

Gadgets and Gizmos: New Tools for the Evaluation of Patients with GI Motility Disorders



Linda Nguyen, MD, FACG
Clinical Professor of Medicine
Stanford University



Objective

- Demonstrate how technology can help in the evaluation & management of patients with DGBI and GI motility disorders

**THE FUTURE
IS NOW**

NS-54

54-year-old male with a history of EDS, allergic rhinitis, chronic pain, insomnia

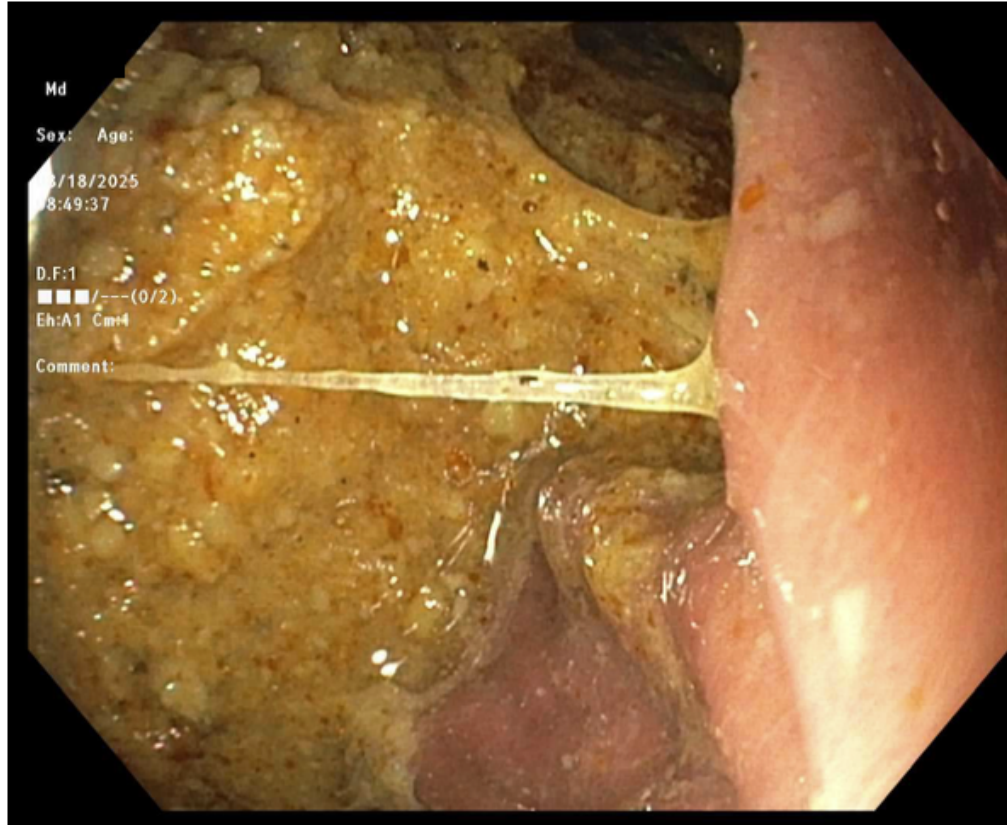
Symptoms x 8 years

- Postprandial fullness, early satiety
- Episodes of severe abdominal pain and mild nausea
- LUQ abdominal pain associated with eating and bowel movement.
- Stools Bristol type 1-2
- Persistent symptoms despite PPI, gabapentin, amitriptyline, mirtazapine, buspirone,

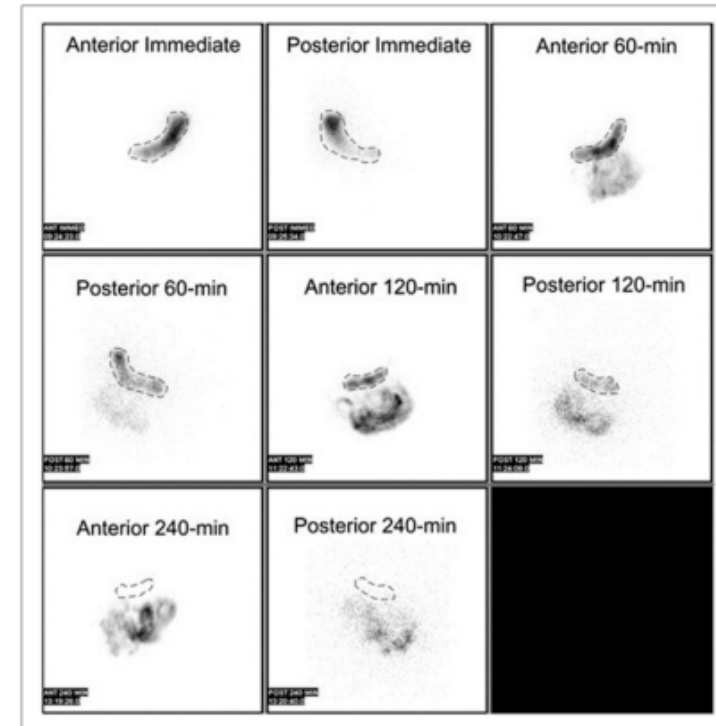
Exam

- BMI 21.3
- HR 114
- LLQ tenderness without guarding or rebound
- Beighton 8/9, tenderness trapezius and paraspinal muscles

Testing



4-hour gastric retention = 8%



What is the diagnosis?
What would you do next?

Reconciling Retained Gastric Food & Normal Gastric Emptying

Digestive Diseases and Sciences (2021) 66:3951–3959
<https://doi.org/10.1007/s10620-020-06718-0>

ORIGINAL ARTICLE

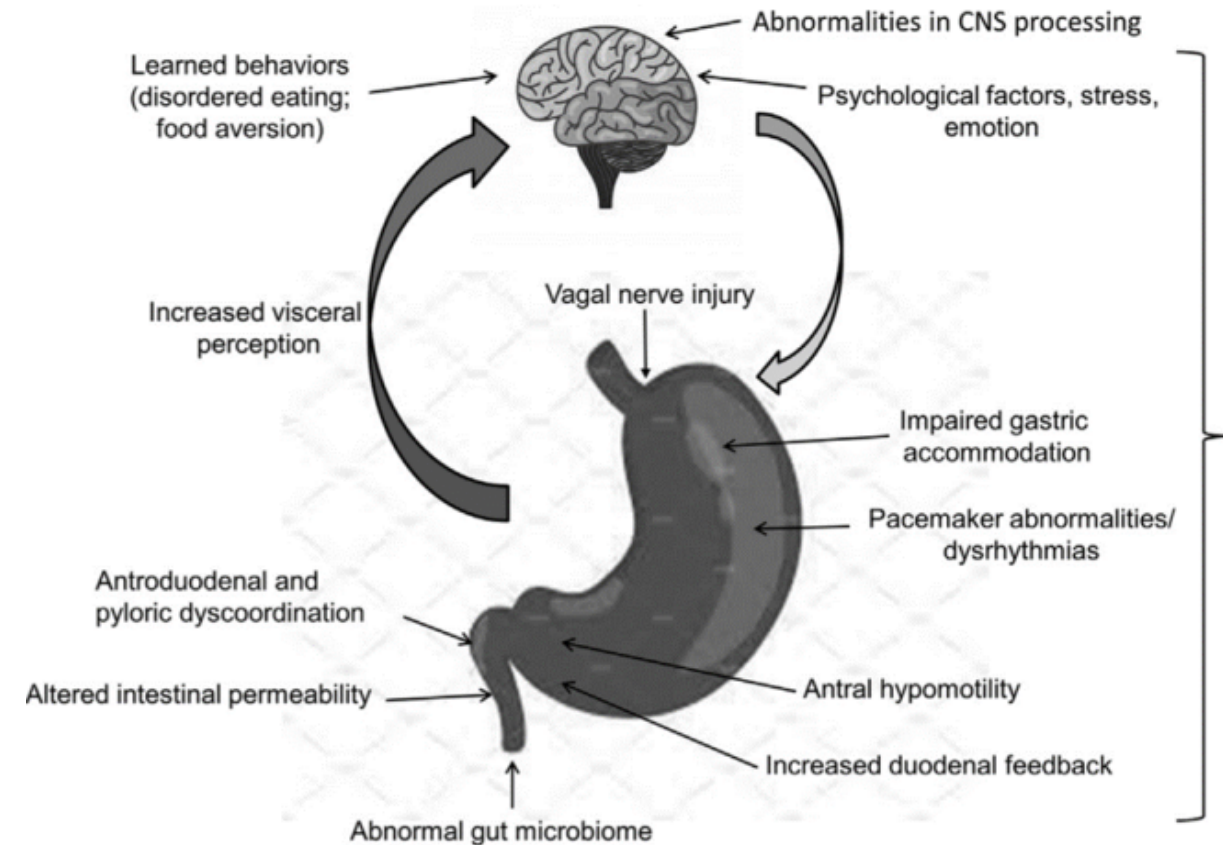
Food Residue During Esophagogastroduodenoscopy Is Commonly Encountered and Is Not Pathognomonic of Delayed Gastric Emptying

Danse Bi¹ · Chansong Choi¹ · John League² · Michael Camilleri^{2,3} · David O. Prichard² 

	PPV DGE	NPV DGE	Sensitivity	Specificity
Retained Gastric Food	55%	73%	12%	96%

	Abnormal Gastric Emptying
Retained Gastric Food	55%
No Retained Food	28%

Mechanisms of Upper GI Symptoms



Anatomic Location	Physiologic Abnormality	Symptoms
Fundus	Impaired accommodation	Diastolic dysfunction - Fullness/early satiety - Weight loss
Antrum	Antral hypomotility, delayed gastric emptying	Systolic dysfunction - Postprandial fullness, abdominal pain - Nausea, vomiting
Pylorus	Pylorospasm	Functional outlet obstruction & delayed gastric emptying - Postprandial fullness - Nausea, vomiting
Duodenum	Duodenal dysmotility or hypercontractility	Outlet obstructive symptoms - Bloating - Fullness
Mucosal immune cells	Duodenal eosinophilia, Gastric mast cells & eosinophils	Abdominal pain, early satiety, fullness
H. Pylori infection	Mucosal inflammation	Epigastric pain
Visceral afferent nerves	Hypersensitivity to acid & lipids	Abdominal pain, early satiety, wt loss
Interstitial cells of Cajal	Tachygastria, bradygastria, dysrhythmia	Any of the above

Adapted Lacy B et al. Clin Gastroenterol Hep 2022

Available Tools For Understanding Upper GI Physiology

➤ Assessment of GI Neuromuscular Function

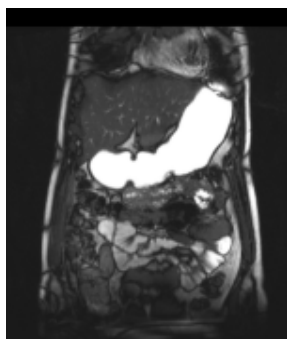
Whole Gut Motility

- Motility capsule
- Gas sensing capsule



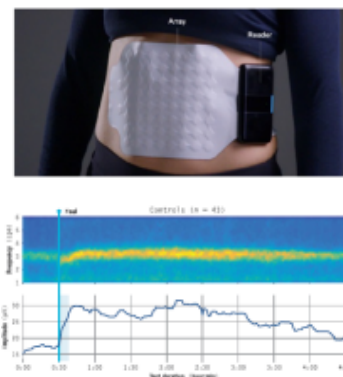
Segmental Contractility

- MRI



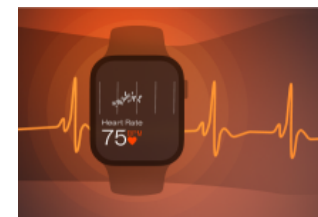
Myoelectrical Activity

- Electrogastrography
- Body surface mapping



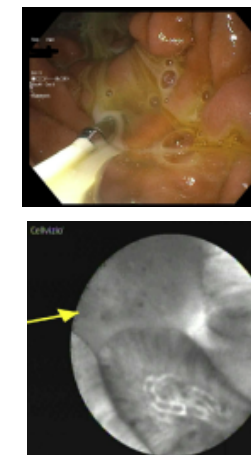
Autonomic Function

- Heart rate variability
- Sham feeding

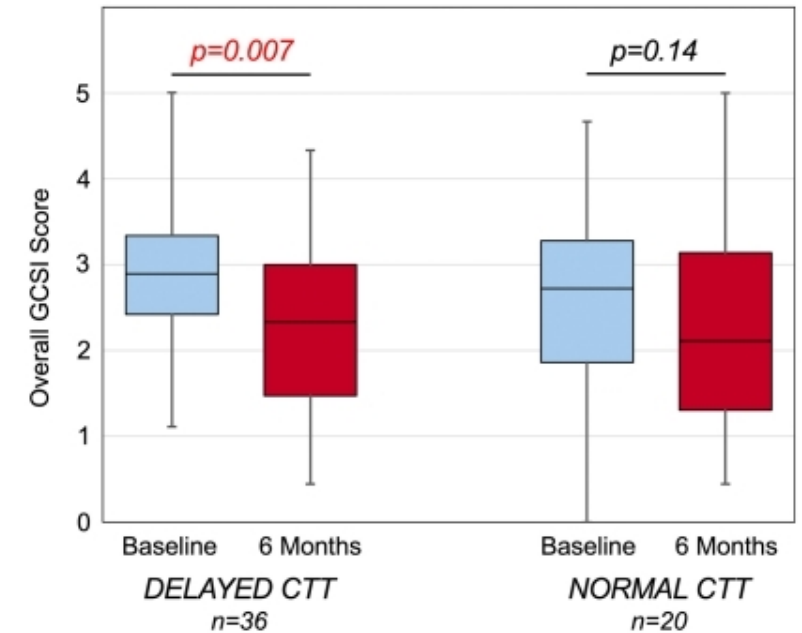
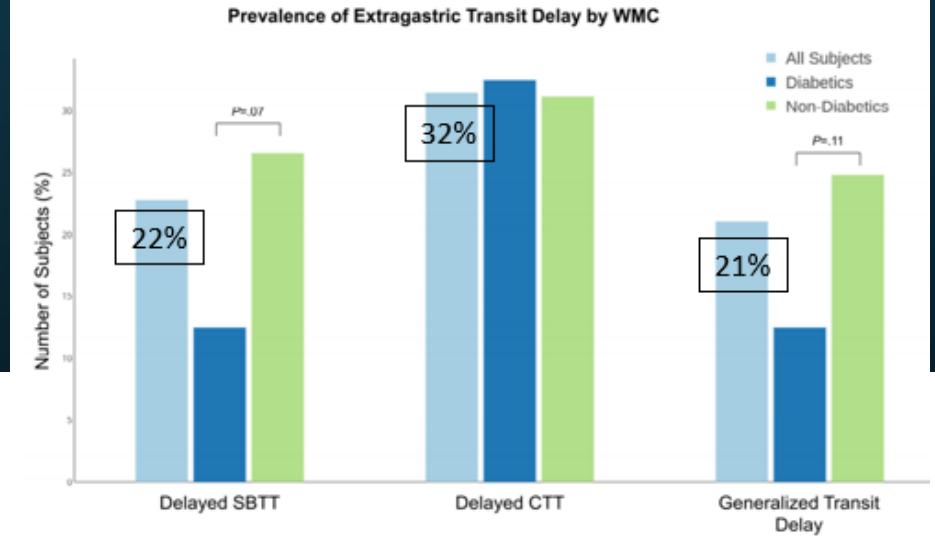
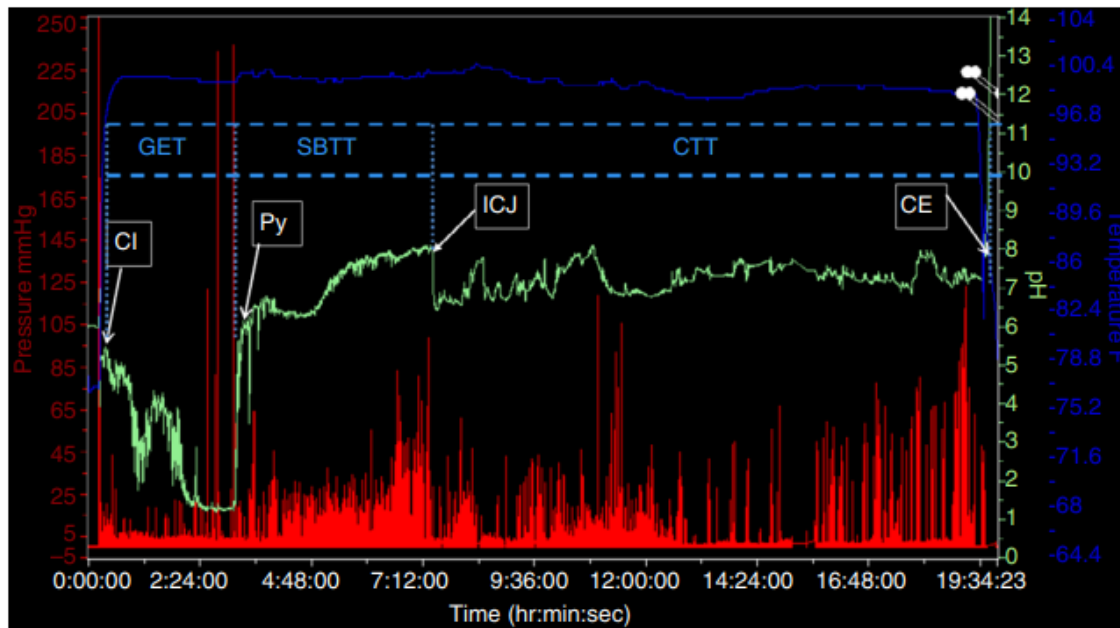
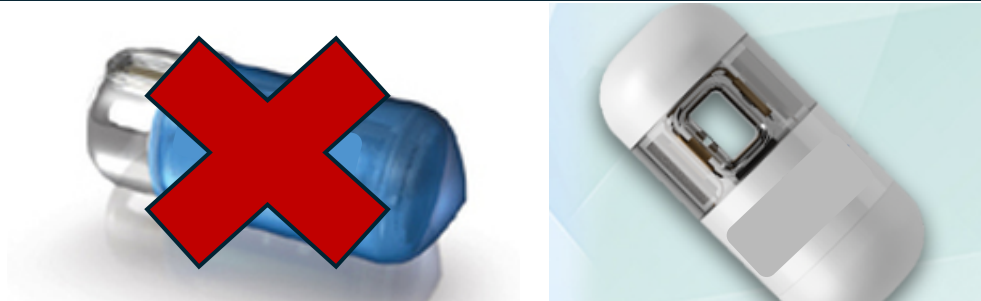


Mucosal Immune Dysfunction

- Confocal laser endomicroscopy (CLE)



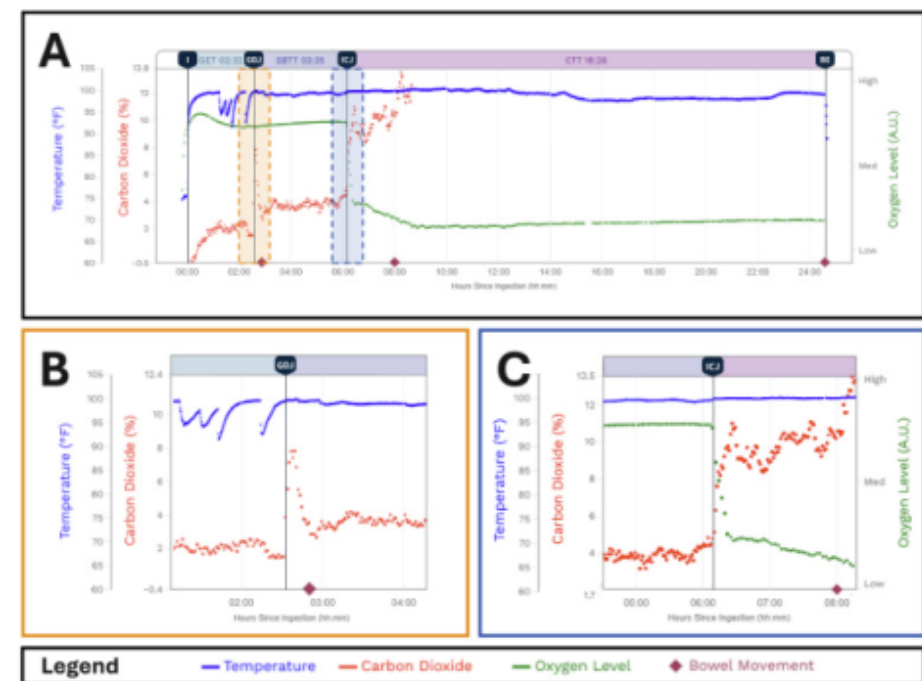
Wireless Capsule Motility: Diagnosing Extragastric Dysmotility & Impacting Outcomes



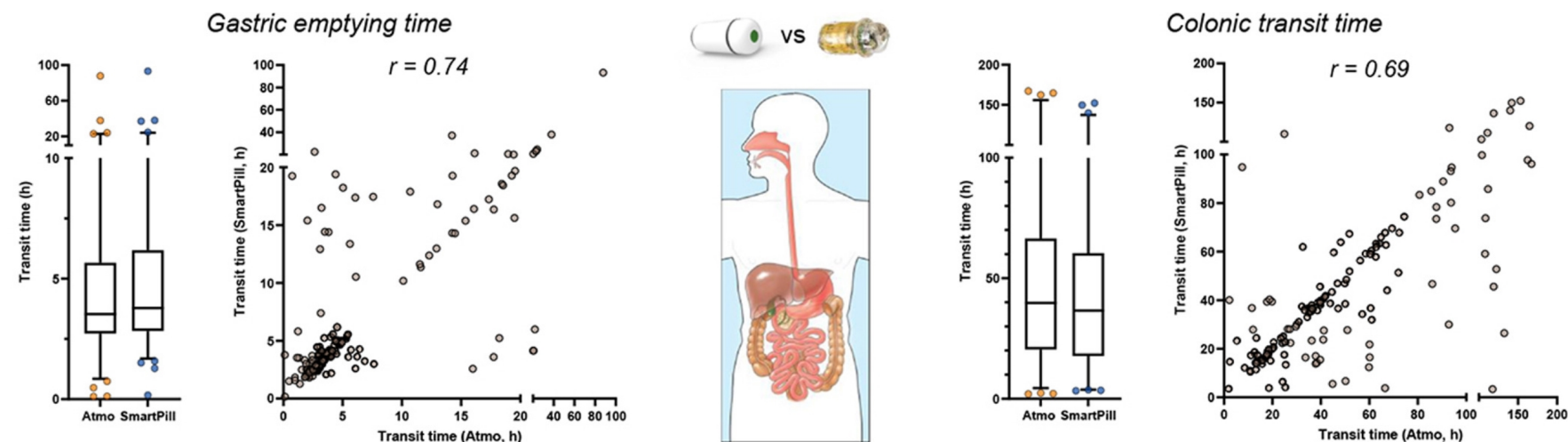
Lee AA, et al. Clinical Gastroenterology & Hepatology 2019

Surjanhata B et al. Neurogastroenterol Motil 2025

Gas Sensing Capsule



Gastrointestinal transit assessment – gas sensing capsule compared with wireless motility capsule

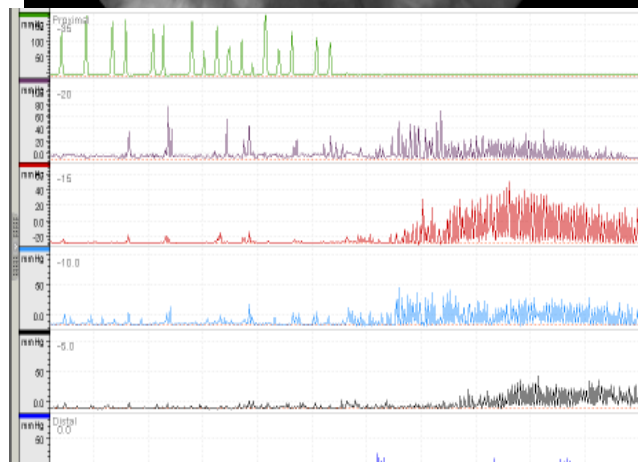
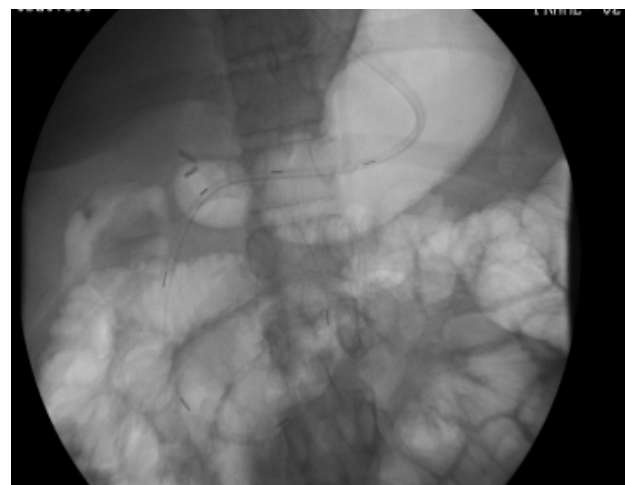


Atmo Capsule has comparable performance characteristics to SmartPill Capsule and is a valid method for assessing gastrointestinal transit.

Clinical Gastroenterology and Hepatology

Kuo B et al. CGH 2025

The Promise of Quantitative MRI

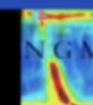


Clinical Trial > PLoS One. 2020 Nov 11;15(11):e0241441. doi: 10.1371/journal.pone.0241441.
eCollection 2020.

Measurement of fasted state gastric antral motility before and after a standard bioavailability and bioequivalence 240 mL drink of water: Validation of MRI method against concomitant perfused manometry in healthy participants

Khaled Heissam¹, Nichola Abrehart¹, Caroline L Hoad^{1 2}, Jeff Wright¹, Alex Menys³, Kathryn Murray^{1 2}, Paul M Glover², Geoffrey Hebbard⁴, Penny A Gowland², Jason Baker⁵, William L Hasler⁵, Robin C Spiller¹, Maura Corsetti¹, James G Brasseur⁶, Bart Hens^{7 8}, Kerby Shedden⁹, Joseph Dickens⁹, Deanna M Mudie^{7 10}, Greg E Amidon⁷, Gordon L Amidon⁷, Luca Marciani¹

Neurogastroenterology & Motility



ORIGINAL ARTICLE |  Open Access |  

Magnetic resonance imaging assessed enteric motility and luminal content analysis in patients with severe bloating and visible distension

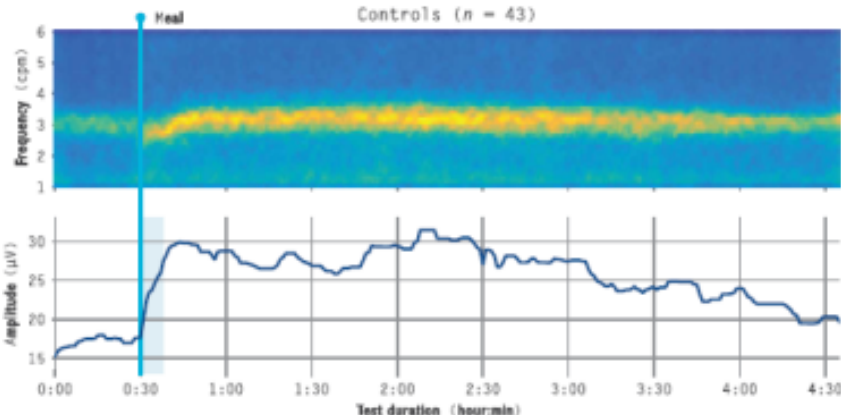
Ruaridh M. Gollifer, Stuart A. Taylor✉, Alex Menys, Natalia Zarate-Lopez, Dave Chatoor, Anton Emmanuel, David Atkinson

First published: 19 April 2022 | <https://doi.org/10.1111/nmo.14381> | Citations: 3

Gastric Myoelectrical Activity & Body Surface Gastric Mapping

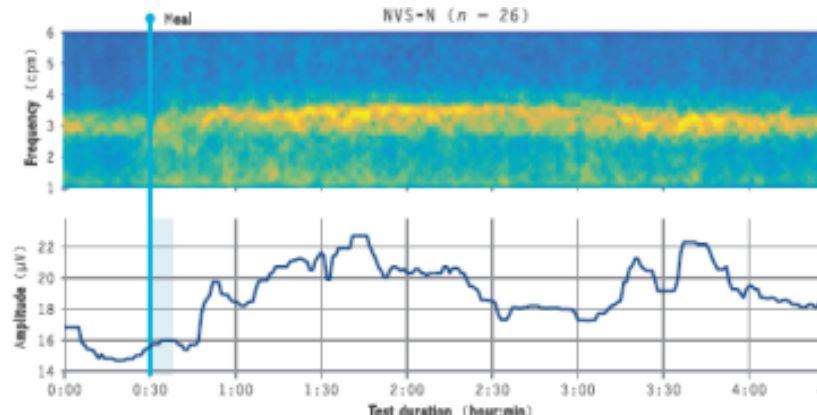
Healthy

Controls (n = 43)



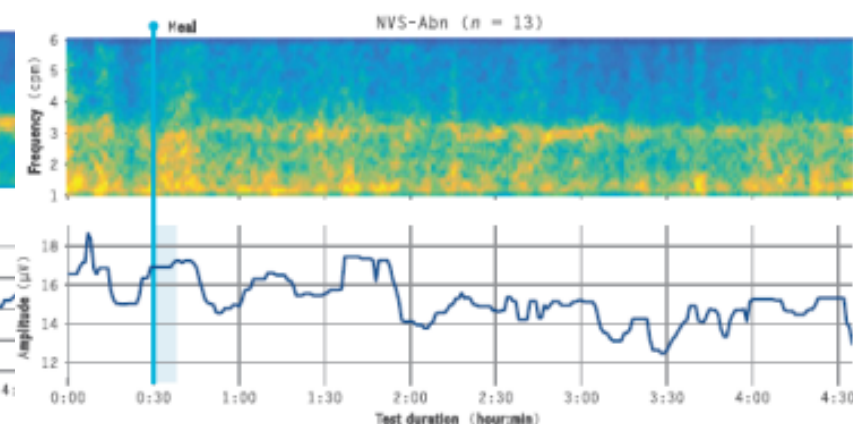
NVS-Normal

NVS-N (n = 26)



NVS-Abnormal

NVS-Abn (n = 13)



2 Gastric Data Capture

High-resolution bioelectrical
signal acquisition

continuous



Body Surface Gastric Mapping Phenotypes

Review

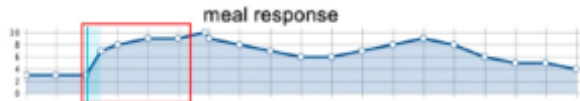
Gastric Alimetry[®] Test Interpretation in Gastroduodenal Disorders: Review and Recommendations

Daphne Foong ¹, Stefan Calder ^{2,3,4}, Chris Varghese ² , Gabriel Schamberg ^{3,4}, William Xu ², Charlotte Daker ⁵, Vincent Ho ^{1,6} , Christopher N. Andrews ⁷, Armen A. Gharibans ^{2,3,4} and Greg O'Grady ^{2,3,4,*}

(a) Assess baselines

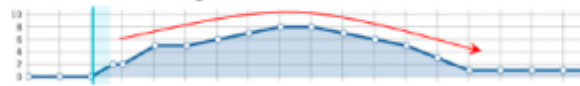


(b) Assess meal response

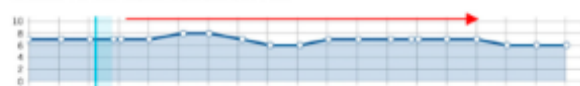


(c) Assess symptom curves

Observe for declining curves



Observe for continuous curves



Observe for late uprending curves



Feature	Criteria	Pathophysiology to Consider *
Dysrhythmic	GA-RI < 0.25	Gastric neuromuscular disorder Dysrhythmic states
Low-amplitude	BMI-adjusted amplitude < 22 μ V	Hypomotility Myopathy Gastric neuromuscular disorder or myopathy
High-amplitude	BMI-adjusted amplitude > 70 μ V	Gastric outlet resistance
High-frequency	Frequency > 3.35 cpm	Long-term diabetes Vagal neuropathy or injury
Low-frequency	Frequency < 2.65 cpm	Impaired pacemaker function Resection of primary gastric pacemaker
Sensorimotor profile	Normal spectral analysis Meal-responsive symptoms that correlate with gastric amplitude	Hypersensitivity and/or impaired accommodation disorder
Continuous profile	Normal spectral analysis Non-meal-responsive symptoms that persist at a high severity throughout test, including before meal	Disorder of gut–brain axis or vagal neuropathy or non-gastric cause
Post-gastric profile	Normal spectral analysis Symptoms trend upwards late in the test as gastric amplitude decays	Consider small bowel pathophysiology

Autonomic Function Testing



Full panel

Valsalva - Adrenergic
Deep breathing - Cardiovagal
QSART - Sudomotor
Tilt table



Heart rate variability

Sympathetic & parasympathetic
balance

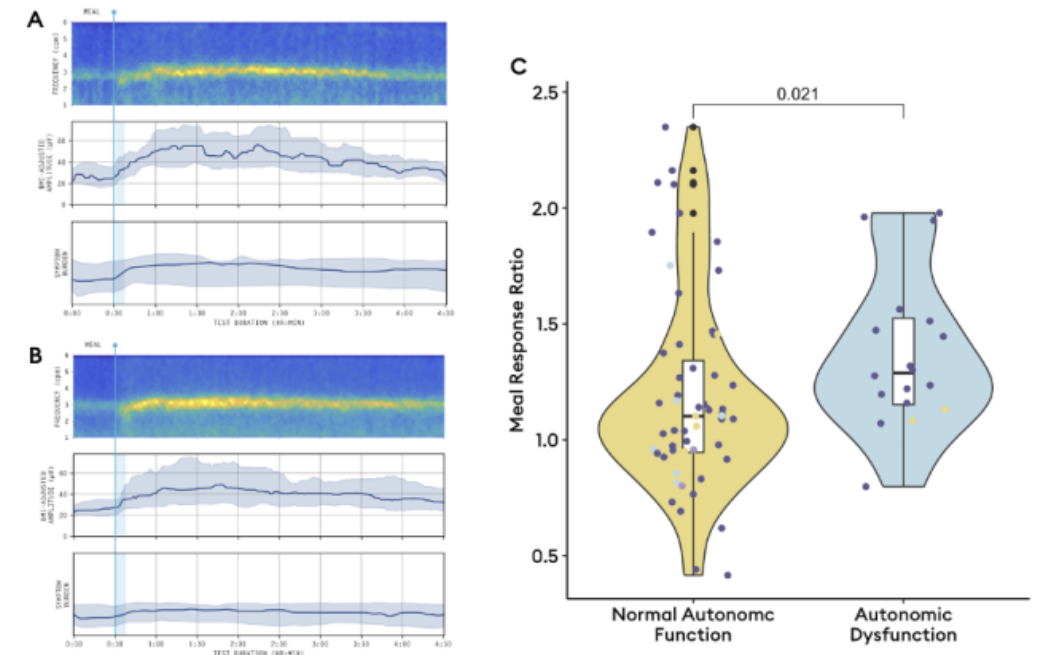
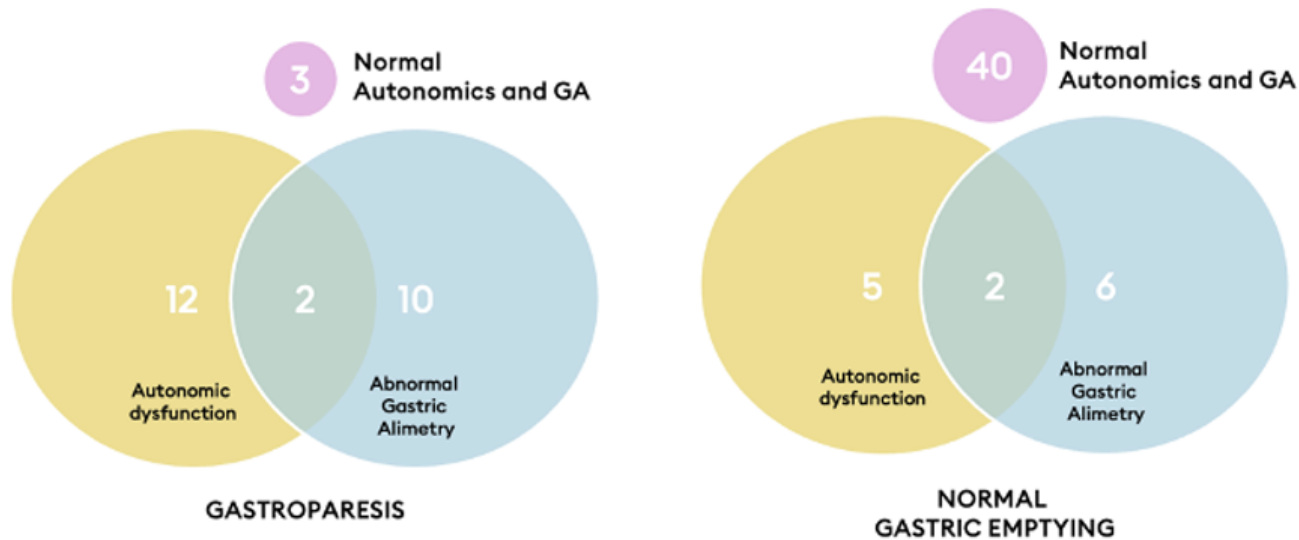


Sham feeding

GI vagal function

Gastric emptying, Alimetry and Autonomic testing yield distinct phenotypes

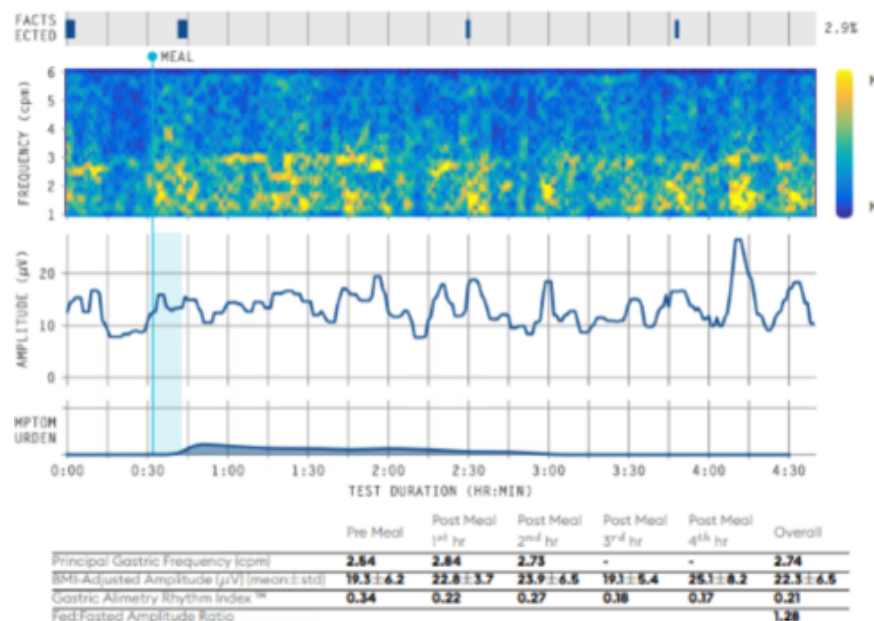
- Patients with autonomic dysfunction are more likely to have greater symptom severity, delayed gastric emptying and altered meal response



NS - "Advanced" Testing

Wireless Capsule Motility

- Gastric Emptying Time (Normal <4 hours): 2:04
- Small Bowel Transit Time (Normal 2.5-6 hours): 5:26
- **Colonic Transit Time (Normal <59 hours): 70:50**
- Whole Gut Transit Time (Normal <73 hours): 78:21



Wireless Capsule Motility

- Normal gastric emptying
- Delayed colonic transit

Body Surface Mapping

- Gastric dysrhythmia and hypomotility
- Correlation of symptoms with postprandial gastric dysrhythmia

Autonomic Testing

- Decreased Valsalva ratio (impaired vagal function)
- Abnormal QSART (small fiber neuropathy)

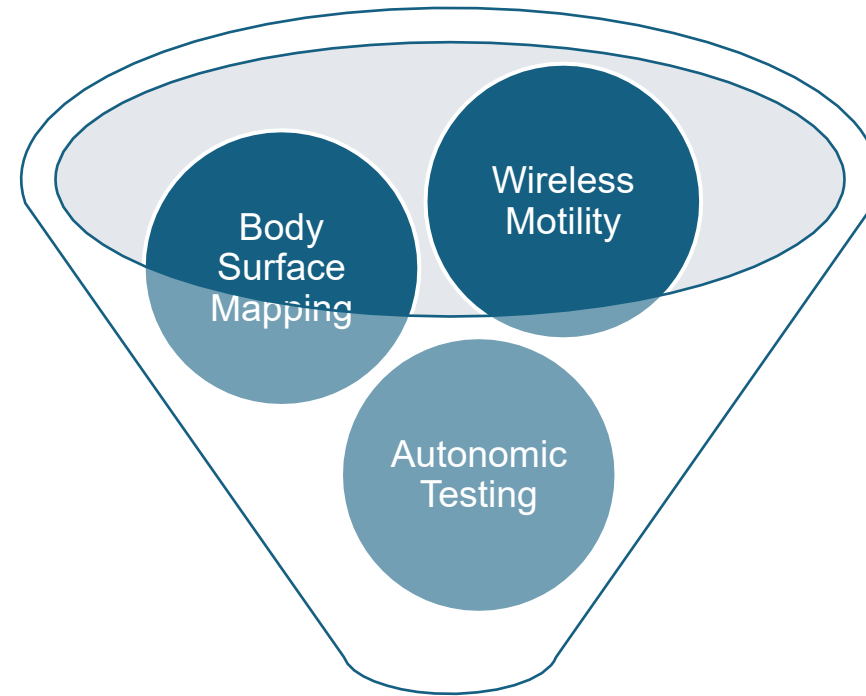
Diagnoses: Slow transit constipation, Gastric neuromuscular dysfunction, Autonomic dysfunction

Functional Dyspepsia

- Abdominal pain
- Early Satiety
- Nausea



Advanced testing



Autonomic dysfunction, Gastric neuromuscular dysfunction, Slow transit constipation

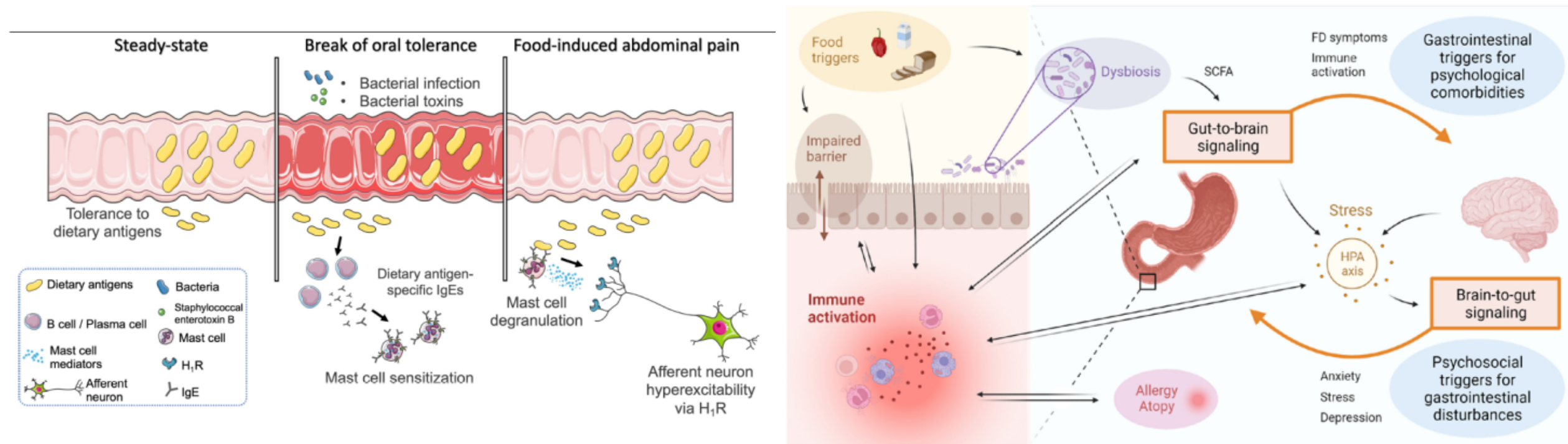


Treatment Regimen:

- Prucalopride
- Propranolol

What is the cause?
What else can be done?

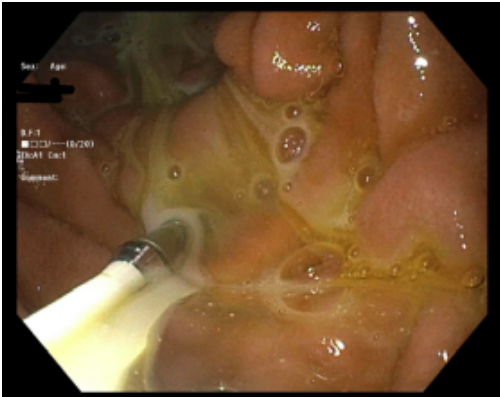
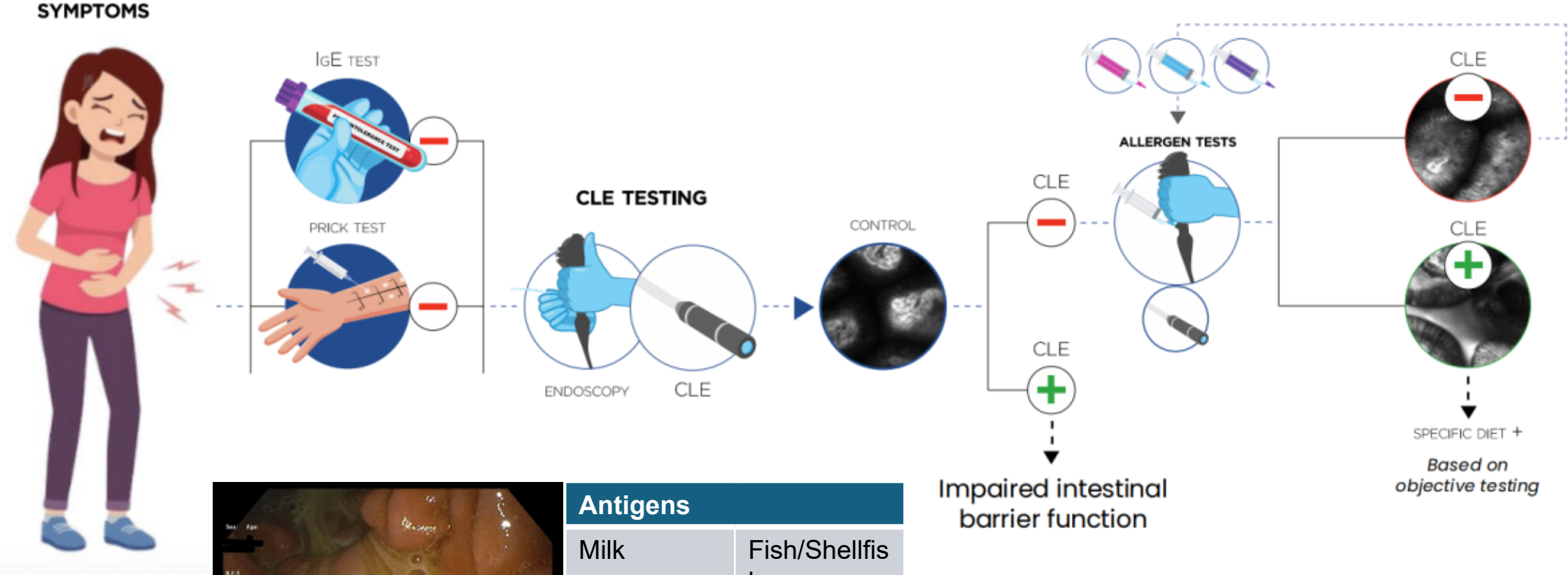
Mucosal Immune Dysregulation and Mechanism of Food-induced Abdominal Pain



Aguilera-Lizarraga et al. Nature 2021;590:151-156.

Ceulemans M et al. Front Neurosci 2022

Confocal Laser Endomicroscopy and Food Antigen Testing



Impact of CLE-FAST on Clinical Care

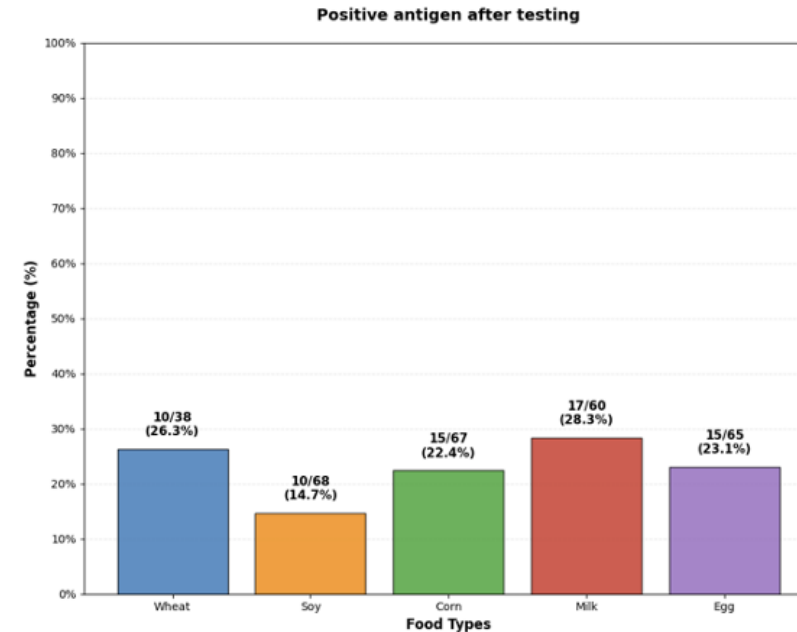
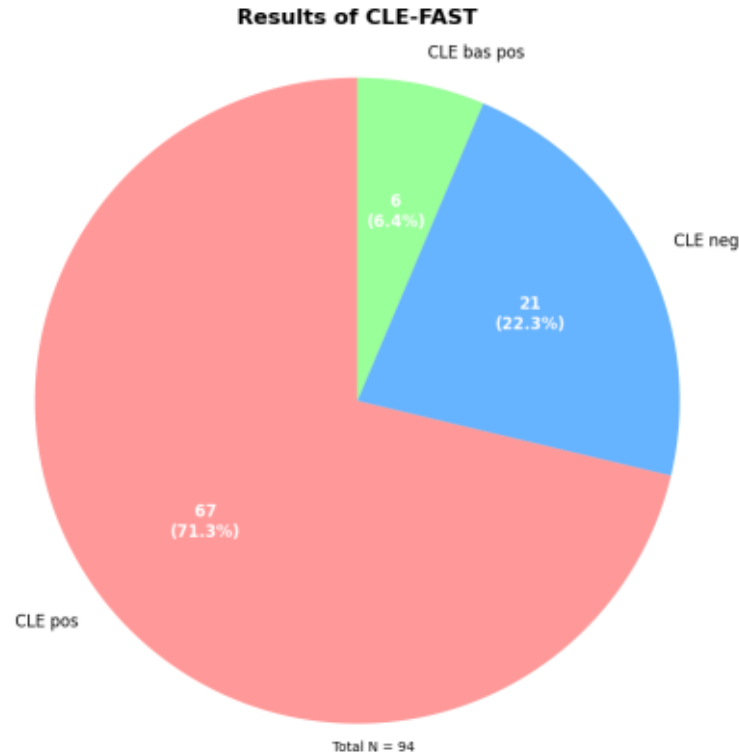
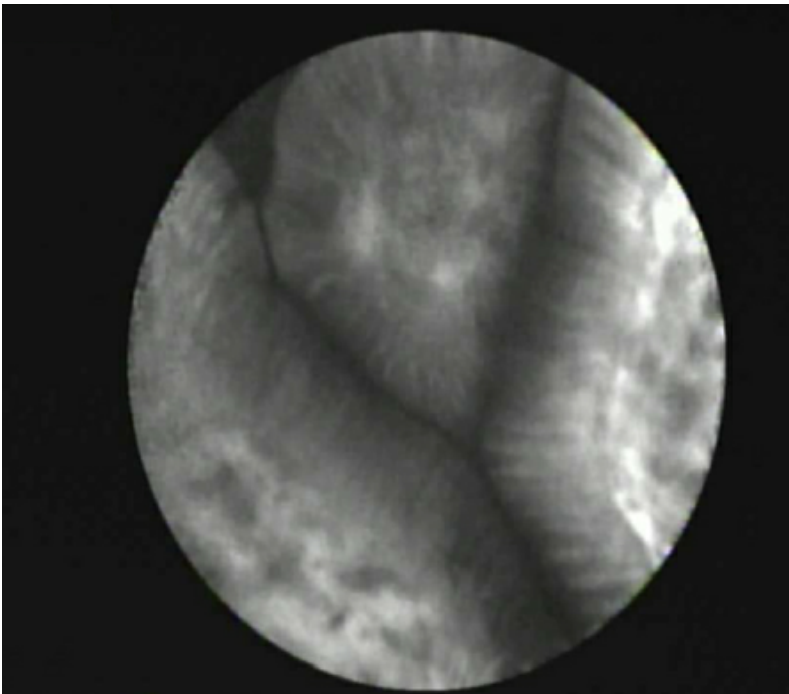


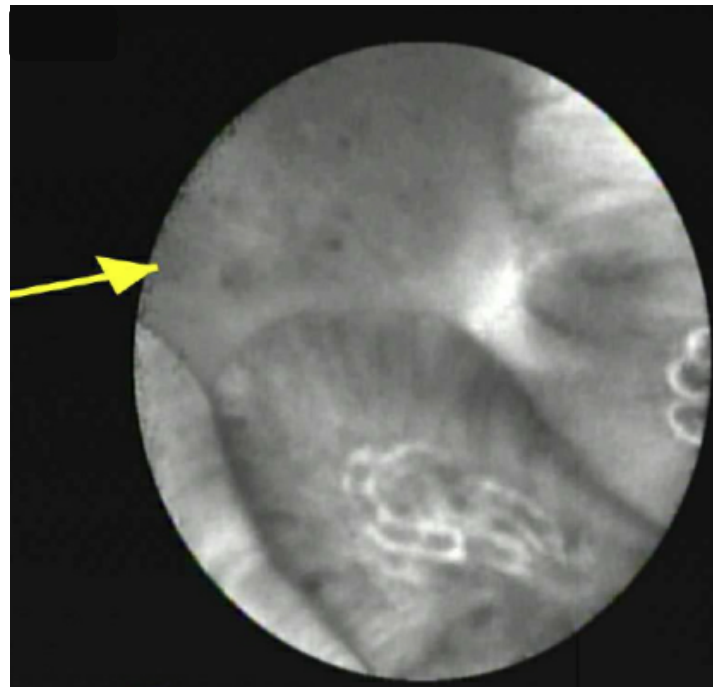
Table 3: Management after CLE-FAST

	Overall (n = 94)	CLE-FAST positive (n = 67)	CLE-FAST negative (n = 21)	CLE-FAST baseline positive (n = 6)
Diet (n,%)				
Exclusion of positive allergen	67 (71.3%)	66 (98.5%)	1 (4.8%)	0
Reintroduction of tested allergens	10 (10.6%)	0	10 (47.6%)	0
No modification of diet	15 (16.0%)	1 (1.5%)	10 (47.6%)	4 (66.7%)

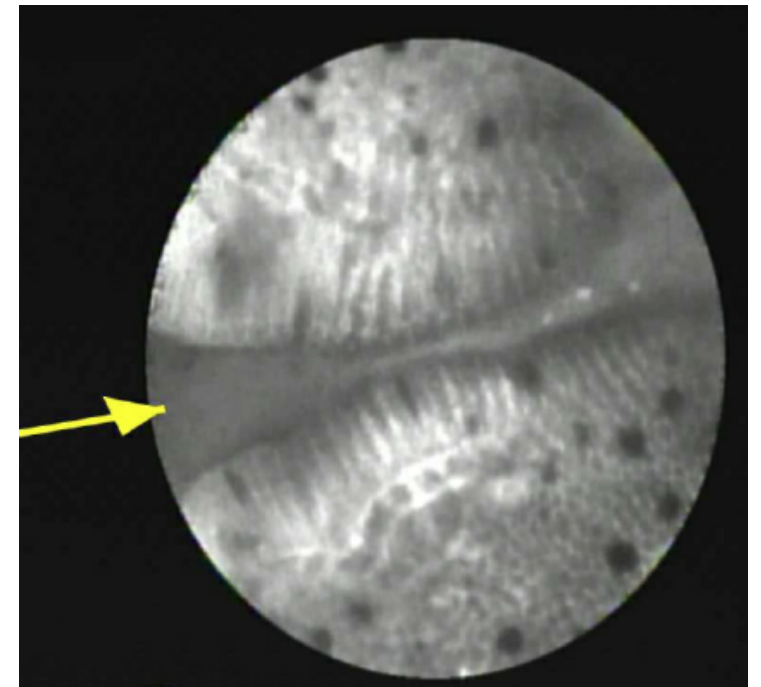
NS- Endomicroscopy with Food Antigen Testing



Baseline



Egg



Corn

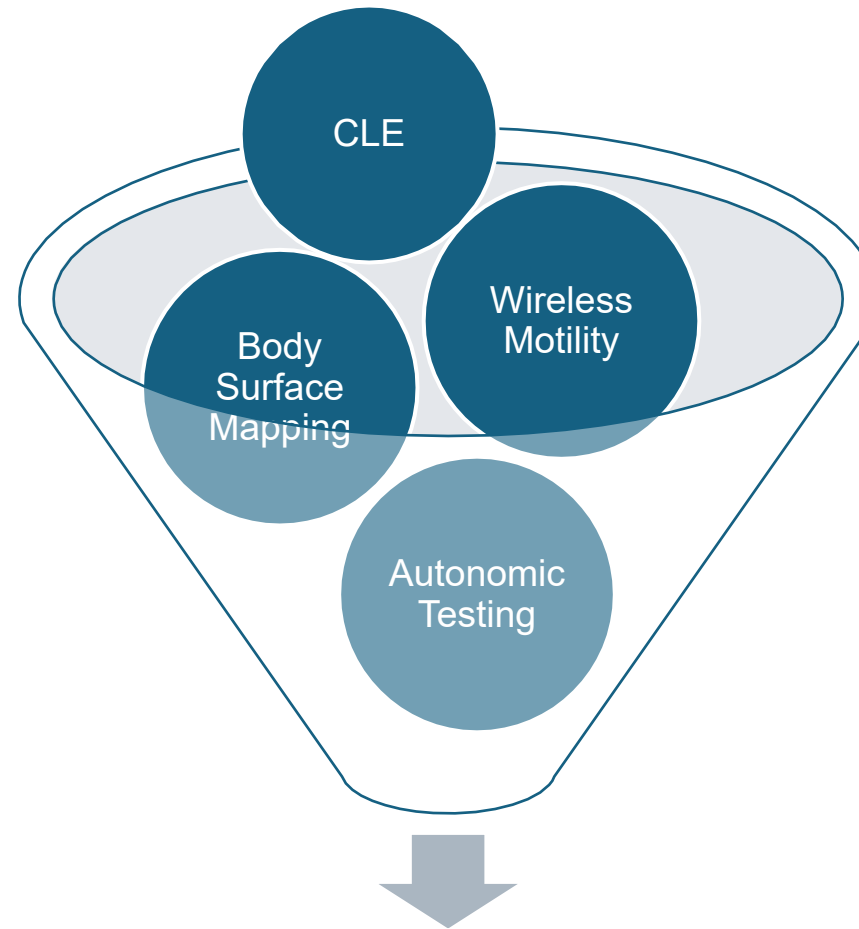
Back to NS

Functional Dyspepsia

- Abdominal pain
- Early Satiety
- Nausea

Treatment Regimen:

- Prucalopride
- Propranolol
- Fexofenadine
- Montelukast
- Dupilumab
- Elimination egg & corn



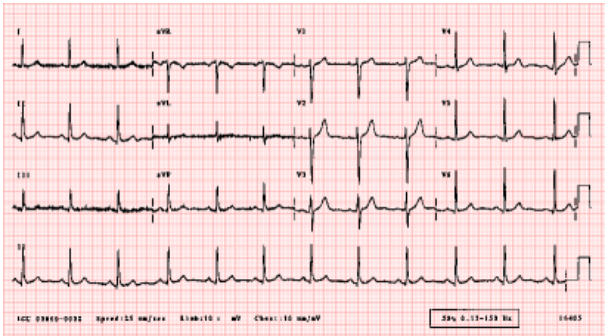
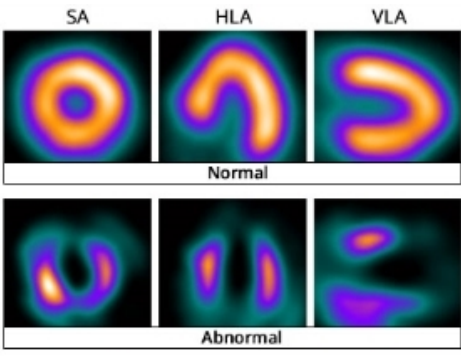
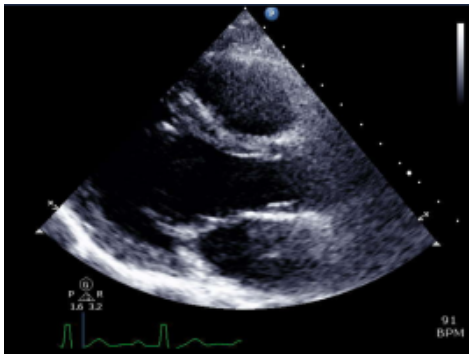
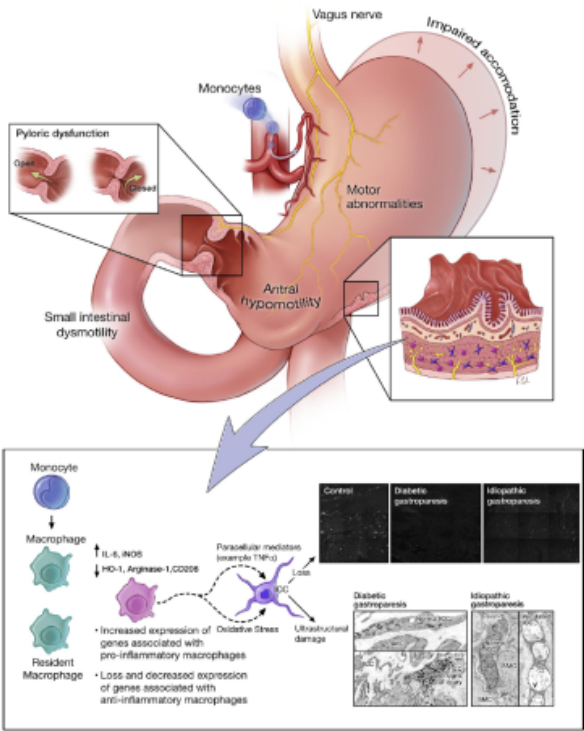
Autonomic dysfunction, Gastric neuromuscular dysfunction, Slow transit constipation

Atypical Food Allergy & Neuroimmune Dysregulation



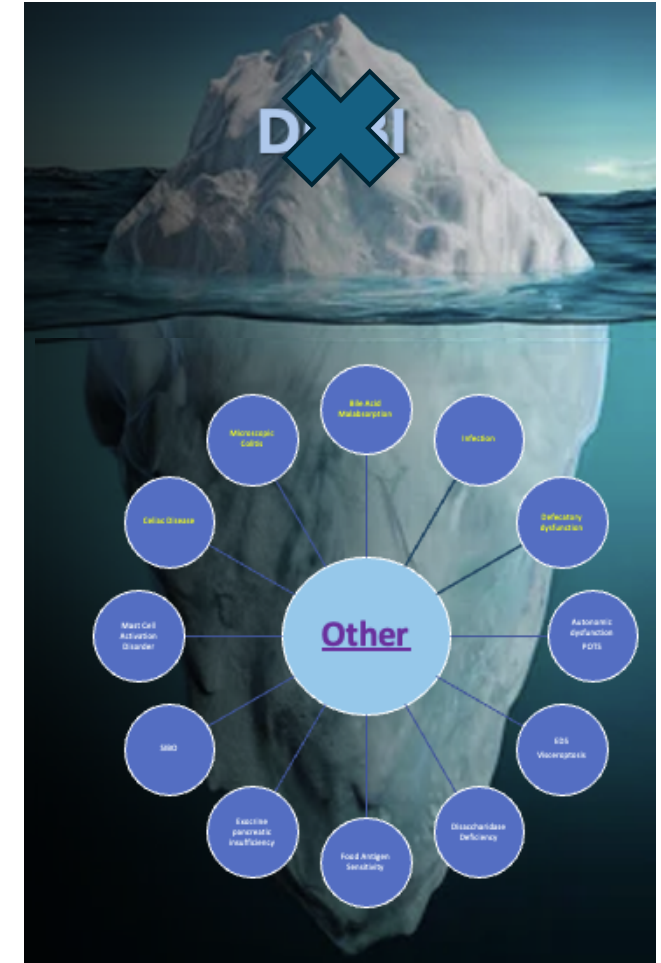
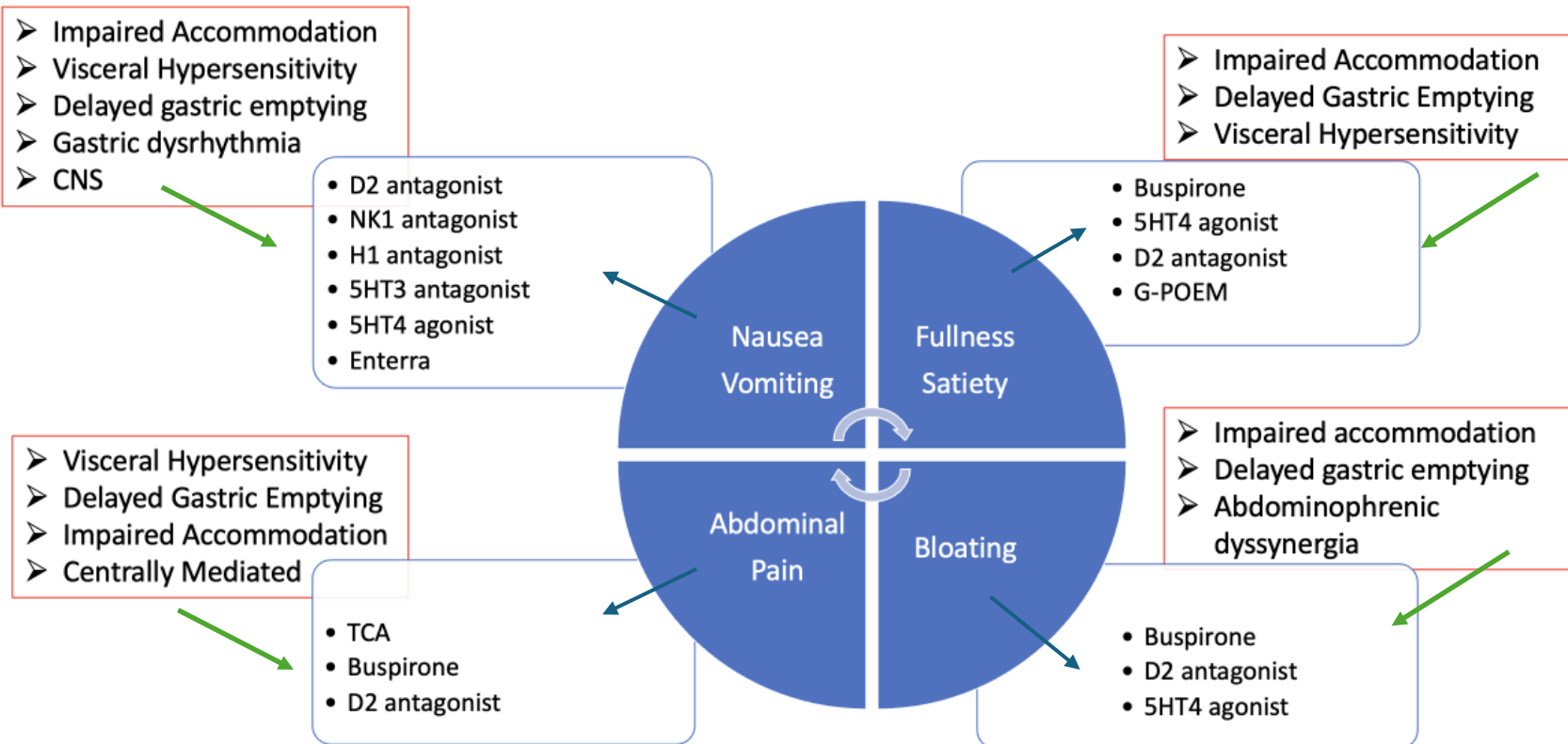
The Potential for Precision Diagnostics and Therapeutics

Test	Physiology	Treatment
Capsule Motility	Whole gut transit	Prokinetic
Electrogastrography	Gastric electrical activity	Neuromodulation, Gastric electrical stimulation
Autonomic Testing	Extrinsic innervation of GI	Vagal stimulation
Endomicroscopy	Mucosal immune function	Immune target therapy



What If...

- Comprehensive physiology testing can take the guessing out of the diagnosis and treatment of upper GI symptoms
- Consider testing in patients not responding to therapies



Take Home Points

- ✓ **Do:** Make a confident DGBI diagnosis when patients meet criteria
 - New technology can help clarify the diagnosis when traditional tests are indeterminate
- ✓ **Do:** Re-evaluate patients who do not respond to appropriate therapies
 - Understanding pathophysiology may help guide therapy in patients not responding to therapy or with more severe disease
- ✓ **Don't:** Start with exhaustive testing and treat DGBI as diagnoses of exclusion