabeling before or after cooking based on the type of institution.

The comparison between use of the meal components recommended by the SNMMI (liquid egg whites) and the number of GES studies performed by each health care institution is analyzed in Table 5. The patient volume was divided into 2 groups: less than or more than 40 monthly examinations. The *P* value was 0.63; thus, there was no association between the number of studies and compliance with meal components. Sixteen of 240 respondents were not applicable for this Fisher exact test.

DISCUSSION

The SNMMI recommends that health care institutions follow the standardized protocol for GES. This ensures consistency in examination outcomes and decreases variation in practice, resulting in patients' receiving the same protocols and treatment regardless of where they undergo GES.

This study aimed to assess compliance with the SNMMI recommendations for the GES protocol. We surveyed practicing technologists and found that 52% are not compliant with the SNMMI guidelines, and the most significant areas of noncompliance are the meal components and the time of radiolabeling (before or after cooking).

How meals are composed and prepared can significantly impact the accuracy of GES (7). Carbohydrates are processed more quickly than foods high in fat and protein, and liquids pass through the stomach more rapidly than semisolid foods, which, in turn, are digested more quickly than solid ones (8). Additionally, the quantity of food and the stress it puts on the stomach wall also influence how quickly the stomach empties (9). Consequently, if an alternative meal with varying nutrients and volume is used without enough research to standardize reference values (baseline results), unreliable interpretations can result (9). Only 37% of respondents use the SNMMI-recommended egg whites, and institutions performing a high volume of GES studies are less compliant than those performing a low volume.

TABLE 3
Standard Protocol Guidelines for Patient Preparation, Meal, and Radiolabeling of Meal

Category	Variable	Definition
Patient preparation	Withheld medications	Prokinetic agents: metoclopramide, tegaserod (Zelnorm; Alfasigma USA), domperidone, erythromycin, and cisapride; opiates; anticholinergic and antispasmodic agents; atropine, nifedipine, progesterone, octreotide, theophylline, benzodiazepine, and phentolamine
	Withholding time	2 d
	Blood glucose testing	Measurement of level before GES and inclusion in final report
Meal	Consensus meal*	118 mL (4 oz) of liquid egg whites, 120 mL of water, 2 slices of toast, 30 g of jam or jelly
	Meal ingestion time	<10 min
Radiolabeling of meal	Radiopharmaceutical	^{99m} Tc-SC
	Radiopharmaceutical dose	18.5–37 MBq (0.5–1.0 mCi)
	Radiolabeling method	Mixing of ^{99m} Tc-SC with liquid egg whites before cooking

*All 4 listed ingredients and no other ingredients (e.g., no butter or juice).

TABLE 4

Relationship Between Time of Radiolabeling and Type of Health Care Institution (Questions 5 and 13)

Institution type	Before cooking (142/240 respondents [59.1%])	After cooking (55/240 respondents [22.9%])
Hospital (nonacademic)	93	40
Academic	49	15

Radiolabeling efficiency for GES studies is significantly higher when ^{99m}Tc -SC is added to liquid egg whites before cooking rather than being injected onto cooked egg whites (10). The study also found that even when whole eggs are used, ^{99m}Tc -SC has a much higher radiolabeling efficiency when applied before cooking than after cooking (10).

Of the 240 institutions, 162 (92 nonacademic, 49 academic, 15 Veterans Administration or military, and 5 outpatient) follow the SNMMI guidelines by radiolabeling the meal before cooking. This indicates that 32.5% of health care institutions label their meal after cooking, regardless of whether they use the standard meal. The accuracy of results may be affected by the use of alternative meals, making reference values for solid-meal GES inapplicable and requiring a liquid-meal GES study. Compliance did not vary between academic and nonacademic institutions.

Other factors, such as medications, can also significantly impact the results (1). Many pharmaceuticals (Table 3) can alter the gastric emptying rate and should be withheld 48 h before the examination (1). About 75% of our respondents follow the guidelines regarding withholding of medications.

This study had limitations. Because the survey was posted on nuclear medicine technologist Facebook groups, multiple technologists from the same department may have taken the survey. Additionally, some participants who wished to portray their department as following the SNMMI standards may have given inaccurate responses.

TABLE 5

Relationship Between Number of GES Studies Performed and Meal Component (Questions 9 and 11)

Meal component	>40 GES/mo (51/249 respondents [21.1%])	<40 GES/mo (173/240 respondents [72%])
Recommended liquid egg whites	19	73
Nonrecommended ingredients*	32	101

*For example, whole eggs, oatmeal, grits, or cheese.

CONCLUSION

Although most respondents follow most aspects of the SNMMI guidelines for GES, more than half do not use the recommended meal of liquid egg whites. Compliance did not vary between academic and nonacademic institutions or between groups performing a large or small number of GES studies.

DISCLOSURE

No potential conflict of interest relevant to this article was reported.

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KEY POINTS

QUESTION: How compliant are GES protocols in health care institutions with the SNMMI procedure guidelines?

PERTINENT FINDINGS: Only 37% of respondent laboratories follow the SNMMI GES guidelines regarding meal components.

IMPLICATIONS FOR PATIENT CARE: The lack of standardization for GES protocols highlights the importance of following standardized procedures, such as those outlined by the SNMMI, to ensure accurate and consistent results.

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