# Preparative Fasting for Contrast-enhanced CT: Reconsideration[1]

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**Purpose:** To evaluate the evidence on the value of preparative fluid fasting for patients undergoing elective computed tomography (CT) with intravenous administration of contrast material and to survey leading institutions in a number of countries on their current policies in this regard.

**Materials and Methods:** This study qualified for exempt status by the institutional review board. First, 20 keyword combinations were entered into Medline to ascertain the correlation between fluid ingestion preceding contrast material–enhanced CT and development of aspiration pneumonia. The numbers of patients were summed up to estimate incidence of aspiration pneumonia attributable to ingestion of clear inert fluid before contrast-enhanced CT examination. Second, a multinational survey was conducted about the length of preparative fasting protocols, if any, for fluids and solids that they recommend to patients before elective non-gastrointestinal contrast-enhanced CT.

**Results:** Aspiration was not noted in any of 2001 patients (13 studies in the literature) who underwent contrast-enhanced CT after fluid ingestion. Data were available from 69 (86.3%) of 80 institutions queried (17 Korean, 14 U.S., 11 French, 10 Australian, 10 German, and seven Egyptian hospitals). Two-thirds (14 of 21 [66.7%]) of the French and German hospitals had a no-restriction policy for both fluids and solids, while Australian hospitals had a policy liberal about fluids (no restrictions in eight of 10 [80%]) only. Policies on fluids were variable in Korea, the United States, and Egypt (restrictions of 0–8 hours, 0–4 hours, and 0–6 hours, respectively), as were policies on solids in Korea, the United States, Australia, and Egypt (restrictions of 0–8 hours, 0–6 hours, 0 to 4–6 hours, and 0 hours to overnight, respectively). The length of fasting was longer for solids than for fluids in 20 hospitals.

**Conclusion:** There is little evidence that ingestion of clear inert fluid prior to contrast-enhanced CT is a cause of aspiration pneumonia; the length of fasting is variable in any country, being much longer in some hospitals than in others.



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It is common for patients not to eat or drink for hours in preparation for computed tomography (CT) with intravenous contrast medium administration. This approach made sense in the past, considering the fairly high rate of emetic complication (4.58% for nausea and 1.84% for vomiting) associated with use of ionic and high-osmolar contrast medium (1,2). However, after introduction of low-osmolar, nonionic contrast medium, the frequency of emesis has declined markedly (0.3% in a 2010 study) (3), lessening the rationale of the dietary restriction.

In fact, currently not every patient around the world fasts prior to contrast material–enhanced CT. During the past 2 decades, contrast-enhanced CT of the stomach has been commonly performed after the patient drinks water, in order to obtain luminal distension (so-called hydro-CT). Authors who have studied the efficacy of hydro-CT did not report any aspiration-related hazards (4–7), nor has such an incident been observed in our own practice. The fact that there is no reported safety issue with hydro-CT makes it hard to justify routine fasting for contrast-enhanced CT, especially when imaging body parts such as the chest or liver with no oral administration of contrast medium. With no standard guidelines or pertinent systemic reviews available to us, we have been divided on whether to maintain this practice at our institution.

The purpose of this study was to evaluate the evidence on the value of preparative fluid fasting in patients undergoing elective intravenous contrast-enhanced CT and to survey leading institutions in a number of countries on their current policies in this regard.

## Advances in Knowledge

- The literature provides no direct evidence suggesting that ingestion of inert clear fluids prior to CT with intravenous contrast medium administration causes aspiration pneumonia.
- Preparatory fluid fasting is uncommon among hospitals in Australia, Germany, and France, whereas it is still common among those in Korea, Egypt, and the United States.
- Currently, the length of preparatory solid food fasting is variable in different medical centers, ranging from 0 hours to overnight.

## Materials and Methods

We decided to look into the matter in the following ways: First, we reviewed the literature more systematically to ascertain the risk of aspiration pneumonia at contrast-enhanced CT after ingesting inert clear fluid. Second, we conducted a multinational survey on preparative fasting protocols.

### Systematic Literature Review

The literature was reviewed to ascertain the correlation between fluid ingestion shortly before contrast-enhanced CT and development of aspiration pneumonia. Twenty combinations of search terms were entered into Medline (Table 1) (time frame: any date before November 8, 2011) for screening. Each result was reviewed by two authors (D.H.H. and B.Y.L. in consensus; radiologists with 10 and 13 years of experience in thoracic imaging, respectively), who selected articles describing the number of patients who underwent contrast-enhanced CT after fluid ingestion, the content and amount of the ingested fluid, the time interval between the ingestion and the examination, and whether aspiration pneumonia occurred in relation to contrast-enhanced CT. We considered that there was no aspiration pneumonia in one or more of the following situations: *(a)* It was explicitly stated that there was no contrast-enhanced CT–related aspiration pneumonia; *(b)* it was stated that there was no vomiting; *(c)* it was stated that there were no adverse reactions (side effects) in the study. If an article quoted another article that revealed such numbers, the original source article was reviewed and the results verified. Articles written in languages other than English, French, German, and Chinese were excluded unless enough information was provided in the English abstract. Case reports were excluded. The numbers were summed up to calculate the estimated incidence of contrast-enhanced CT–related aspiration pneumonia. We did not look into the relationship between solid food ingestion prior to contrast-enhanced CT and the risk of aspiration pneumonia.

## Implication for Patient Care

- Policies on fluid restriction prior to contrast-enhanced CT should be reconsidered and there is need for more definitive research on the subject.

### Survey of Current Policy

During the period between February and July of 2011, we used e-mails, facsimiles, or phone calls to contact radiologists or other health care providers at CT units in six countries (Korea, Egypt, United States, France, Germany, and Australia) to inquire about the policies at their institutions regarding the length of preparative fasting (for fluids and solids), if any, for contrast-enhanced CT of chest, neck, or liver (without oral contrast medium administration) (Appendix). We also asked whether they routinely encourage hydration at the end of contrast-enhanced CT. D.H.H. and B.Y.L. conducted the survey of Korea. and J.J.O., A.A.A.E., and Y.K. surveyed France, Egypt, and the United States, respectively. Bayer Healthcare Pharmaceuticals provided contacts to

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the German hospitals. Table 2 shows how the hospital lists were obtained in each country.

## Results

### Systematic Literature Review

The results of the literature review on fluid restriction prior to contrast-enhanced CT are shown in Tables 3 and 4 (8–22). Overall, 2001 patients included in 13 studies (5,8–11,13,14,16–21) underwent contrast-enhanced CT shortly after (1 hour or less) drinking clear fluids, with development of aspiration in none of them. Of those 13 studies, 11 were found directly by using the search terms; the results of the remaining two studies (5,11) not directly found in the search were quoted in opinion articles by others (13,15).

Search term 1 returned two articles, including one by Nastanski et al (22). Although Nastanski et al evaluated the role of oral contrast material administration (4% Gastrografin) immediately prior to CT in a large patient group, their article was excluded because it was not mentioned whether intravenous administration of iodinated contrast medium was performed in their patients. They reported one case (0.1%; Glasgow Coma Score of 3) of aspiration pneumonia and transient desaturation; the patient was subsequently declared brain dead secondary to admission trauma. The other article was excluded due to irrelevant content. Search term 2 returned 23 articles, of which 20 were excluded because of irrelevant content ($n$ = 18) or because they were case reports ($n$ = 2; including one case of fatal contrast medium aspiration [23]). The number of excluded articles and the reason for exclusion of each of the other 18 search terms are listed in Table 3, and the fasting and contrast medium protocols in eligible articles are shown in Table 4.

### Survey of Current Policy

We received responses from 69 of 80 institutions queried (86.3%; 17 Korean, 14 U.S., 11 French, 10 Australian, 10 German, and seven Egyptian institutions) (Table 5). Two-thirds (14 of 21 [66.7%]) of the investigated French and German hospitals were allowing free ingestion of both fluids and solids, while Australian hospitals had a policy liberal about fluids (no restrictions in eight of 10 [80%]) only. Policies on fluids were variable in Korea, the United States, and Egypt (restriction times were 0–8, 0–4, and 0–6 hours, respectively), as were policies on solids in Korea, the United States, Australia, and Egypt (restrictions of 0–8 hours, 0–6 hours, 0 to 4–6 hours, and 0 hours

**Table 1**

**The 20 Combinations of Keywords Used for Medline Search**

| Search No. | Keywords |
|---|---|
| 1 | Aspiration pneumonia contrast-enhanced CT |
| 2 | Contrast CT aspiration pneumonia |
| 3 | Aspiration pneumonia intravenous contrast media |
| 4 | "Aspiration pneumonia" AND "contrast media" NOT "oral contrast" NOT barium NOT Gastrografin |
| 5 | Aspiration pneumonia intravenous pyelography (urography) |
| 6 | Intravenous contrast aspirated ARDS |
| 7 | Contrast administration intravenous aspirated |
| 8 | Stomach CT aspiration pneumonia |
| 9 | Water oral contrast gastrointestinal CT |
| 10 | Oral hydration ureter CT contrast |
| 11 | Hydro CT |
| 12 | Hydro-CT |
| 13 | "Chemical pneumonitis" CT |
| 14 | Pneumonia contrast media intravenous |
| 15 | Aspiration Ggastrografin intravenous administration |
| 16 | Contrast intravenous aspiration vomit |
| 17 | Iodinated contrast intravenous aspiration |
| 18 | Iodine contrast intravenous aspirated |
| 19 | Iodine contrast intravenous aspiration |
| 20 | Iodinated contrast intravenous aspirated vomit |

Note.—ARDS = acute respiratory distress syndrome.

**Table 2**

**Criteria for Hospitals Selected for Survey**

| Selection Method and Country | Resource |
|---|---|
| Top-rated by the government | |
| Korea ($n$ = 17) | "Excellence in Care Quality 2008" (Ministry of Health and Welfare) |
| France ($n$ = 15) | Top 15 among the 50 best hospitals in France *(http://www.lepoint.fr/html/palmares/hopitaux/classement)* |
| Top-rated by a private party | |
| United States ($n$ = 14) | "2010-2011 Honor Roll" (U.S. News & World Report) |
| Australia ($n$ = 10) | Top 10 Australian Hospitals *(http://www.australiatop.com/Health/hospitals.asp)* |
| Egypt ($n$ = 14) | Those with an affiliated hospital among 33 top ranked universities *(http://www.webometrics.com)* |
| Availability of personal connection | |
| Germany ($n$ = 10)* | Via Bayer Healthcare Pharmaceuticals |

* Including nine tertiary hospitals.

**Table 3**

**Selection of Eligible Articles from the Results of Medline Search**

| Keyword Search No. | No. of Results | No. of Excluded Articles according to Reason for Exclusion | | | | | | No. of Eligible Articles* |
|---|---|---|---|---|---|---|---|---|
| | | Irrelevant Content | IV | Language | Aspiration | Review Article | Case Report | |
| 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 2 | 23 | 18 | 0 | 0 | 0 | 0 | 2 | 3 (references 8–10) |
| 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 (references 8,11) |
| 4 | 25 | 21 | 0 | 1 | 0 | 1 | 1 | 1 (reference 11) |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 6 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 14 | 11 | 0 | 0 | 0 | 0 | 0 | 3 (references 8–10) |
| 9 | 25 | 10 | 1 | 0 | 5 | 3 | 0 | 8 (references 5,13,14,16–20) |
| 10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 (reference 21) |
| 11 | 58 | 35 | 0 | 1 | 15 | 6 | 1 | 0 |
| 12 | 23 | 9 | 0 | 1 | 9 | 4 | 0 | 0 |
| 13 | 8 | 8 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 14 | 12 | 0 | 0 | 0 | 0 | 0 | 2 (references 8,11) |
| 15 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 16 | 6 | 3 | 1 | 0 | 0 | 0 | 0 | 2 (references 8,11) |
| 17 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 1 (reference 11) |
| 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note.—Number of results indicates the number of articles directly returned from Medline search. IV = either noncontrast study or lack of description on whether there was intravenous administration of iodinated contrast material, Language = written in a language other than English, German, French, or Chinese, with not enough information in the English abstract (if any), and Aspiration = lack of description on whether there was occurrence of aspiration pneumonia.

* Reference 5 was found in reference 15, and reference 11 was found in reference 12.

to overnight, respectively). Among the hospitals with solid fasting policies ($n$ = 49), the fasting hours were longer for solids than for fluids in 20 (40.8%; eight Korean, five Australian, three U.S., two German, and two Egyptian) hospitals: In one Egyptian hospital, the fasting period was 6 hours for fluids and overnight for solids. The length of fasting was being decided by the referring physicians in one German hospital. The differences between solid and fluid fasting lengths at the other hospitals are summarized in Table 6.

The poll showed that of 25 hospitals with a fluid restriction of 4 hours or longer, all but four (two Egyptian, one Australian, and one Korean) were routinely encouraging hydration after the examination.

## Discussion

The sheer number of the patients undergoing contrast-enhanced CT every day makes the question of whether a preparatory fast is necessary an important one. Our literature search found that few have attempted to answer this question properly. Although Wagner et al (11) conducted a large randomized prospective study evaluating the effect of fasting on the rate of acute complications in radiologic studies with intravenous administration of iodine-based contrast medium, their study was not dedicated to contrast-enhanced CT. We performed a literature review and found no cases of aspiration pneumonia attributable to ingestion of clear inert fluid prior to contrast-enhanced CT. In addition, our multinational survey revealed that the current fasting policies were highly variable. There were differences between countries, with generally longer fasting in Korea and Egypt and shorter fasting in Germany and France. However, the lack of standardization was also evident, with fluid fasting policies of 0 and 4 hours both found in each country. The most extreme example was for solid fasting in Egypt, which ranged from 0 hours to overnight. It was also found that fasting policies continue in a small number of the European hospitals we surveyed.

The results of our systematic review show little evidence supporting the necessity of fluid fasting. The review identified reports covering 2001 individuals who safely underwent contrast-enhanced CT shortly after drinking a large amount of water or diluted contrast medium. This is consistent with the results of our survey, which showed that free liquid ingestion is allowed by at least two hospitals in each of the six countries we surveyed and by most of those included from Australia, France, and Germany.

In 20 of the 49 hospitals with restriction on solids ingestion, the fasting period was longer for solids than for fluids. This probably reflects an awareness of the different gastric emptying

**Table 4**

**Fasting and Contrast Medium Administration Protocols in the Eligible Articles**

| Study | No. of Patients | Intravenous Contrast Medium | | Oral Fluid | | Time (min)* |
|---|---|---|---|---|---|---|
| | | Injection Rate | Amount | Amount (mL) | Type | |
| Mahmoud et al (8) | 365‡ | 2 mL/sec or by hand injection | 2 mL/kg, maximum 100 mL | Age-dependent | 0.6% Isohexol | 60 |
| Federle et al (9) | 510 | 2 mL/sec | 2 mL/kg, maximum 150 mL | 450 | 2.5% Diatrizoate meglumine and sodium | <30 |
| Lim-Dunham et al (10) | 50‡ | NA | 2 mL/kg, maximum 150 mL | 100 or 900† | 3% Gastrografin or Gastroview | NA |
| Wagner et al (11) | 344 | NA | 113 mL ± 39 | Free diet | Free diet (solid and fluid) | 0 |
| Berther et al (13) | 200 | 1.5–2.5 mL/sec | 120 mL | 1000 | 3% Mannitol or Telebrix | >60 |
| Megibow et al (14) | 90 | 2–4 mL/sec | NA | 1200 | Volumen or Readi-Cat 2% | 0 |
| Baert et al (5) | 24 | 2 mL/sec, 0.7 mL/sec | 150 mL | 500–700 | Water | 0 |
| Wold et al (16) | 15 | 3 mL/sec | 150 mL | 1800 | Thin barium | 10 |
| Thompson et al (17) | 16 | 2–3 mL/sec | 100–150 mL | 800–1000 | Water | 20 |
| Thompson et al (17) | 12 | 2–3 mL/sec | 100–150 mL | 800–1000 | 2% Barium suspension | 20 |
| Winter et al (18) | 102 | 3 mL/sec | 150 mL | 1000 | Water | 0 |
| Chen et al (19) | 25 | 2mL/sec | 100 mL | 600–1000 | Water | NA |
| Schunk et al (20) | 56 | NA | 100 mL | | Water | 30–60 |
| Szolar et al (21) | 192 | 3 mL/sec | 60–120 mL | 1000 | Water | 30–45 |

Note.—NA = not available from the article (main body).

* Minutes elapsed between last fluid ingestion and contrast-enhanced CT.

† Amount was 100 mL in patients younger than 6 years and 900 mL in patients older than 6 years.

‡ Pediatric.

**Table 5**

**Fasting Protocols from 80 Hospitals in Six Countries**

| Length of Preparative Fasting (h) | Korea (*n* = 17) | | Egypt (*n* = 7) | | United States (*n* = 14) | | France (*n* = 11) | | Australia (*n* = 10) | | Germany (*n* = 10) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fluid | Solid | Fluid | Solid | Fluid | Solid | Fluid | Solid | Fluid | Solid | Fluid | Solid |
| 0 | 7 | | 2 | 2 | 3 | 1 | 7 | 7 | 8 | 2 | 7 | 7 |
| 1.5 | | | | | | | | | | 1 | | |
| 2 | | | | | 4 | 3 | | | | 1 | 1 | |
| 2–4 | | | | | 2 | 3 | 2 | 2 | | | | |
| 4 | 4 | 5 | 2 | 1 | 5 | 6 | 1 | 1 | 1 | 5 | 1 | |
| 4–6 | | | 2 | 3 | | | | | 1 | 1 | | 2 |
| 6 | 5 | 10 | 1 | | | 1 | 1 | 1 | | | | |
| 8 | 1 | 2 | | | | | | | | | | |
| Overnight | | | | 1 | | | | | | | | |
| Clinician* | | | | | | | | | | | 1 | 1 |

* Decided by the ordering clinician.

times for solids and fluids. Studies on gastric emptying time have shown that clear fluids not containing particles larger than 2 mm empty exponentially, 50% in 10–20 minutes (24), 90% within 1 hour, and virtually all within 2 hours (25). Solids take much longer hours to empty from the stomach (26).

Our intuition might lead us to think that contrast-enhanced CT–related vomiting would occur more often when the stomach is full (12). On the contrary, the results of a large randomized control study by Wagner et al (11) comparing two groups (4-hour minimum fasting versus no food or liquid restriction) revealed that there was no significant difference ($P = .29$) in the rate of acute complications (3.5%). Albeit small in number, the rate of emetic complication was higher in the fasting group (0.4%) than in the nonfasting group (0%). The study of Oowaki et al (27) also showed that fasting before contrast-enhanced

**Table 6**

**Difference between Length of Fasting for Solids and Fluids in 49 Hospitals with Restriction on Solid Foods before Contrast-enhanced CT**

| Length of Solids Fasting–Length of Fluids Fasting (h) | Korea (*n* = 17) | Egypt* (*n* = 5) | United States (*n* = 13) | France (*n* = 4) | Australia (*n* = 8) | Germany† (*n* = 2) |
|---|---|---|---|---|---|---|
| 0 | 9 | 3 | 10 | 4 | 2 | 0 |
| >0 to 2 | 1 | 1 | | | 2 | 1 |
| >2 to 4 | 2 | | 3 | | 4 | 1 |
| >4 to 6 | 4 | | | | | |
| >6 | 1 | | | | | |

* Policy of 6 hours for fluids and overnight for solids at one hospital.

† Length of fasting decided by the referring physicians at one hospital.

CT increases the adverse effects of nausea and vomiting. According to the study by Sutherland et al (28), a fast of longer than 3 hours not only fails to reduce the volume of the gastric content but lowers the pH level, placing patients at increased risk for aspiration pneumonia.

This does not mean, however, that every hospital should change its policy on solid food fasting. First of all, patients still need to fast prior to a contrast-enhanced CT examination of the abdomen and pelvis, since they would be unwilling to drink oral contrast medium with a full stomach. Second, several hours of solid-food restriction causes little, if any, discomfort to patients scheduled for elective CT, and the decision of whether or not to use a no-solids fasting protocol is mainly a matter of scheduling flexibility. What is more important, however, is whether fluid fasting can be omitted or not, since reducing hydration may affect the risk of subsequent contrast material–induced nephropathy. Although there is a dispute on the validity of the prior studies on contrast material–induced nephropathy (29), hydration is undeniably a de facto standard for preventing contrast material–induced nephropathy in at-risk patients (30), and, for outpatients, intravenous hydration is impractical.

Therefore, we believe that drinking of clear fluids such as water, tea, or decaffeinated black coffee should be allowed either without restriction or until at least 1 hour (gastric emptying of 90%) prior to contrast-enhanced CT. With respect to solids, our recommendation is less clear-cut. Some radiologists may choose to follow the examples of the European countries and abandon dietary restriction entirely. Others, if still concerned that vomiting after food intake may complicate an act of resuscitation or may cause minor problems in patient handling (12), may choose to maintain or modify their restriction on solids while encouraging drinking of clear fluids during the fasting hours. Of course, the situation calls for establishing a standard to resolve such differences, which we anticipate would be less strict than the Fasting Guideline for Healthy Patients Undergoing Elective Procedures recently updated by the American Society of Anesthesiology (ASA) (31): The ASA recommends in healthy patients of all ages a minimum fasting time of 2, 4, 6, and 6 hours for clear fluids, breast milk, infant formula, and light meal respectively.

Finally, this study found a small number of fluid-restricting hospitals that were not routinely recommending hydration after contrast-enhanced CT examination. Awareness should be further raised among radiologists and other health care providers regarding the role of hydration in preventing CT-related contrast material–induced nephropathy.

Our study has some limitations. The literature search may have missed cases of CT-related aspiration pneumonia owing to a poor choice of key words; some important articles may have been excluded due to language barrier. There may be a risk of bias, although minimal, in selecting eligible studies among the articles screened with Medline search. The hospitals, especially those in Germany, were somewhat randomly chosen. A limited number of countries were surveyed.

In conclusion, the policy of multihour preparatory fasting seems to be unnecessary for elective non-gastrointestinal contrast-enhanced CT. In particular, we believe that restrictions on fluid intake may be omitted. Establishment of new consensus guidelines is warranted to ensure better standard of patient care.

## Appendix

A questionnaire (Figure A1) was administered to the included hospitals to inquire about their policies regarding the length of preparative fasting (for fluids and solids), if any, for contrast-enhanced CT of chest, neck, or liver (without oral contrast medium).

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**Questionnaire (Part)**

Please answer us about typical contrast-enhanced CT (chest CT, neck CT, liver CT, etc) performed in an elective (non-traumatic, non-emergency) setting. Stomach CT, CT urography, or any other CT protocol involving intentional water drinking prescribed by either the attending clinician or radiologist are not the subject of this questionnaire.

Name of the respondent
Institution Name
Category of the affiliated institution
1) Tertiary Care Center
2) Secondary Care Center
3) Primary Care Center
4) Free-standing Clinic

Q1. In your protocol, is the length of NPO (nothing by mouth) different for solid foods and clear fluids? (Yes/No)
Q2. How long is the NPO (hours) for clear fluids?
(0, 2, 4, 4–6, 6, 6–8, 8, "Several," usually decided by the ordering clinician)
Q3. How long is the NPO (hours) for solid foods?
(0, 2, 4, 4–6, 6, 6–8, 8, "Several," Overnight, usually decided by the ordering clinician)
Q4. Do you encourage post-CT hydration?
<example> After test: If you had contrast, you may be told to drink extra fluid. This will flush the contrast from your body.
(Yes/No)

**Figure A1:** Questionnaire administered to hospitals participating in the survey.

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