Gastric Emptying
Consensus Recommendations
Where Do We Go From Here?

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Philadelphia, PA
Goals

• Summarize briefly the clinical importance and role of scintigraphy in evaluating patients with functional bowel disease

• Describe which components of the gastric emptying study did/did not need standardization

• Discuss problems associated with the prior lack of a standardized gastric emptying study

• Review the recent consensus recommendations for standardizing GE scintigraphy
Importance of Functional GI Disorders

• Incidence ≈ 25% of general population
• Common diagnoses in general practice
  – Functional (Nonulcer) dyspepsia
  – GERD (15% population)
  – IBS (irritable bowel syndrome)
  – Constipation (15-20% population)
• Cost estimates high
  – UK 1992-94 job related study = 500 million £
Gastric Emptying Scintigraphy

**Indications**

- **Gastroparesis** (Nausea, early satiety, postprandial fullness, abdominal pain/discomfort)
  - Diabetic
  - Idiopathic
  - Surgical, Post transplantation
- **Dyspepsia**
  - Post prandial fullness, nausea, vomiting, distention, easy satiety, weight loss, pain
- **Symptoms of rapid emptying (Mimic slow emptying)**
  - Post gastrectomy (dumping)
  - Cyclic vomiting syndrome
- **GER with poor response to therapy**
- **Assess response to therapy**
- **Unexplained GI symptoms** (? Organic Cause)
Goals of Diagnosing GI Motility Disorders

• Confirm or exclude a diagnosis
  – Reduce anxiety, explain symptoms
  – Educate about natural course of disease

• Initiate proper treatment
  – Prokinetic agent
  – Antispasmodic, anticholinergic
  – Invasive: surgical or endoscopic
When to Order GI Scintigraphy?

- After an anatomic cause for symptoms has been excluded by:
  - Endoscopy
  - Radiologic or other anatomic study
- When functional GI symptoms persist
- Equivocal other studies
  - Manometry
  - Endoscopy
  - pH probe
  - Radiologic/anatomic
What is Normal Gastric Emptying?

• Depends on:
  – Patient preparation (Glucose control, fasting, medications...)
  – Meal
  – Acquisition
  – Data analysis
Gastric Emptying Studies

Controversial items Needing Standardization

• Radiolabeled meal
  – Normal values
  – Solids vs Liquids
    » Eggs, chicken liver, others…

• Acquisition protocol and times
  – Static images (90 min, 2 hr, 4 hr)
  – Dynamic

• Analysis and values reported
  – T 1/2, % retention
Gastric Emptying

The Radiolabeled Meal

- Must be standardized for:
  - Volume (solids + liquids)
  - Nature of solids
  - Caloric content
  - Amounts of CHO, Fat, and Protein

- Must be stable in gastric juice
  - Compare to "gold standard" (In vivo labeled chicken liver)

- Solid phase - most clinically relevant

- Liquid phase
  - Used to record small bowel and colon transit (Whole gut studies)
  - May be abnormal in early diabetic gastropathy
## Radiolabel Meal Stability

<table>
<thead>
<tr>
<th></th>
<th>% Bound at 4 Hr</th>
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<tbody>
<tr>
<td><strong>Liver</strong></td>
<td></td>
<td><strong>0.1 N HCl</strong></td>
<td><strong>Gastric Juice</strong></td>
</tr>
<tr>
<td>Surface labeled</td>
<td>90%</td>
<td>84%</td>
<td></td>
</tr>
<tr>
<td>In-vivo labeled</td>
<td>94%</td>
<td>98%</td>
<td></td>
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<tr>
<td><strong>Eggs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two large natural</td>
<td>97%</td>
<td>81%</td>
<td></td>
</tr>
<tr>
<td>Synthetic (Egg Beater)</td>
<td>&gt; 90%</td>
<td></td>
<td>&gt; 90%</td>
</tr>
</tbody>
</table>
Popular Standardized Meals

**Whole Egg (Temple) Dual Isotope**

- **Solid Phase**
  - 500 µCi Tc-99m sulfur colloid
  - Two large eggs
  - Two pieces white toast

  Total = 282 kcal

- **Liquid Phase**
  - (125 µCi In-111 DTPA)
  - 300 cc water

**Tougas Meal**

- **Solid Phase**
  - 500 µCi Tc-99m sulfur colloid
  - 120 gm Egg Beater (equiv vol = 2 large eggs)
  - Two pieces white bread
  - 30 gm strawberry jam

  Total = 255 kcal

- **Liquid Phase**
  - 120 cc water
Meal Preparation
Microwave vs Skillet
Cooking - Microwave vs Griddle

Egg Labeling Methods for Gastric Emptying Scintigraphy Are Not Equivalent in Producing a Stable Solid Meal

Linda C. Knight\textsuperscript{1}, Steven Kantor\textsuperscript{1,2}, Siva Doma\textsuperscript{2}, Henry P. Parkman\textsuperscript{2}, and Alan H. Maurer\textsuperscript{1}

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<table>
<thead>
<tr>
<th>Egg type</th>
<th>Method of cooking</th>
<th>% Solids at 2 h</th>
<th>% Solids at 4 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg substitute</td>
<td>Griddle</td>
<td>95.7 ± 1.1</td>
<td>96.4 ± 0.8</td>
</tr>
<tr>
<td>Whole eggs</td>
<td>Griddle</td>
<td>85.8 ± 5.3</td>
<td>80.7 ± 19.0</td>
</tr>
<tr>
<td>Egg substitute</td>
<td>Microwave</td>
<td>95.4 ± 1.6</td>
<td>96.2 ± 1.1</td>
</tr>
<tr>
<td>Whole eggs</td>
<td>Microwave</td>
<td>73.1 ± 12.4</td>
<td>42.5 ± 2.3</td>
</tr>
</tbody>
</table>

Incubation in human gastric fluid, pH 1.5

<table>
<thead>
<tr>
<th>Egg type</th>
<th>Method of cooking</th>
<th>% Solids at 2 h</th>
<th>% Solids at 4 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg substitute</td>
<td>Griddle</td>
<td>96.0 ± 3.0</td>
<td>95.5 ± 1.7</td>
</tr>
<tr>
<td>Whole eggs</td>
<td>Griddle</td>
<td>97.4 ± 0.3</td>
<td>97.9 ± 0.5</td>
</tr>
<tr>
<td>Egg substitute</td>
<td>Microwave</td>
<td>96.0 ± 2.9</td>
<td>95.2 ± 1.2</td>
</tr>
<tr>
<td>Whole eggs</td>
<td>Microwave</td>
<td>96.9 ± 0.6</td>
<td>97.3 ± 0.7</td>
</tr>
</tbody>
</table>

Incubation in HCl, pH 1.5

\footnotetext{\textsuperscript{*}} P < 0.05 (by unpaired t test).

\footnotetext{\textsuperscript{†}} P < 0.00005 (by unpaired t test).
Gastric Emptying

Parameters

• In use
  – T 1/2
  – % Remaining at fixed time: 1 hr, 90 min, 2 hr, 3 hr, … 4 hr
  – Dynamic acquisitions
    » Continuous for lag phase
    » Antral contraction studies
      • Frequency of contractions
      • Amplitude of contractions
  – Curve fitting: lag phase, rate of gastric emptying
  – Two compartment: fundal/antral emptying
  – Fundal accommodation studies
  – Whole abdomen analysis
Need for 4 Hr Gastric Emptying

Extending Gastric Emptying Scintigraphy from Two to Four Hours Detects More Patients with Gastroparesis

Jin-Ping Guo, Alan H. Maurer, Robert S. Fisher, and Henry P. Parkman, MD

Assessment of Gastric Emptying Using a Low Fat Meal Establishment of International Control Values

% Gastric Retention

2 Hr vs 3,4 Hr

Camilleri et al. DDS, Vol 36, 609-615, 1991
Less Controversial
ROIs and Processing

1. Manual, irregular computer regions of interest drawn to obtain gastric counts (volume remaining)

2. Correction for physical decay (scatter, if dual isotope)

3. Attenuation Correction
   a. Geometric Mean (Ant X Post)$^{1/2}$
   b. LAO view

4. Plot % retention normalized to 100% at t=0
Camera Acquisition - A-P(LAO), Upright, Positioning
(60 sec static imaging at each time point)
Geometric Mean Attenuation Correction
Gastric Emptying Curves
Geometric Mean* vs Single View LAO

*GM = \( \sqrt{\text{Ant Cts} \times \text{Post Cts}} \)
Manual ROIs: Global, Fundus, Antrum
Can Automated Edge Detection Be Developed?
Gastric Emptying

Results

- Plot % remaining as function of time
- Report 2 hr(< 50%), and 4 hr(< 10%) values
  - May be discordant results Abn early vs Abn late
- Rapid GE = <35% at 1 hr
### Analysis - TUH Excel Spreadsheet

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<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Time</td>
<td>Anterior</td>
<td>Posterior</td>
<td>Geom Mean</td>
<td>Decay Corrected</td>
<td>% Remaining</td>
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<tr>
<td>0</td>
<td>43,581</td>
<td>13,111</td>
<td>23,904</td>
<td>23,904</td>
<td>94</td>
<td></td>
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<tr>
<td>15</td>
<td>48,326</td>
<td>12,517</td>
<td>24,595</td>
<td>25,308</td>
<td>100</td>
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<tr>
<td>30</td>
<td>43,686</td>
<td>10,551</td>
<td>21,469</td>
<td>22,733</td>
<td>90</td>
<td></td>
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<td>45</td>
<td>47,069</td>
<td>9,791</td>
<td>21,467</td>
<td>23,390</td>
<td>92</td>
<td></td>
<td></td>
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<td>60</td>
<td>38,415</td>
<td>6,604</td>
<td>15,928</td>
<td>17,857</td>
<td>71</td>
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<td>75</td>
<td>30,954</td>
<td>5,663</td>
<td>13,240</td>
<td>15,274</td>
<td>60</td>
<td></td>
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<tr>
<td>90</td>
<td>25,992</td>
<td>4,282</td>
<td>10,550</td>
<td>12,524</td>
<td>49</td>
<td></td>
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<tr>
<td>105</td>
<td>16,043</td>
<td>2,704</td>
<td>6,586</td>
<td>8,046</td>
<td>32</td>
<td></td>
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<tr>
<td>120</td>
<td>7,290</td>
<td>1,574</td>
<td>3,387</td>
<td>4,258</td>
<td>17</td>
<td></td>
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</tbody>
</table>

![Graph showing % Remaining vs Time](image1.png)
![Graph showing % Remaining vs Time](image2.png)
Normal Dual Isotope Gastric Emptying
Diabetic Gastroparesis

- T= 0 min
- T= 120 min
- T= 30 min
- T= 180 min
- T= 60 min
- T= 240 min

Graph showing % Gastric Retention over time (min):
- 0 min
- 50 min
- 100 min
- 150 min
- 200 min
- 250 min
- 100
- 75
- 50
- 25
- 0
Antral retention
Normal at 2 hr - Abn at 3,4 hr
Fundal Retention Pattern

![Images showing gastric retention at different times](image)

- **T = 0 min**
- **T = 30 min**
- **T = 60 min**
- **T = 120 min**
- **T = 180 min**
- **T = 240 min**

![Graph showing % Gastric Retention vs Time](image)
Transplant: Must Rule Out Obstruction
“Dumping Syndrome”

![Image of scintigraphy scans showing gastric retention over time](image)

- T=0 min
- T=15 min
- T=30 min
- T=60 min
- T=90 min
- T=120 min

% Gastric Retention vs Time (min)

0 25 50 75 100
0 50 100 150 200 250

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Limitations of Current Gastric Emptying Scintigraphy

Where do we go from here?

• Not Sufficient Test To Explain All Upper GI Dyspepsia
  – Less than 50% patients with typical symptoms have abnormal gastric emptying

• Limited to physiology of “emptying” need to evaluate other factors:
  – Gastric accommodation response (40% abn in dyspepsia)
  – Fundal antral coordination
  – Antropyloric coordination
  – Gastric arrhythmias

• Need to address rapid emptying
Gastric Accommodation Response
Loss of Fundal Accommodation

T = 0 min
T = 30 min
T = 60 min
T = 120 min
T = 180 min
T = 240 min

% Gastric Retention

Time (min)

0 50 100 150 200 250

0 25 50 75 100

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Using this, we found that diabetic gastroparetic patients have delayed proximal gastric emptying in addition to antral hypomotility. More recently, we correlated regional GE with symptoms. An initially delayed proximal gastric emptying is seen in GERD. In contrast, an initially rapid proximal gastric emptying is seen in the dyspeptic symptoms of upper abdominal fullness, nausea, and vomiting. These results suggest that excessive fundic relaxation with impaired contraction is present in GERD. Proximal gastric accommodation appears impaired in functional dyspepsia.
## Regional GE - Better Correlation with Symptoms

Table 5 B. Odd Ratios for the chance of delay total, proximal, and distal gastric emptying in patients with each of the upper GI symptom*

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Odd Ratio</th>
<th>95 % CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total GE</td>
<td>2.51</td>
<td>0.72-8.73</td>
<td>0.15</td>
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<tr>
<td>Nausea</td>
<td>Prox GE</td>
<td>4.5</td>
<td>1.26-16.11</td>
</tr>
<tr>
<td></td>
<td>Dist GE</td>
<td>2.8</td>
<td>0.50-15.87</td>
</tr>
<tr>
<td></td>
<td>Total GE</td>
<td>5.19</td>
<td>1.43-18.89</td>
</tr>
<tr>
<td>Vomiting</td>
<td>Prox GE</td>
<td>5.54</td>
<td>1.46-21.08</td>
</tr>
<tr>
<td></td>
<td>Dist GE</td>
<td>5.11</td>
<td>1.22-21.37</td>
</tr>
<tr>
<td>Heartburn</td>
<td>Prox GE</td>
<td>1.83</td>
<td>0.55-6.13</td>
</tr>
<tr>
<td></td>
<td>Dist GE</td>
<td>1.04</td>
<td>0.22-4.93</td>
</tr>
<tr>
<td></td>
<td>Total GE</td>
<td>2.51</td>
<td>0.70-9.01</td>
</tr>
<tr>
<td>Acid regurg</td>
<td>Prox GE</td>
<td>3.72</td>
<td>1.04-13.31</td>
</tr>
<tr>
<td></td>
<td>Dist GE</td>
<td>3.16</td>
<td>0.56-17.87</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Odd Ratio</th>
<th>95 % CI</th>
<th>p value</th>
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</thead>
<tbody>
<tr>
<td>Total GE</td>
<td>5.97</td>
<td>1.16-30.70</td>
<td>0.03</td>
</tr>
<tr>
<td>Early satiety</td>
<td>Prox GE</td>
<td>5.8</td>
<td>1.35-24.93</td>
</tr>
<tr>
<td></td>
<td>Dist GE</td>
<td>2.29</td>
<td>0.41-12.82</td>
</tr>
<tr>
<td></td>
<td>Total GE</td>
<td>1.67</td>
<td>0.50-5.51</td>
</tr>
<tr>
<td>Abd pain/discomfort</td>
<td>Prox GE</td>
<td>2.56</td>
<td>0.77-8.51</td>
</tr>
<tr>
<td></td>
<td>Dist GE</td>
<td>1.12</td>
<td>0.26-4.91</td>
</tr>
<tr>
<td>Abd distention</td>
<td>Prox GE</td>
<td>4.41</td>
<td>1.01-19.19</td>
</tr>
<tr>
<td></td>
<td>Dist GE</td>
<td>2.08</td>
<td>0.34-12.54</td>
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<tr>
<td>Anorexia</td>
<td>Prox GE</td>
<td>0.81</td>
<td>0.24-2.76</td>
</tr>
<tr>
<td></td>
<td>Dist GE</td>
<td>0.43</td>
<td>0.08-2.42</td>
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* Mantel-Haenszel test adjusted for sex
Antral Contraction Studies
Dynamic Antral Contraction Scintigraphy (DACS)

Dynamic acquisition every 1 second allows gastric antral contractions to be characterized noninvasively with scintigraphy; both the frequency and an estimate of the contractions can be obtained.

With a region of interest drawn around the mid antrum, the time activity curves show the counts oscillate at about 3 contractions per minute. The amplitude of the FFT analysis gives an approximation of the ejection fraction (contraction strength).
Future?
Direct New Therapies

Pre/post Gastric pacing
Whole Gut Transit Scintigraphy
*(Gastroenterocolonic)*

- **T=0**: Gastric Emptying
- **T=90**: Small Bowel Transit
- **T=48 Hrs**: Colon Transit
Why A Gastric Emptying Consensus?

- Better Patient Care - requires standardization
- Preserving a scintigraphic “Gold standard”
- Prepare for “Pay for Performance”
  - Combined effort multiple professional societies
The Issues

• Gastroenterologists unhappy

• New modalities threaten future utilization of scintigraphy for gastric emptying studies

• Patients unhappy
The Issues (cont)

• Gastroenterologists unhappy
  – GE results vary from site to site, comparisons not possible
  – Standards already being established
    » NIH Gastroparesis Research Consortium
    » $15 million, study 1000 patients, began Dec 2006
    » Established a standardized GE test

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ClinicalTrials.gov
A service of the U.S. National Institutes of Health

Gastroparesis Registry

This study is currently recruiting patients.

Sponsored by: National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)
Information provided by: National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)
ClinicalTrials.gov Identifier: NCT00398801

Purpose

The Gastroparesis Registry (GpR) is an observational study to clarify the epidemiology, natural history, clinical course, and other outcomes of gastroparesis.
The Issues (cont.)

• New modalities threaten utilization of scintigraphic gastric emptying studies
  – Office Based
  – Non “nuclear” (no radiation exposure)
    » Breath testing
    » Smart Pill
The Issues (cont.)

- Patients unhappy - Feedback from GPDA
  - Need for repeat studies
    » Different doctors
    » Different test protocols/meals
    » Insurance issues
Consensus: Methodology

- Joint project of the Society of Nuclear Medicine (SNM) and the American Neurogastroenterology and Motility Society (ANMS)
- Contributors
  - Academic
  - Private Practice
- Proposed to SNM Procedure Guidelines Committee (Nov 2005)
- Conjoint meetings
  - Philadelphia (April 2006)
  - San Diego (SNM) (June 2006)
  - Boston (ANMS) (Sept. 2006)
  - Final draft (March 2007)
- Final draft manuscript approval (May/June 2007)
  - SNM GI Council
  - SNM Procedure Guidelines Committee and SNM Board
 Contributors

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Recent Publication


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Limitations - Current SNM Guideline

• SNM Guidelines and Communications Committee (GCC) was established 1998

• Guiding Principles:
  – “After much discussion”, it was felt that the guidelines should not describe optimal cutting edge technology
    » but should describe the current “best practice”
  – Should include “all acceptable variations” in practice
    » Often dictated by the resources and expertise at a particular facility
    » Assuming a panel of experts found those practices to be acceptable

Courtesy Kevin Donahoe, MD
Goals - ANM/ANMS GE Consensus

• Provide a single, standardized protocol
  – Based on large number of normals and well documented normative data

• Meet the needs of clinicians
  – Clinical results meaningful (site to site)

• Meet the needs of imaging specialists
  – Cost/time/scheduling and equipment needs vs current reimbursement

• Meet the needs of patients
  – Diagnostic results which direct management
  – Consistent results pre/post therapy

• Address those items in most immediate need of standardization
  – The meal
  – The frequency of imaging
  – Duration of the test
  – Normative data
Items - Not Addressed

• Technical factors
  – Already covered in current SNM Procedure Guideline

• Unresolved Questions
  – Many questions raised that need to be addressed in future are delineated

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Consensus - Summary

- ANMS and SNM recommend a standardized method for measuring gastric emptying by scintigraphy (GES)
- Protocol uses a low-fat, egg white meal with imaging at 0, 1, 2, 4 hours after meal ingestion
- Normal data from multicenter study (Tougas et al)
  - Provides information about normal and abnormal gastric emptying
    » rapid
    » delayed
- Promote standardization by providing
  - Sample patient instructions, sample questionnaires and report content
- Adoption of this standardized protocol will:
  - Resolve the lack of uniformity of testing
  - Add reliability and credibility to the results
  - Improves the clinical utility of the gastric emptying test.
Consensus Elements

• **Patient preparation**
  – Sample patient instruction sheet
  – Symptom questionnaire

• **Meal, preparation, and ingestion**
  – 4 oz liquid egg white, bread, jam, water
  – Eggs cooked skillet or microwave
  – Ingested within 10 minutes

• **Image Acquisition**
  – Minimum 1hr/2hr/ and 4 hr Ant/Post images
  – Dynamic imaging not excluded

• **Image Analysis**
  – Manual ROI, total gastric counts
  – Geometric mean, decay corrected total gastric counts

• **Report elements**
  – % retained (1hr/2hr/4hr); (graph & dynamic optional)
  – **Fasting blood glucose if diabetic**
  – Medications at time of study
  – Total % meal ingested
  – Other findings: reflux, hiatal hernia…
Patient Prep and Instructions

• Fasting (overnight or min 6 hrs)
• Medications (Listing those to stop, no tobacco day of study)
• Diabetics (Insulin(1/2), glucose < 275)
• Female patients
  – Pregnancy
  – Menstrual cycle (early cycle)
• Description of test procedure
  – Meal
  – Duration of testing
  – Activity between images
Sample Patient Info Questionnaire

• Main symptom(s)

• Concurrent medications
  – Pain, promotility
  – Other

• Prior GI tract surgery
Report Content

• Medications at time of study
• Pre meal serum glucose (if known diabetic)
  – Treat if > 275 mg/dL
• Amount of meal ingested
  – Time to ingest meal
• Evidence of rapid GE:
  – 1 hour % retained
• Evidence of delayed GE:
  – 2 and 4 hour % retained
• Other findings
The Tougas EggBeaters® Meal

- Low fat egg whites
- Radiolabeled with 0.5 -1 mCi Tc 99m
- Served with toast, jam, water
- Imaging at 0, 1, 2 and 4 hr
Generic Liquid Egg Substitutes
Tougas - Normal Subject Results

- 123 Normal volunteers
- 11 International centers
- Median retention values
  - 1 hr = 64%
  - 2 hr = 24%
  - 4 hr = 1%
- Abnormal values (95% confidence intervals)
  - > 60% at 2 hr
  - > 10% at 4 hrs
Male vs Female Normal Values

![Graph showing differences in gastric retention between males and females at 1, 2, and 4 hours.]

- **1 hour**:
  - Males: Lower values
  - Females: Higher values
  - Statistical significance: P < 0.002

- **2 hours**: Similar trend as 1 hour
  - Males: Lower values
  - Females: Higher values
  - Statistical significance: P < 0.0001

- **4 hours**:
  - Males: Lower values
  - Females: Higher values
  - Statistical significance: P < 0.2

Gastric Emptying vs Age

P < 0.03

N = 123

P < 0.08

P < 0.04

% Gastric Retention

1 hr 2 hr 4 hr
## Table 2: Future Issues

1. Interpretation of discordant results for delayed gastric emptying (2 vs 4 hour)
2. Optimization of the specific time points used for imaging
   - Use of 0.5 or 1 hour result for detection of rapid gastric emptying.
   - Use of 3 hour result vs 2/4 hour results for detection of delayed GE.
3. Better define patient-related factors: Age, Gender (Menstrual cycle), Weight and BMI
4. Need for a larger database for normal early values at 30 vs 60 min of gastric emptying
5. Evaluation of alternative meals
   - For patients allergic to eggs
   - For patients with gluten sensitive enteropathy
   - Use of different meals with different caloric/fat challenges.
6. Management of diabetic patients
   - Assessment of glucose in diabetic patients prior to the test: glucose and Hgb-A1c.
   - Management of hyperglycemic patients on day of test
   - Administration of insulin and oral hypoglycemic agents
   - Need for monitoring postprandial glucose
7. Need for data base of “normal” values for post surgery patients
8. Clinical value of additional characterization of gastric emptying
   - Regional analysis of gastric emptying (antral and fundal measurements)
   - Lag phase analysis
   - Use of curve fitting techniques to analyze the time activity points
   - Dynamic antral contraction studies
   - Fundal accommodation studies with SPECT
9. Clinical value of liquid phase gastric emptying