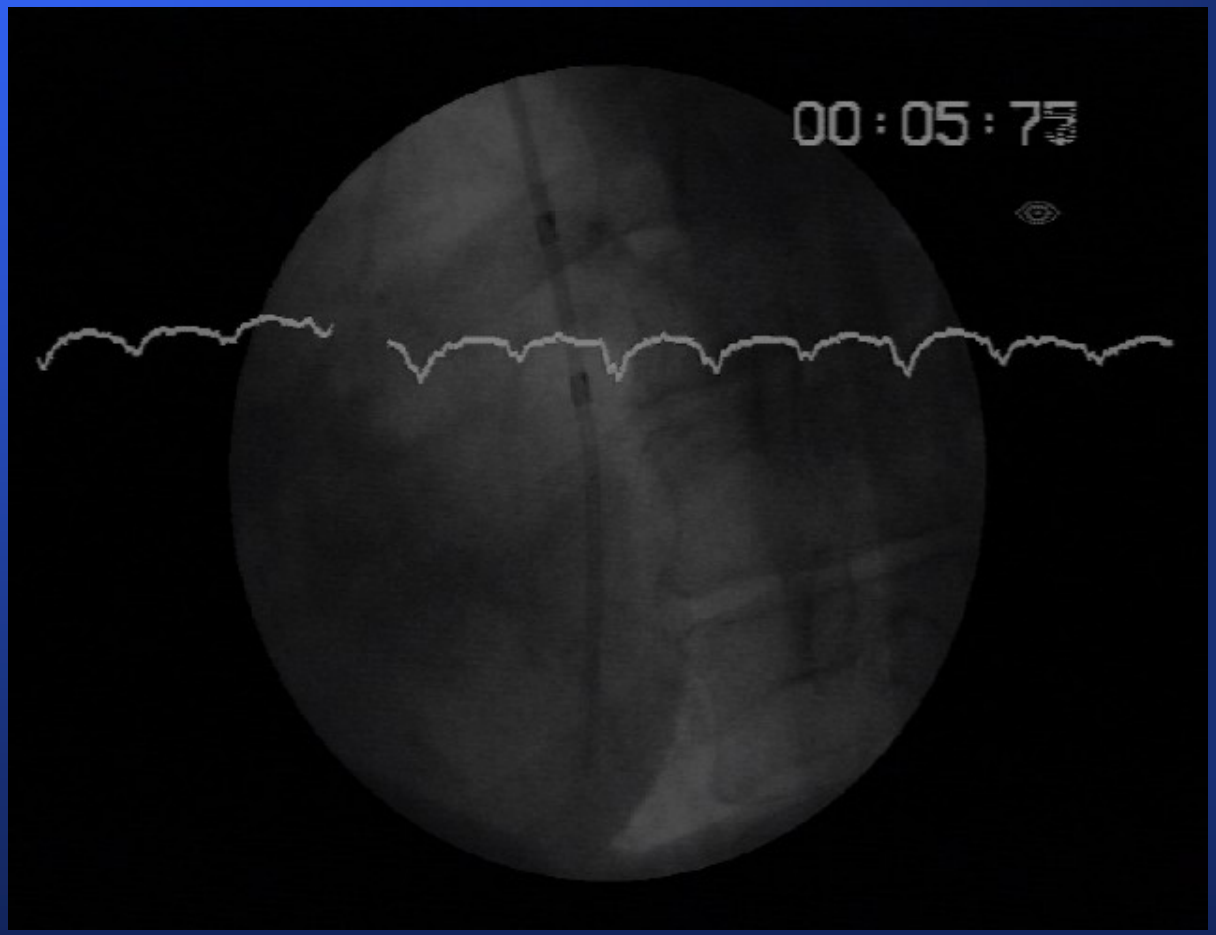
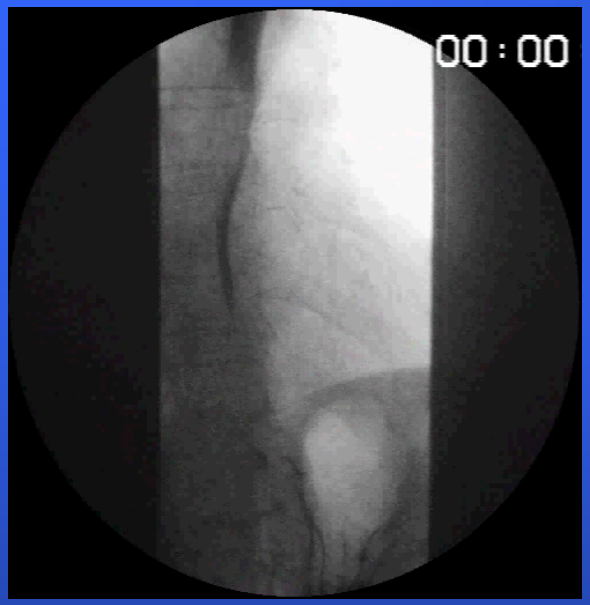
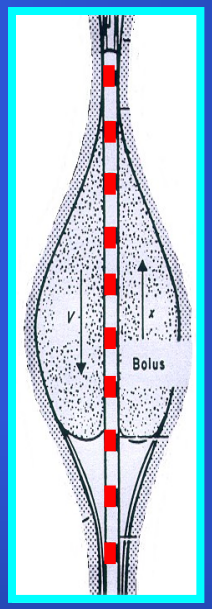
Esophageal impedance monitoring

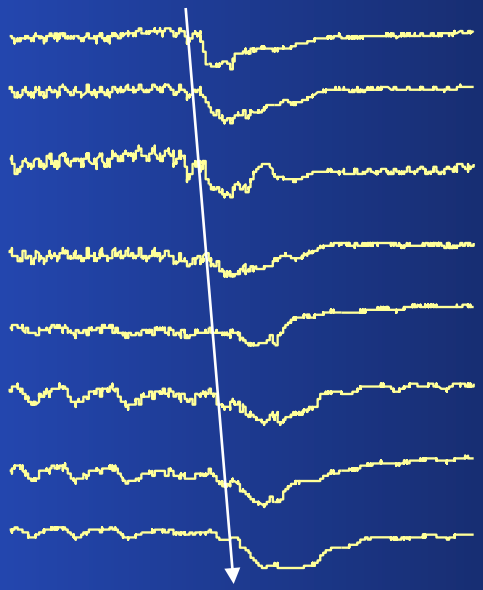
Daniel Sifrim MD, PhD

IMPEDANCE, the measurement

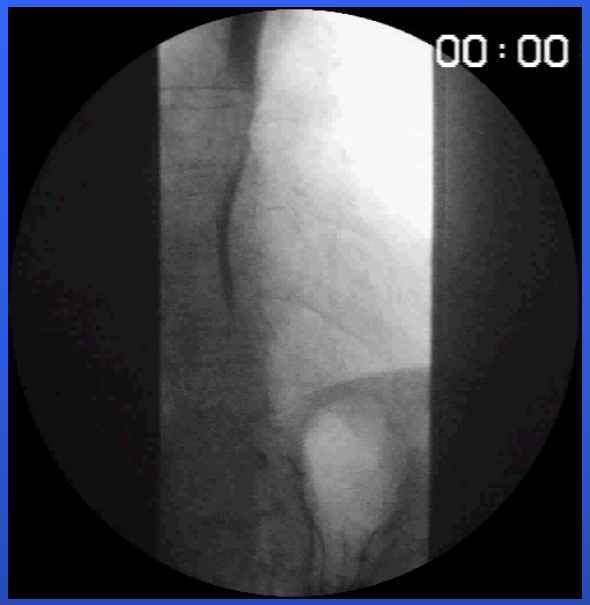


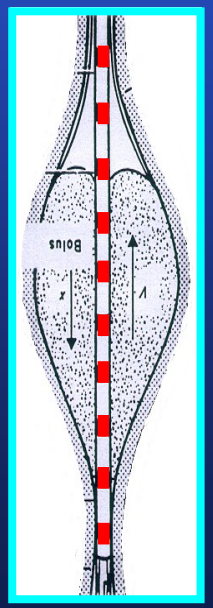


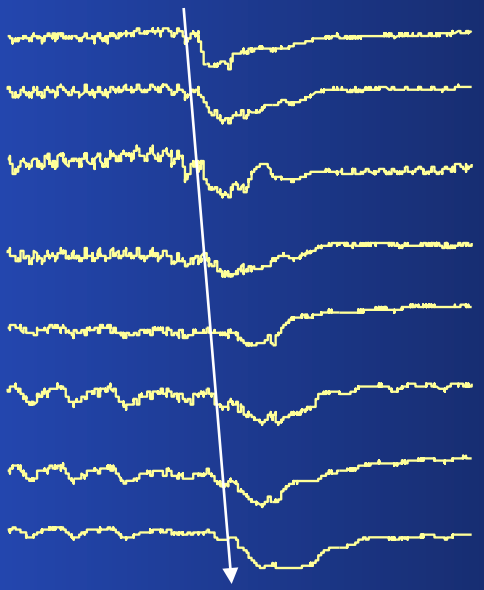




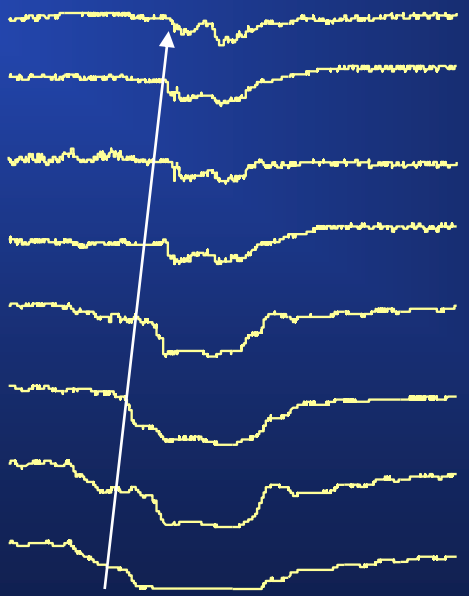
Swallow







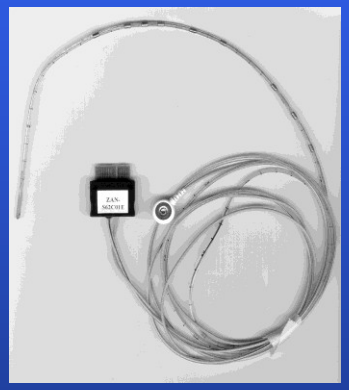
Swallow

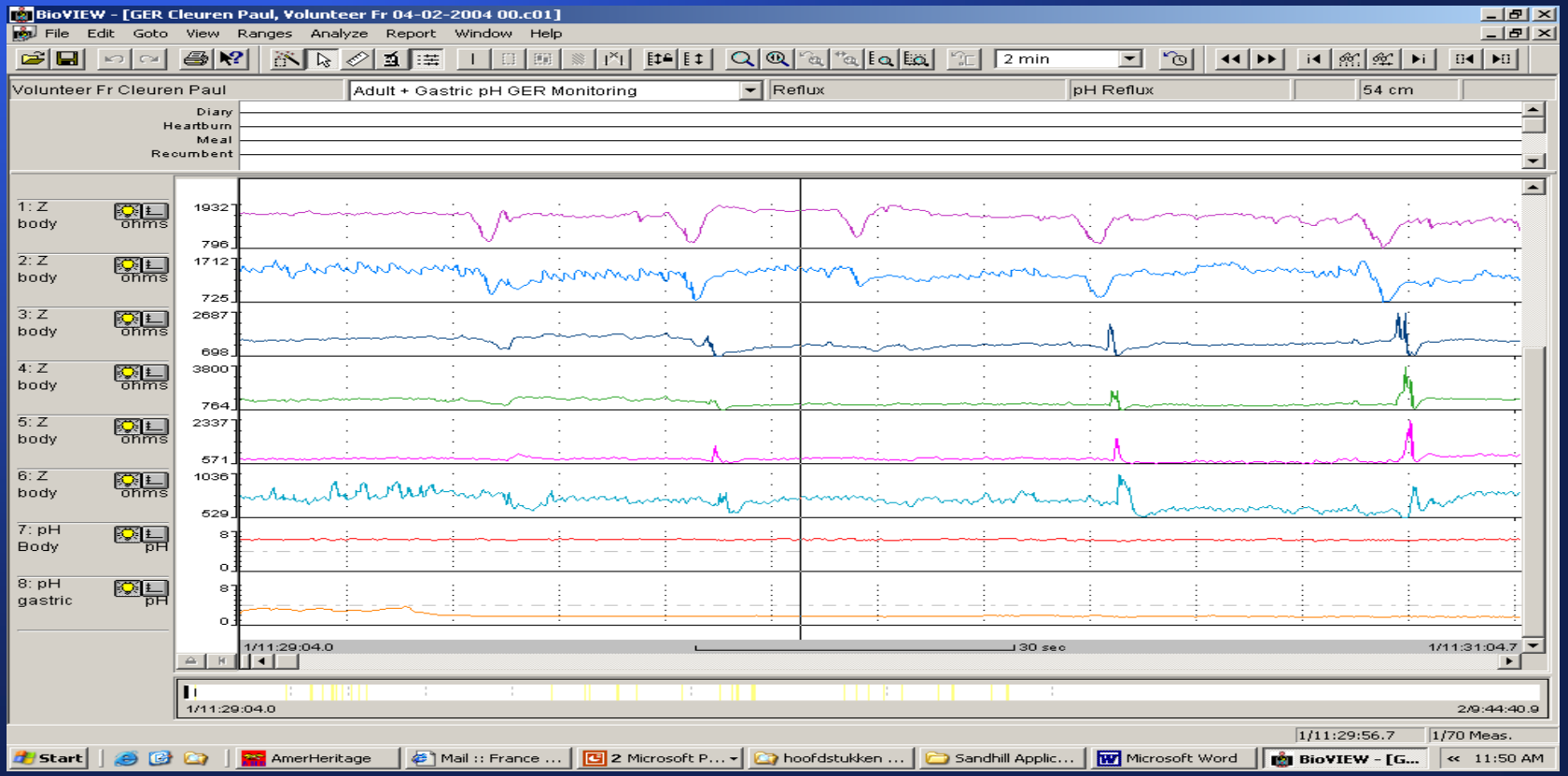


Reflux

IMPEDANCE, the techniques

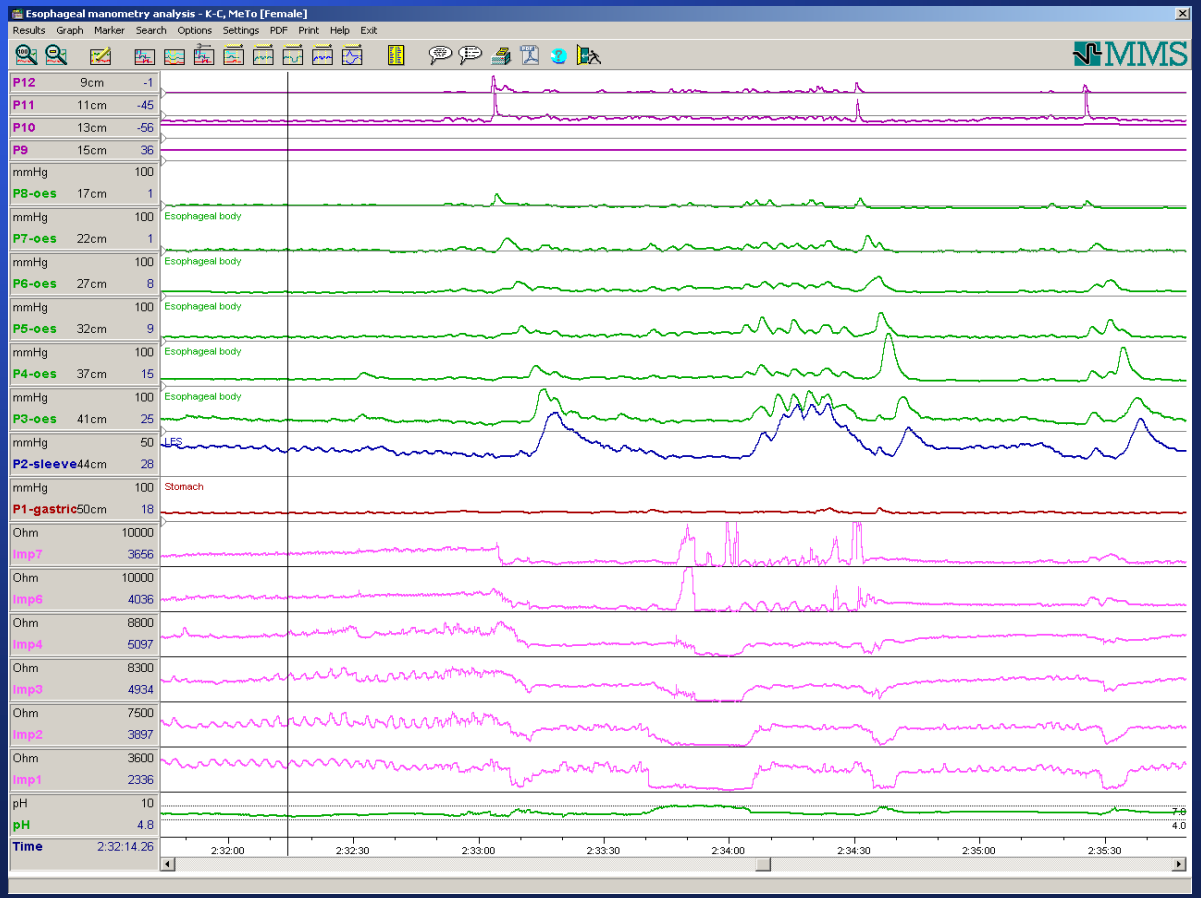
Ambulatory pH-impedance





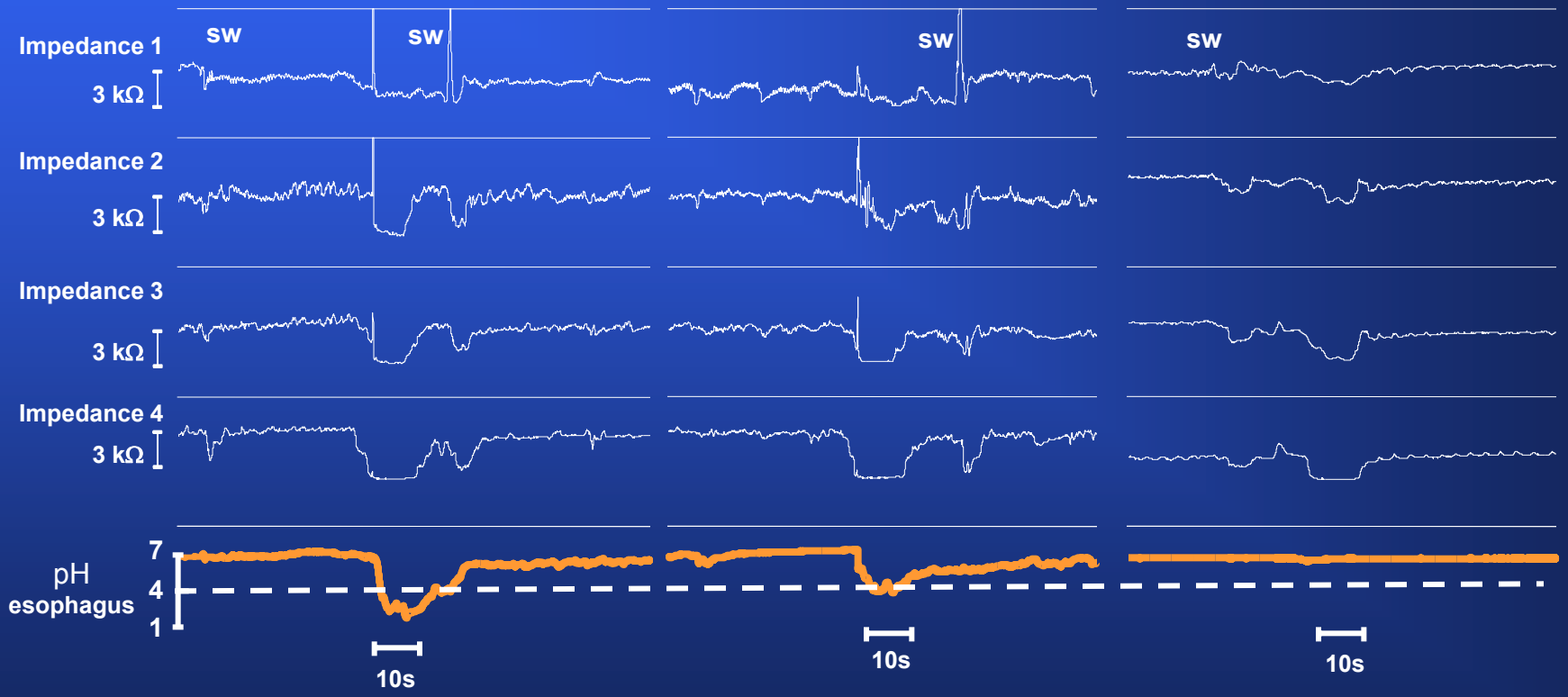
Stationary manometry-impedance

Stationary manometry-impedance



IMPEDANCE, the interpretation

Patterns of gastroesophageal reflux



acid reflux

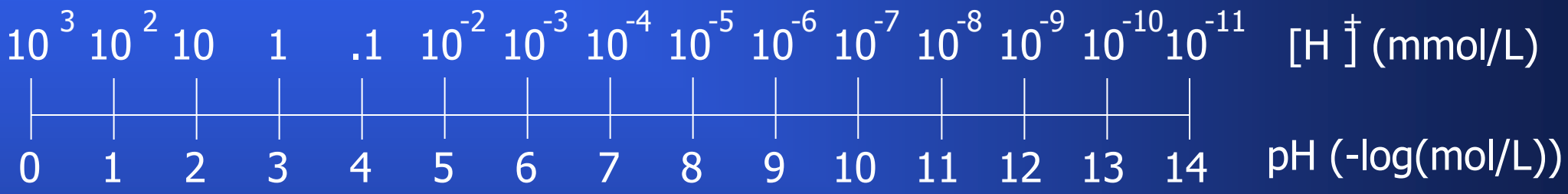
Weakly acidic reflux

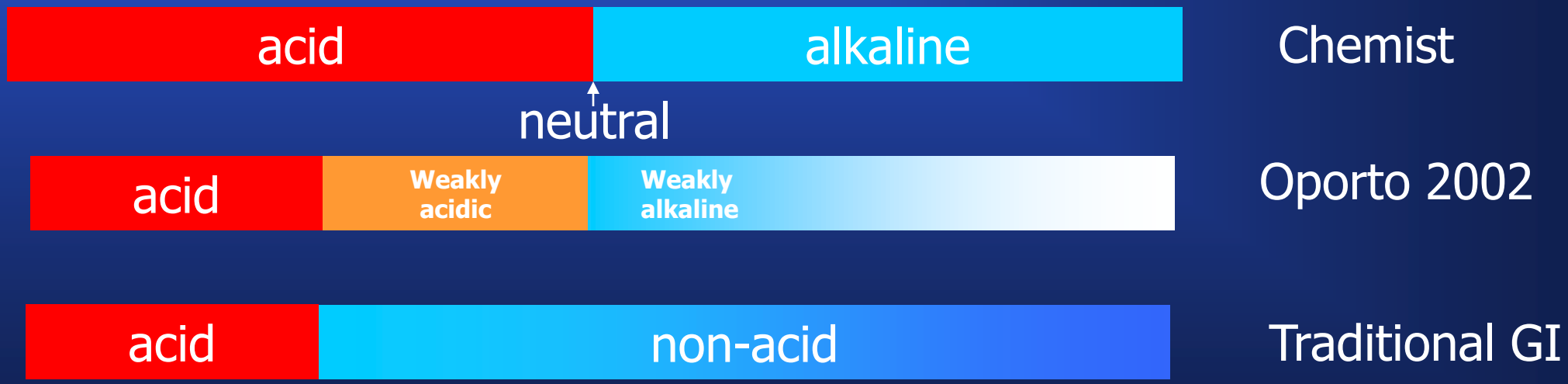
Weakly alkaline reflux

Sifrim et al 2004

Non-acid and weakly acidic reflux

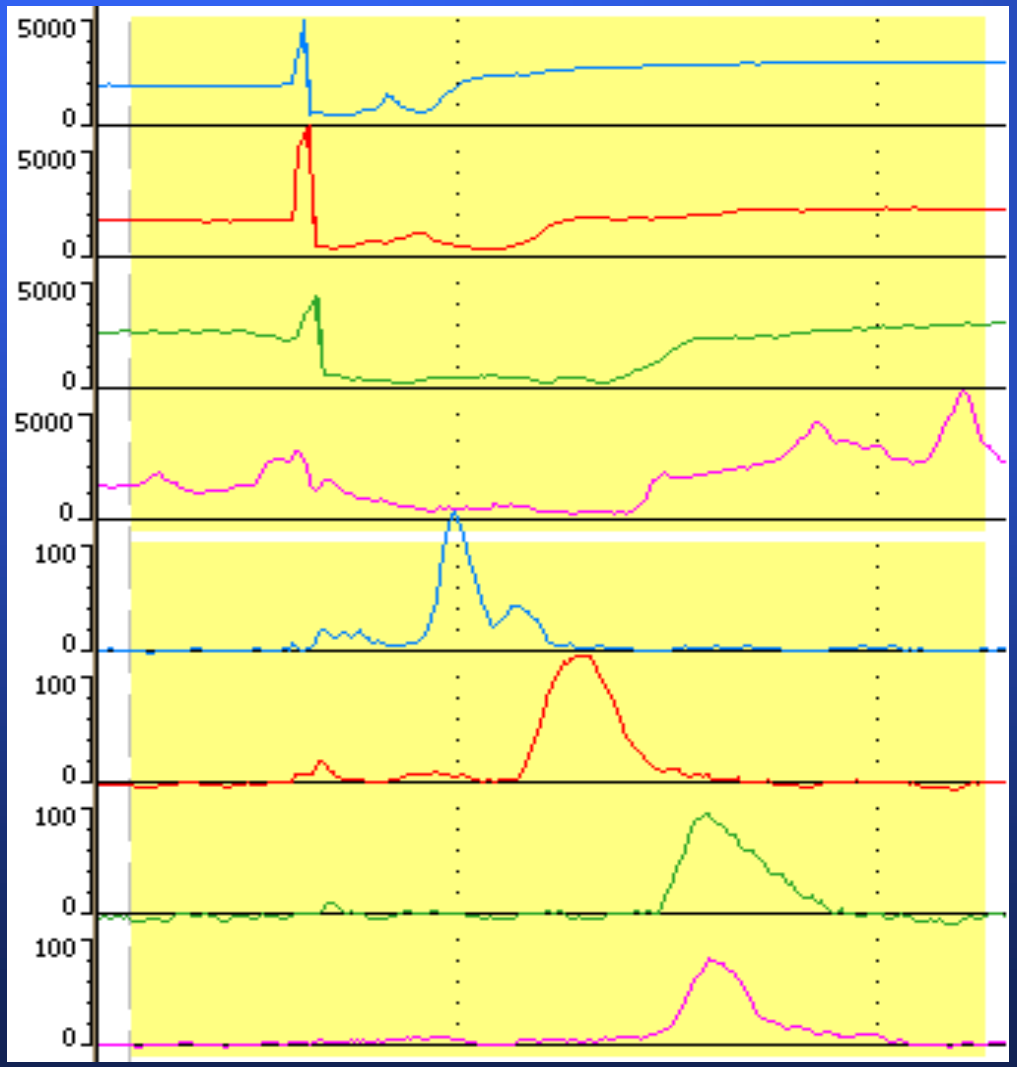
$$H_2O \rightleftharpoons H^+ + OH^-$$



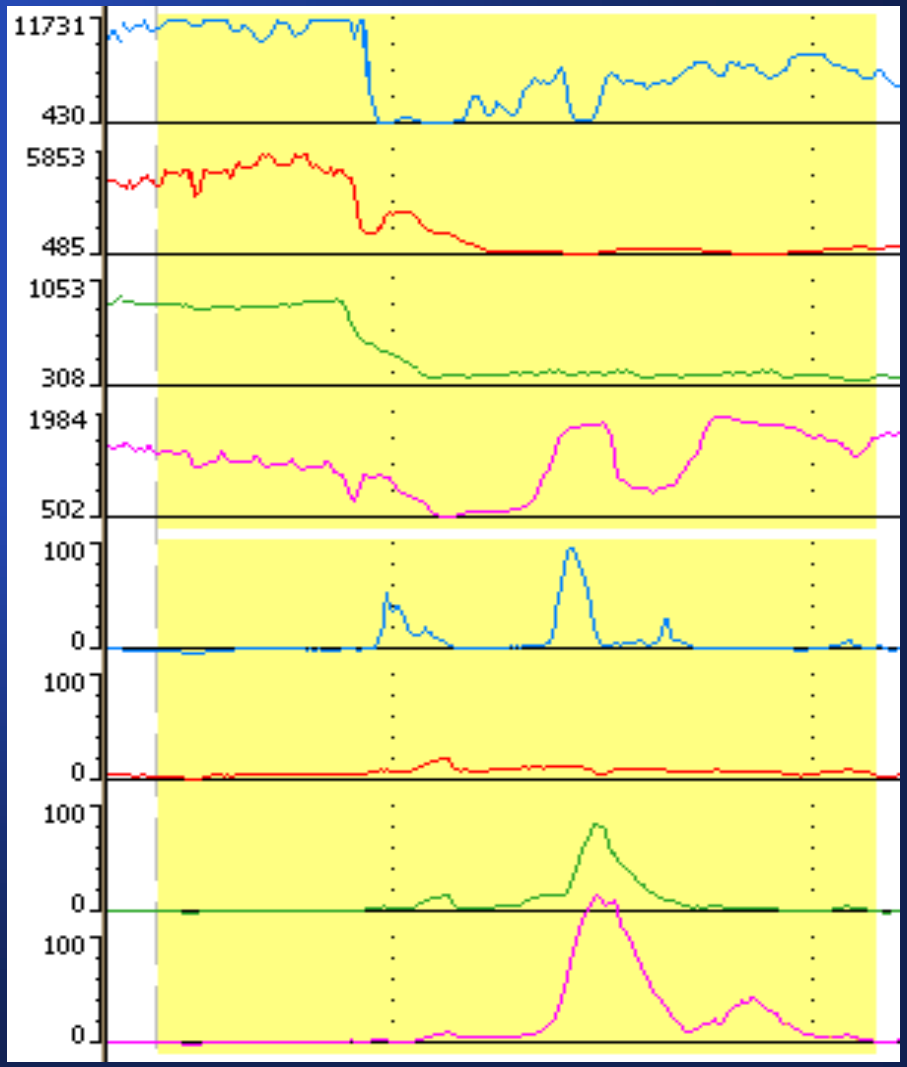


Patterns of bolus transit

Complete transit



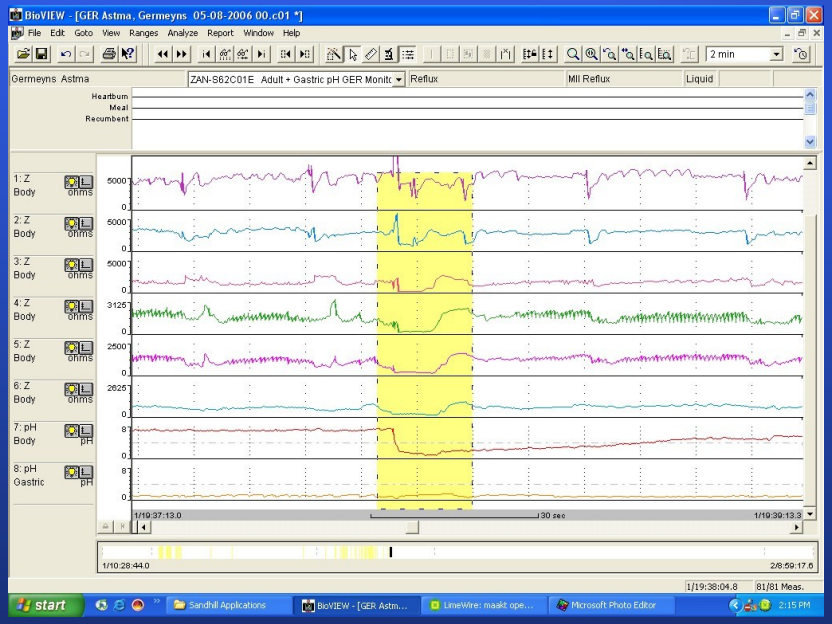
Incomplete transit

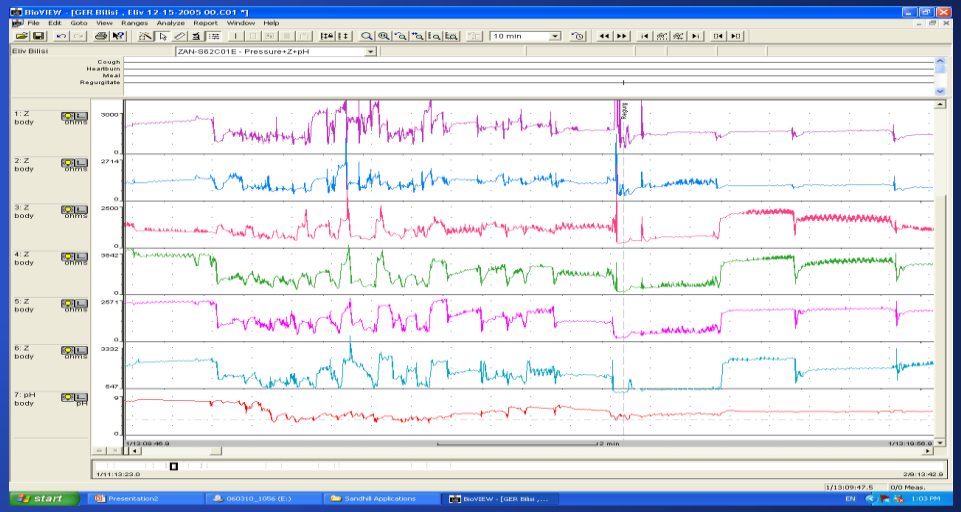


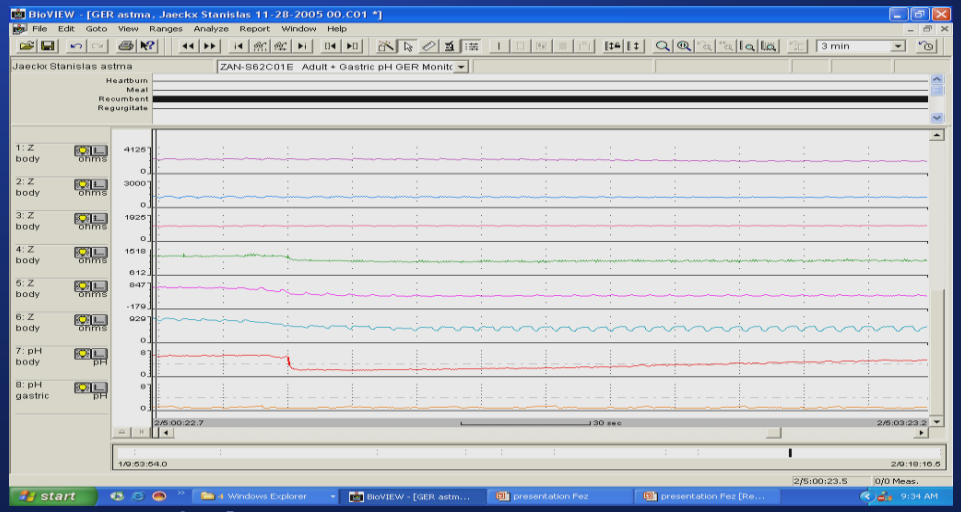
IMPEDANCE, problems with interpretation

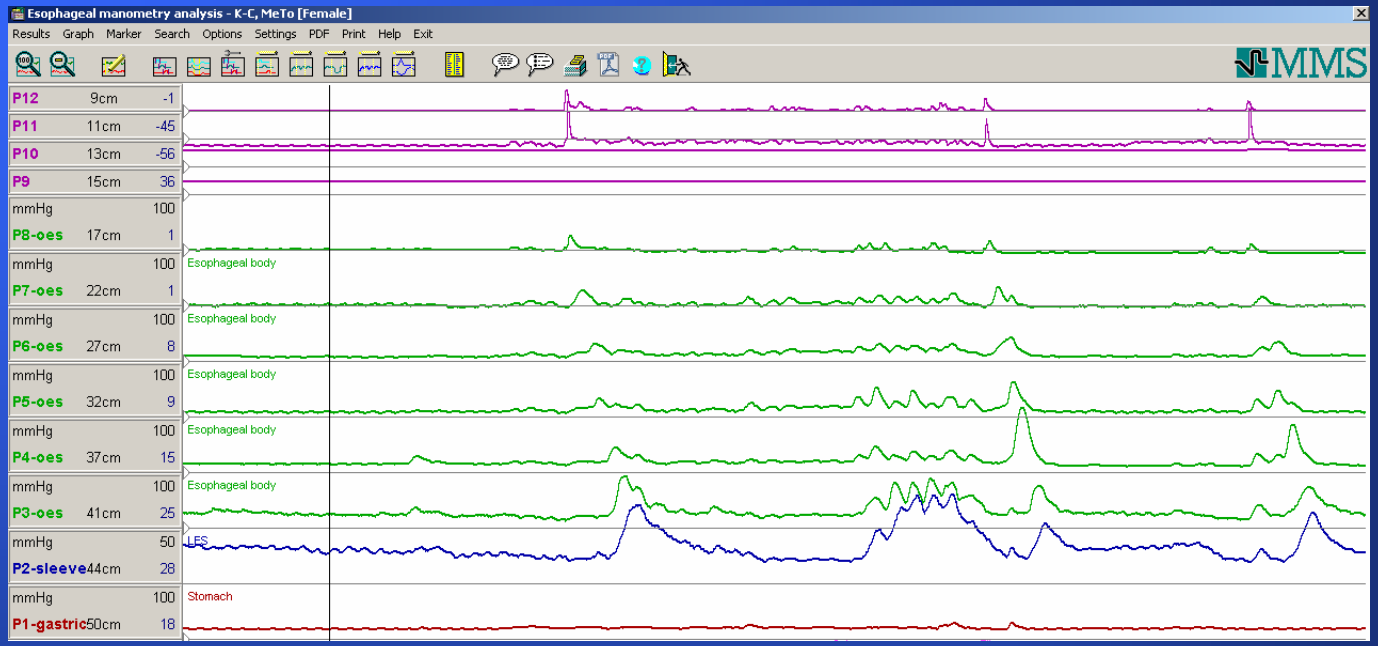
pH only = relevant reflux?

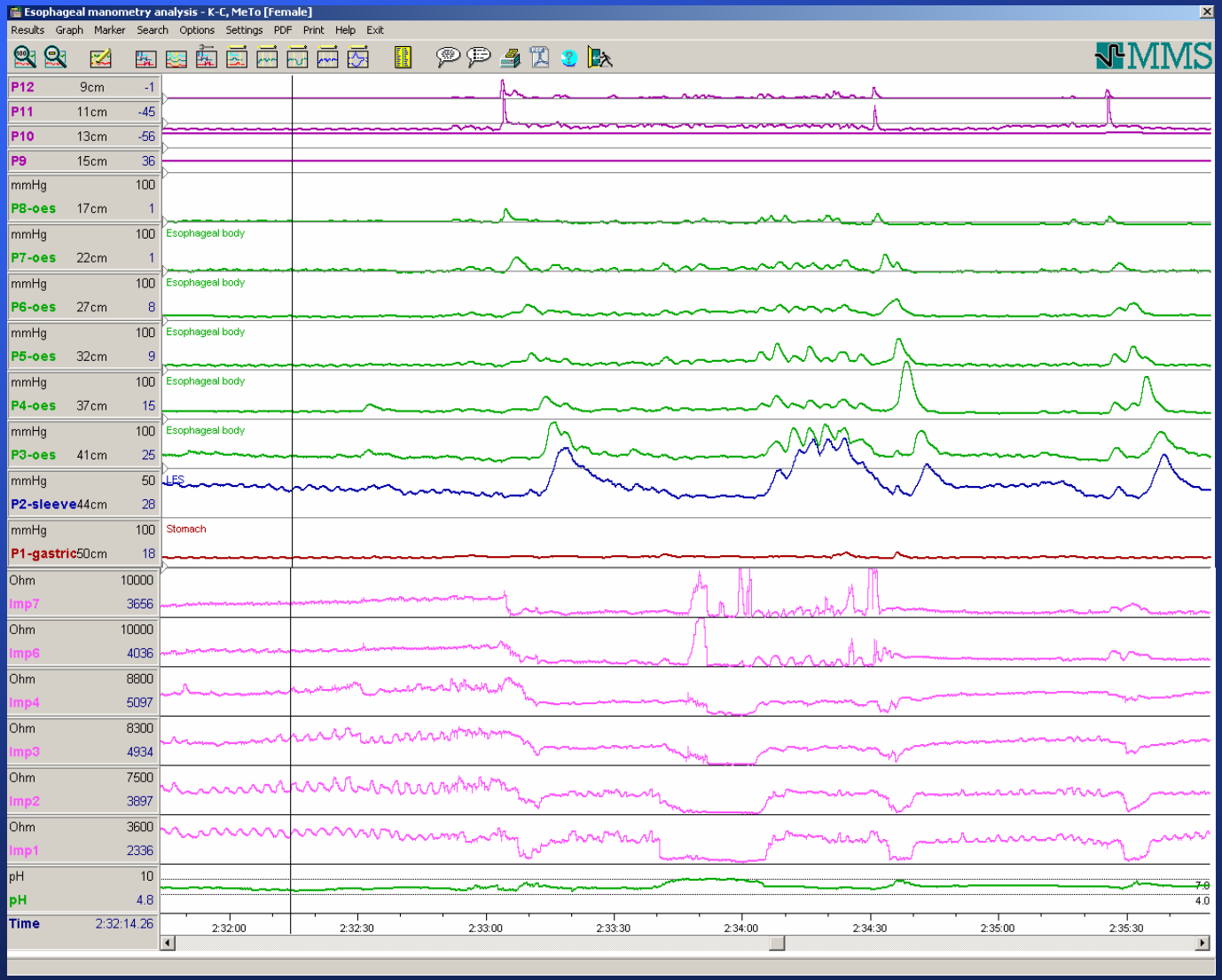
Impedance-pH reflux

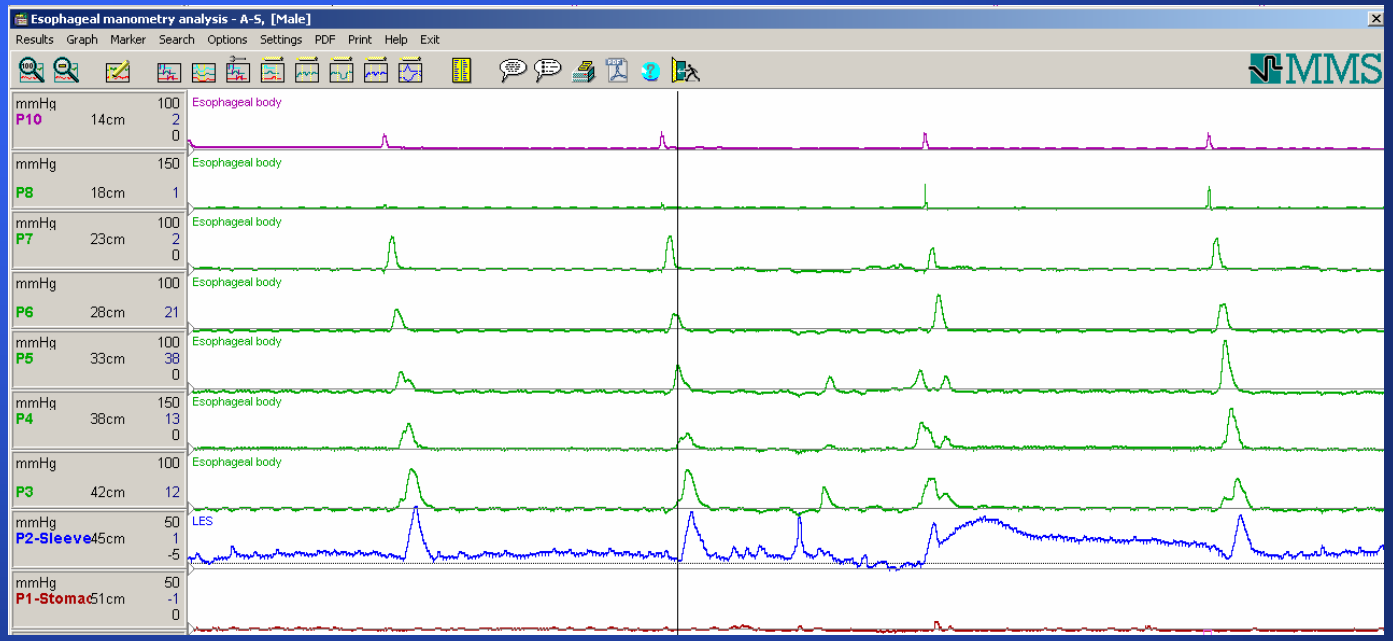


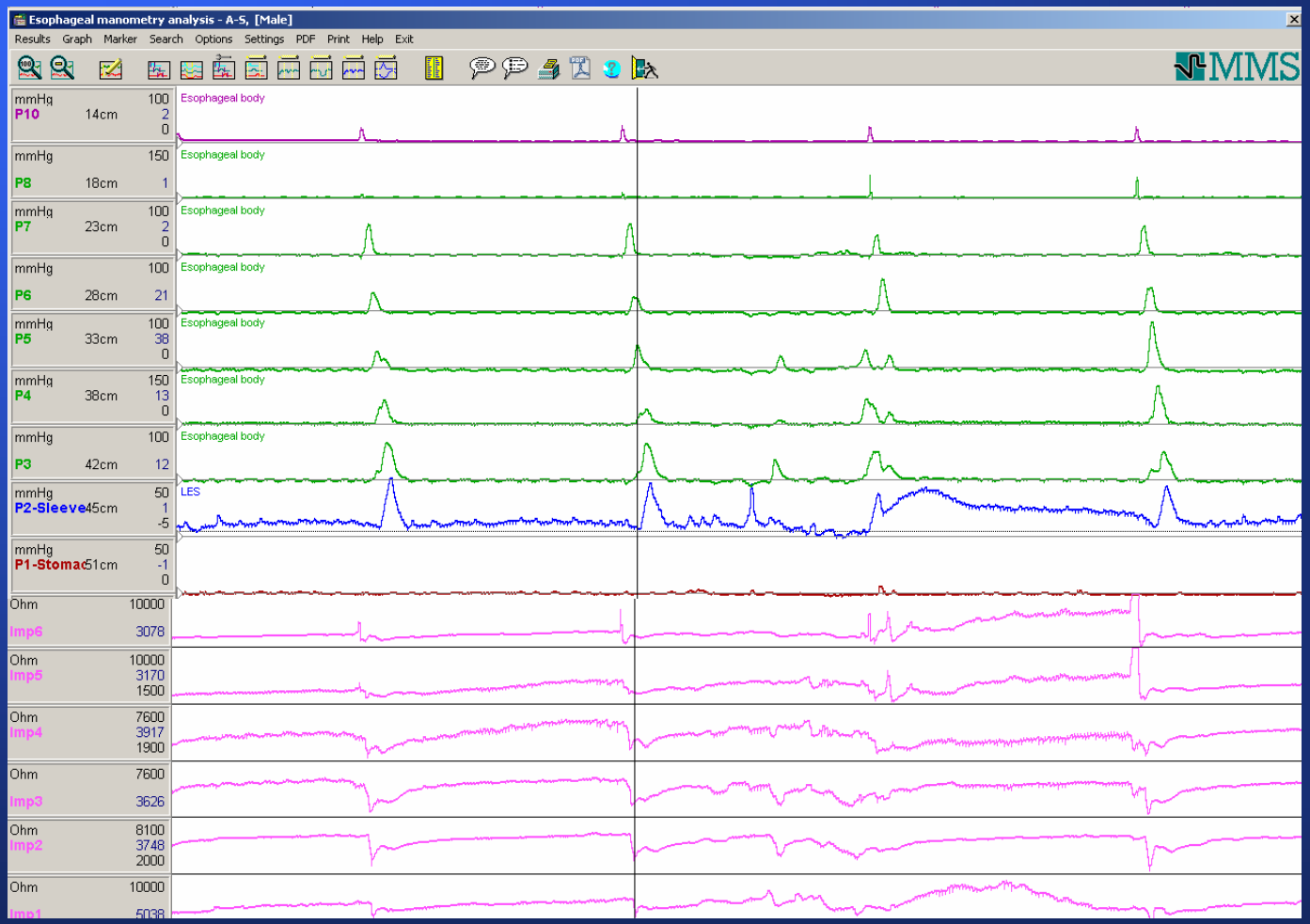





Esophageal manometry analysis - K-C, MeTo [Female]
Results Graph Marker Search Options Settings PDF Print Help Exit
MMS
P12 9cm -1
P11 11cm -45
P10 13cm -56
P9 15cm 36
mmHg 100
P8-oes 17cm 1
mmHg 100
Esophageal body
P7-oes 22cm 1
mmHg 100
Esophageal body
P6-oes 27cm 8
mmHg 100
Esophageal body
P5-oes 32cm 9
mmHg 100
Esophageal body
P4-oes 37cm 15
mmHg 100
Esophageal body
P3-oes 41cm 25
mmHg 50
LES
P2-sleeve 44cm 28
mmHg 100
Stomach
P1-gastric 50cm 18


Esophageal manometry analysis - K-C, MeTo [Female]
Results Graph Marker Search Options Settings PDF Print Help Exit
MMS
P12 9cm -1
P11 11cm -45
P10 13cm -56
P9 15cm 36
mmHg 100
P8-oes 17cm 1
mmHg 100
P7-oes 22cm 1
mmHg 100
P6-oes 27cm 8
mmHg 100
P5-oes 32cm 9
mmHg 100
P4-oes 37cm 15
mmHg 100
P3-oes 41cm 25
mmHg 50
P2-sleeve 44cm 28
mmHg 100
P1-gastric 50cm 18
Esophageal body
LES
Stomach
Ohm 10000
Imp7 3656
Ohm 10000
Imp6 4036
Ohm 8800
Imp4 5097
Ohm 8300
Imp3 4934
Ohm 7500
Imp2 3897
Ohm 3600
Imp1 2336
pH 10
pH 4.8
7.0
4.0
Time 2:32:14.26
2:32:00
2:32:30
2:33:00
2:33:30
2:34:00
2:34:30
2:35:00
2:35:30

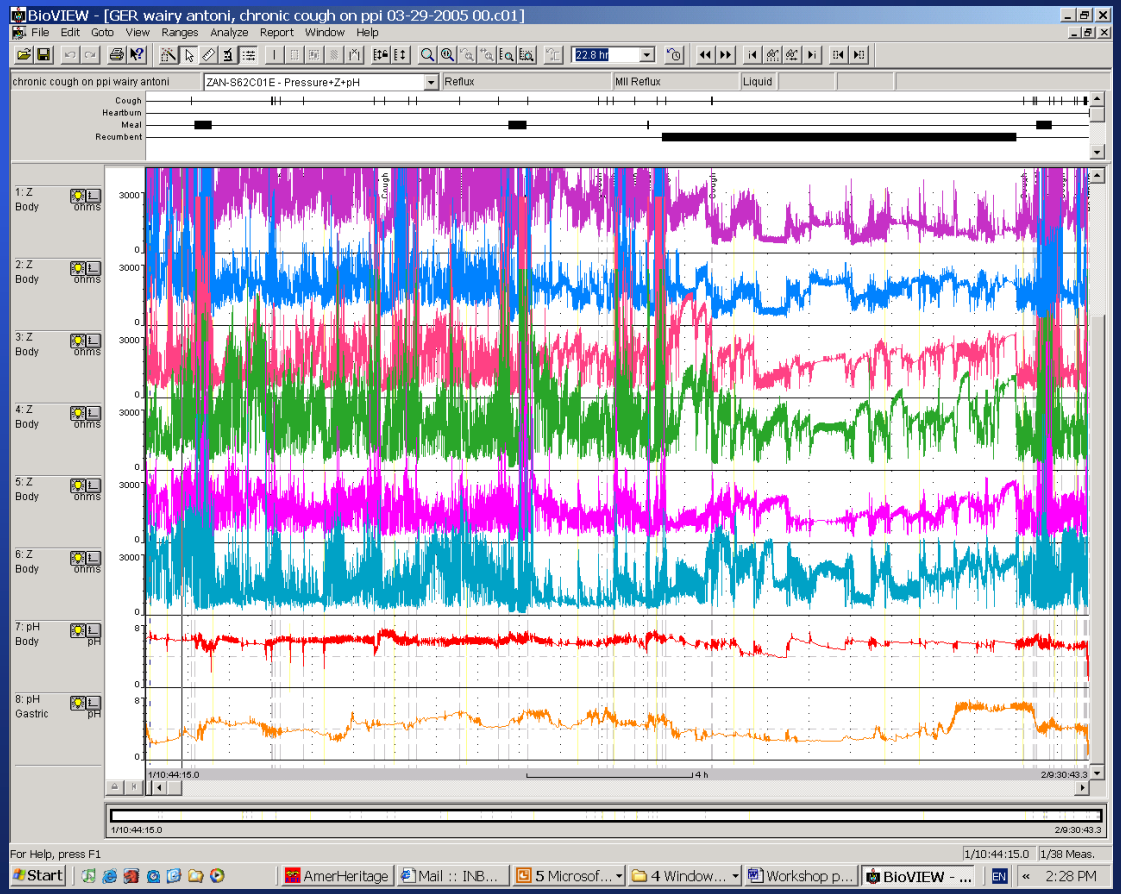

Esophageal manometry analysis - A-S, [Male]
Results Graph Marker Search Options Settings PDF Print Help Exit
MMS
mmHg P10 14cm 100 2 0 Esophageal body
mmHg P8 18cm 150 1 Esophageal body
mmHg P7 23cm 100 2 0 Esophageal body
mmHg P6 28cm 100 21 Esophageal body
mmHg P5 33cm 100 38 0 Esophageal body
mmHg P4 38cm 150 13 0 Esophageal body
mmHg P3 42cm 100 12 Esophageal body
mmHg P2-Sleeve 45cm 50 1 -5 LES
mmHg P1-Stoma 51cm 50 -1 0


Esophageal manometry analysis - A-S, [Male]
Results Graph Marker Search Options Settings PDF Print Help Exit
MMS
mmHg P10 14cm 100 2 0 Esophageal body
mmHg P8 18cm 150 1 Esophageal body
mmHg P7 23cm 100 2 0 Esophageal body
mmHg P6 28cm 100 21 Esophageal body
mmHg P5 33cm 100 38 0 Esophageal body
mmHg P4 38cm 150 13 0 Esophageal body
mmHg P3 42cm 100 12 Esophageal body
mmHg P2-Sleeve 45cm 50 1 -5 LES
mmHg P1-Stoma 51cm 50 -1 0
Ohm Imp6 10000 3078
Ohm Imp5 10000 3170 1500
Ohm Imp4 7600 3917 1900
Ohm Imp3 7600 3626
Ohm Imp2 8100 3748 2000
Ohm Imp1 10000 5038

IMPEDANCE, the clinical application

- ✓ Gastroesophageal reflux
  (24hs ambulatory pH-impedance)
- ✓ Non-obstructive dysphagia
  (1/2h stationary manometry-impedance with liquids and semi solids)
- ✓ Aerophagia and belching
  (2hs ambulatory impedance with high frequency sampling: 1000Hz)
- ✓ Rumination syndrome vs. postprandial belching
  (2hs postprandial stationary manometry-impedance)

Analysis
clinical ≠ research



Analysis of ambulatory pH-impedance monitoring

Clinical setup

1) Visual evaluation of the tracing (technical problems)

2) Adding or correction of symptom events

3) Running automatic analysis (fast editing of false positives)

4) Report
   - Number of reflux
   - Number of symptoms
   - Exposures
     - Acid (total and impedance reflux related)
     - Volume

5) Visual evaluation of symptom association followed by editing of automatic SI and SAP

Analysis of ambulatory pH-impedance monitoring

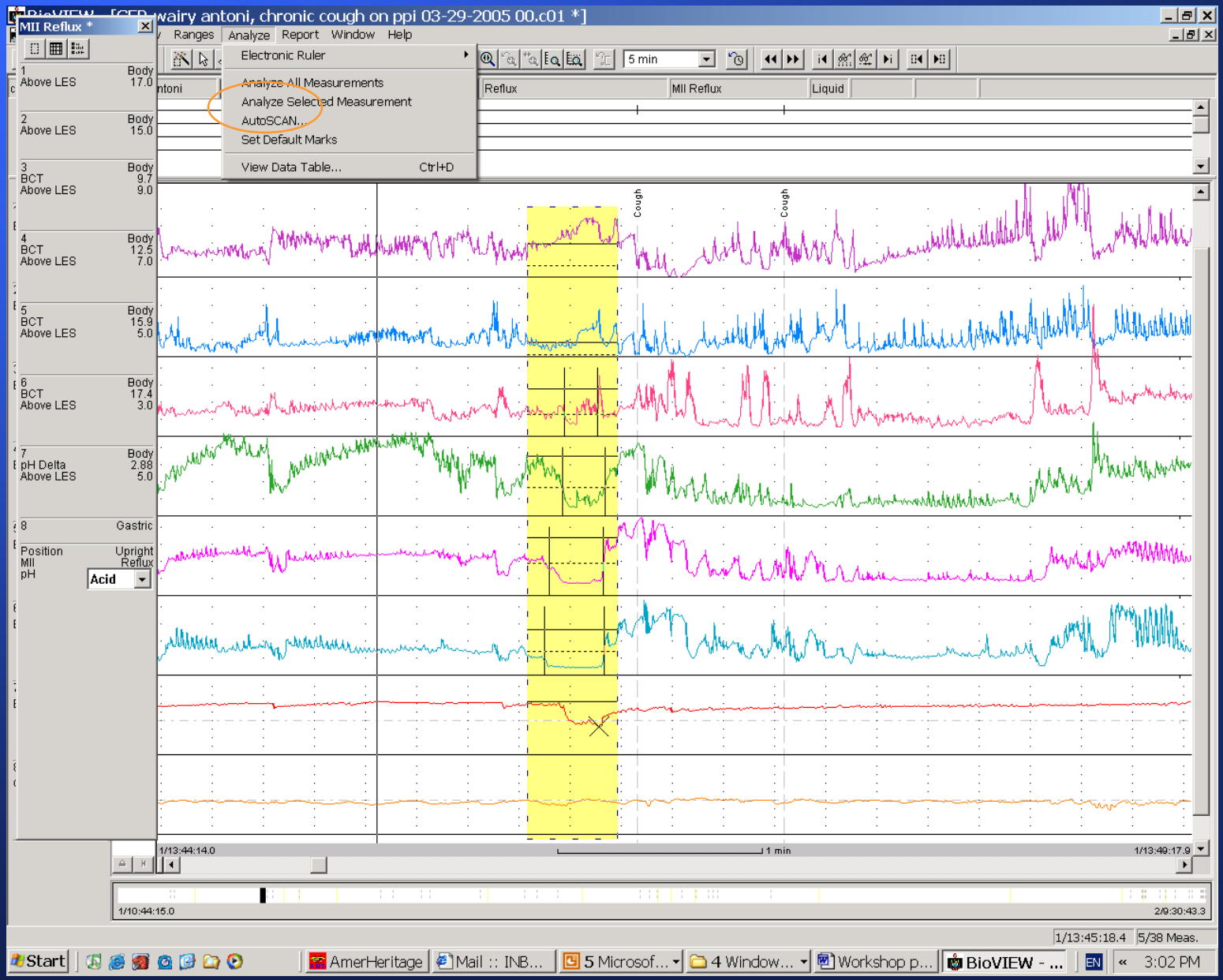
Research setup

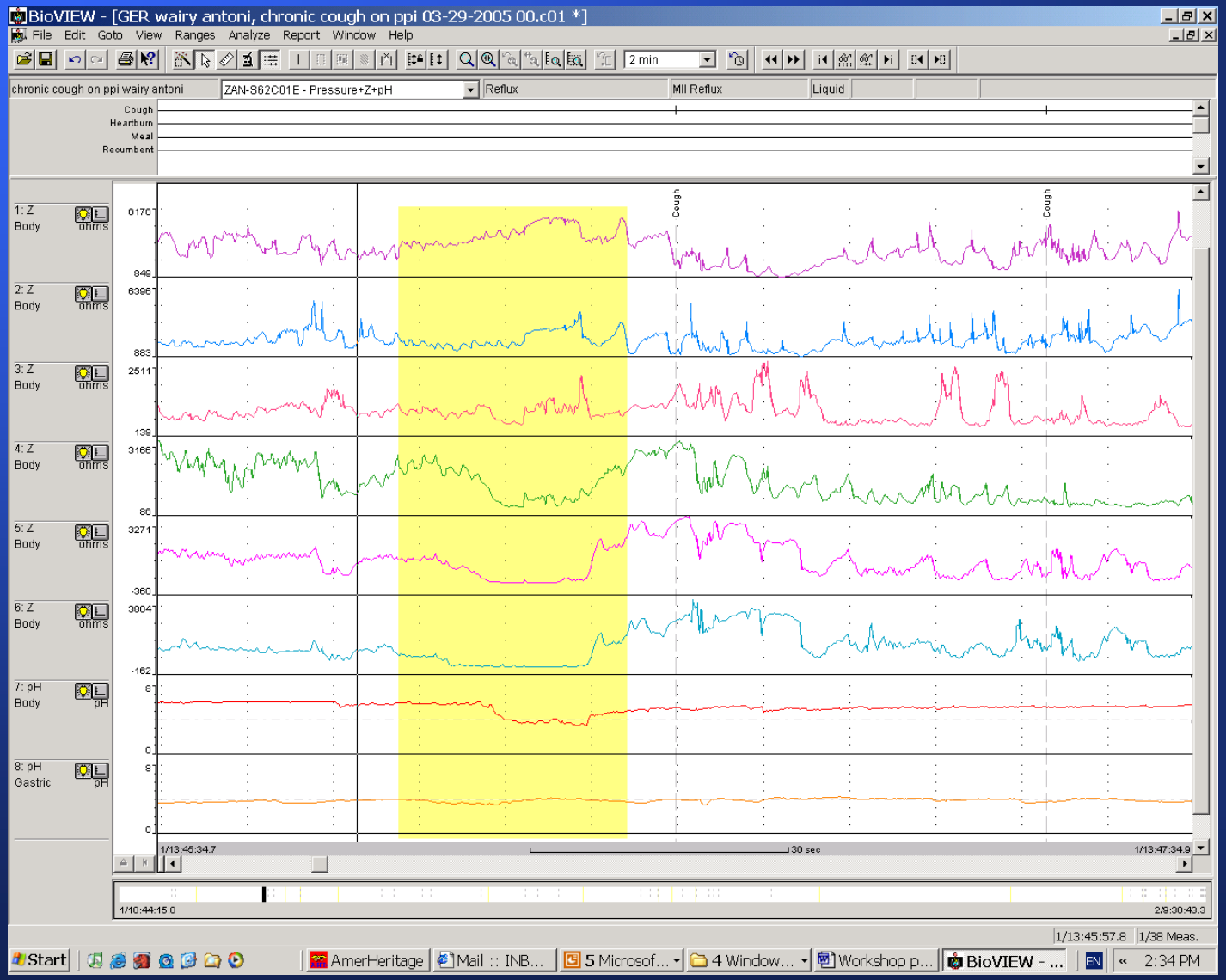
1) Full visual evaluation of the tracing

2) Adding or correction of symptom events

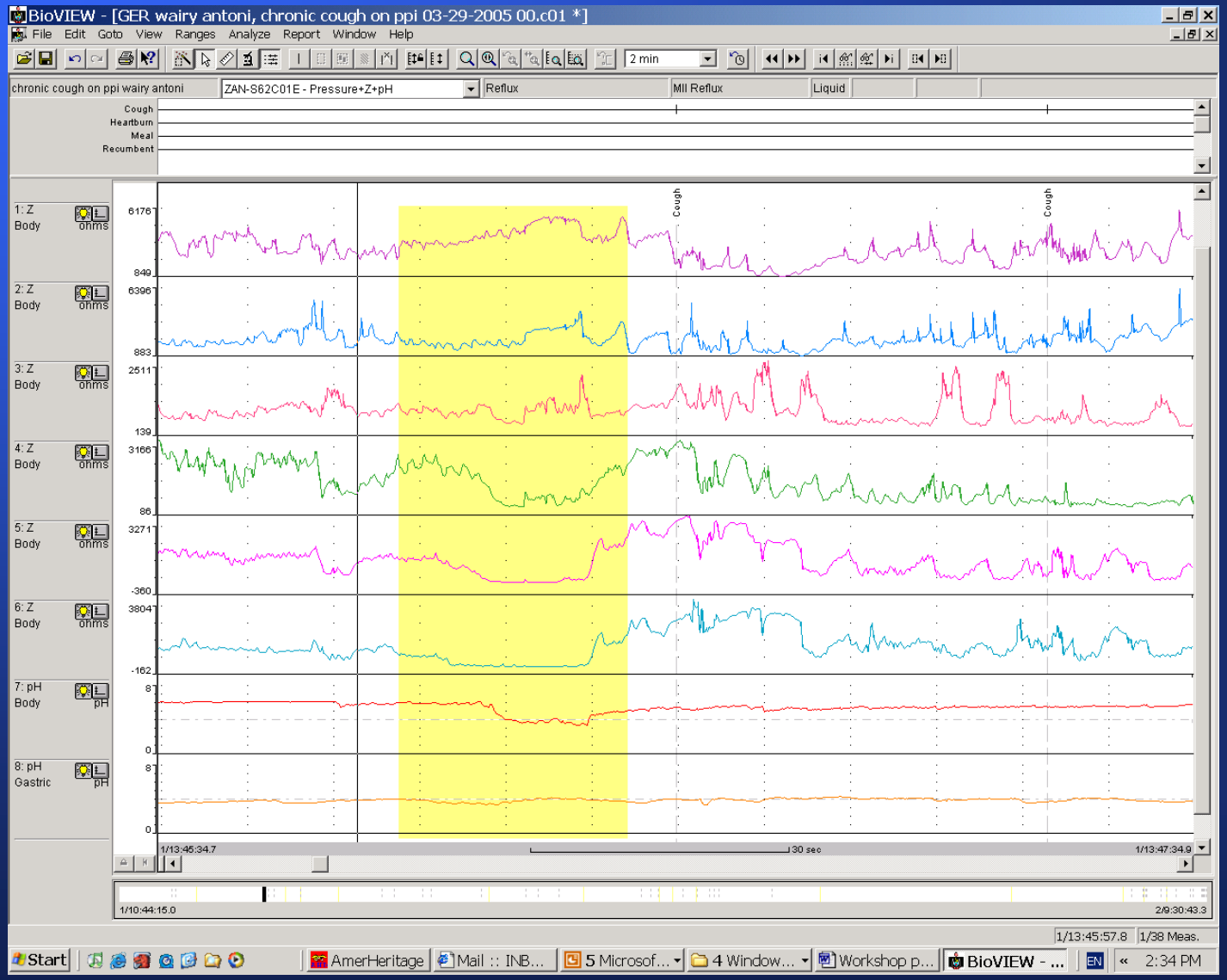
3) Report
   - Number of reflux
   - Number of symptoms
   - Exposures
     - Acid (total and impedance reflux related)
     - Volume

5) Visual evaluation of symptom association

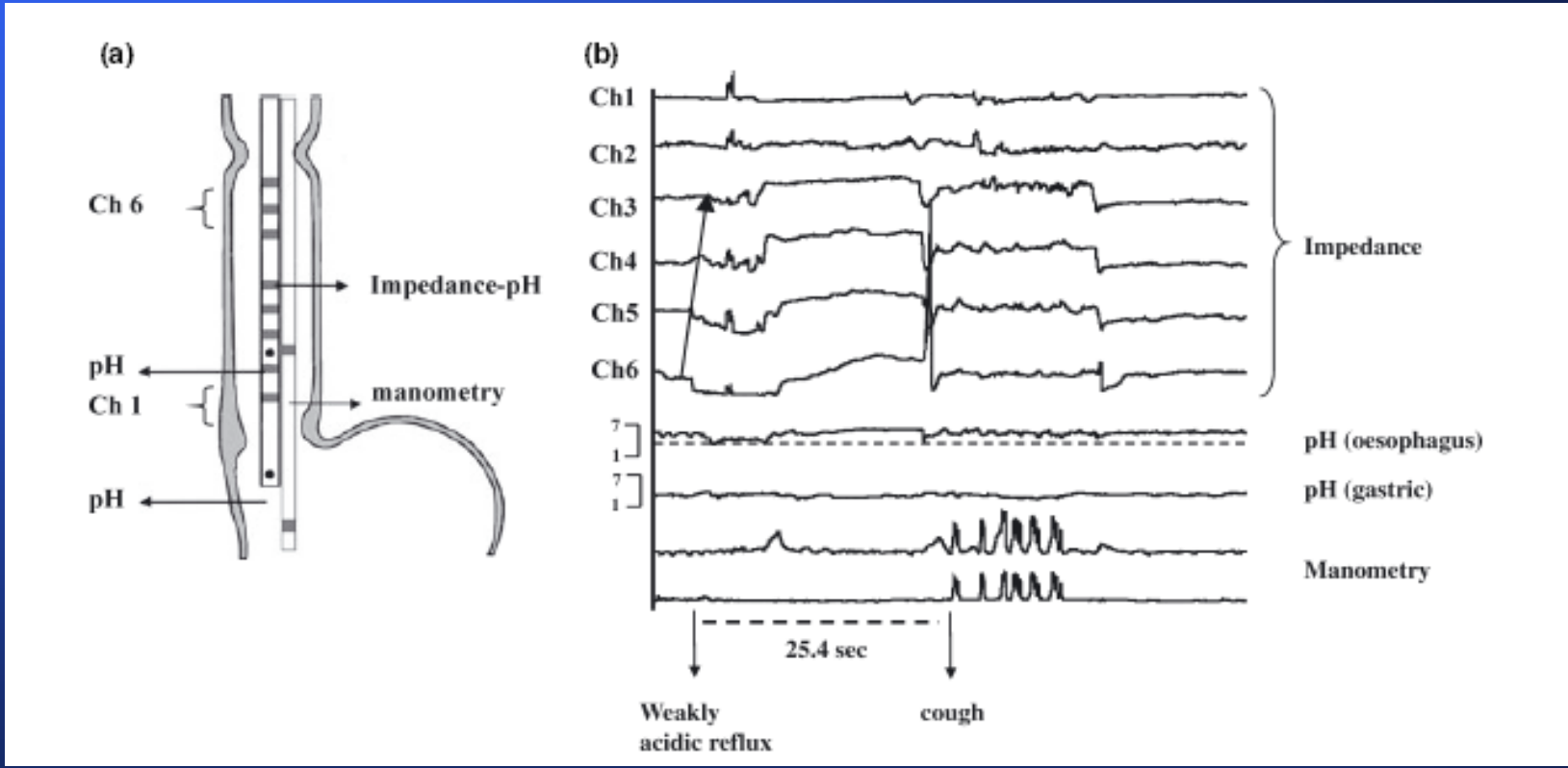

wairy antoni, chronic cough on ppi 03-29-2005 00.c01 *]
MII Reflux *
Ranges
Analyze
Report
Window
Help
Electronic Ruler
Analyze All Measurements
Analyze Selected Measurement
AutoSCAN...
Set Default Marks
View Data Table... Ctrl+D
5 min
Reflux
MII Reflux
Liquid
1 Body Above LES 17.0
2 Body Above LES 15.0
3 Body BCT 9.7 Above LES 9.0
4 Body BCT 12.5 Above LES 7.0
5 Body BCT 15.9 Above LES 5.0
6 Body BCT 17.4 Above LES 3.0
7 Body pH Delta 2.88 Above LES 5.0
8 Gastric
Position Upright
MII Reflux
pH Acid
Cough
Cough
1/13:44:14.0
1 min
1/13:49:17.9
1/10:44:15.0
2/9:30:43.3
1/13:45:18.4
5/38 Meas.
Start
AmerHeritage
Mail :: INB...
5 Microsof...
4 Window...
Workshop p...
BioVIEW - ...
EN
3:02 PM


BioVIEW - [GER wairy antoni, chronic cough on ppi 03-29-2005 00.c01 *]
File Edit Goto View Ranges Analyze Report Window Help
2 min
chronic cough on ppi wairy antoni
ZAN-S62C01E - Pressure+Z+pH
Reflux
MII Reflux
Liquid
Cough
Heartburn
Meal
Recumbent
1: Z Body ohms
2: Z Body ohms
3: Z Body ohms
4: Z Body ohms
5: Z Body ohms
6: Z Body ohms
7: pH Body pH
8: pH Gastric pH
6176
849
6396
883
2511
139
3166
86
3271
-360
3804
-162
8
0
8
0
Cough
Cough
1/13:45:34.7
30 sec
1/13:47:34.9
1/10:44:15.0
2/9:30:43.3
1/13:45:57.8
1/38 Meas.
Start
AmerHeritage
Mail :: INB...
5 Microsof...
4 Window...
Workshop p...
BioVIEW - ...
EN
2:34 PM

pH-impedance in patients with GERD “on” PPI

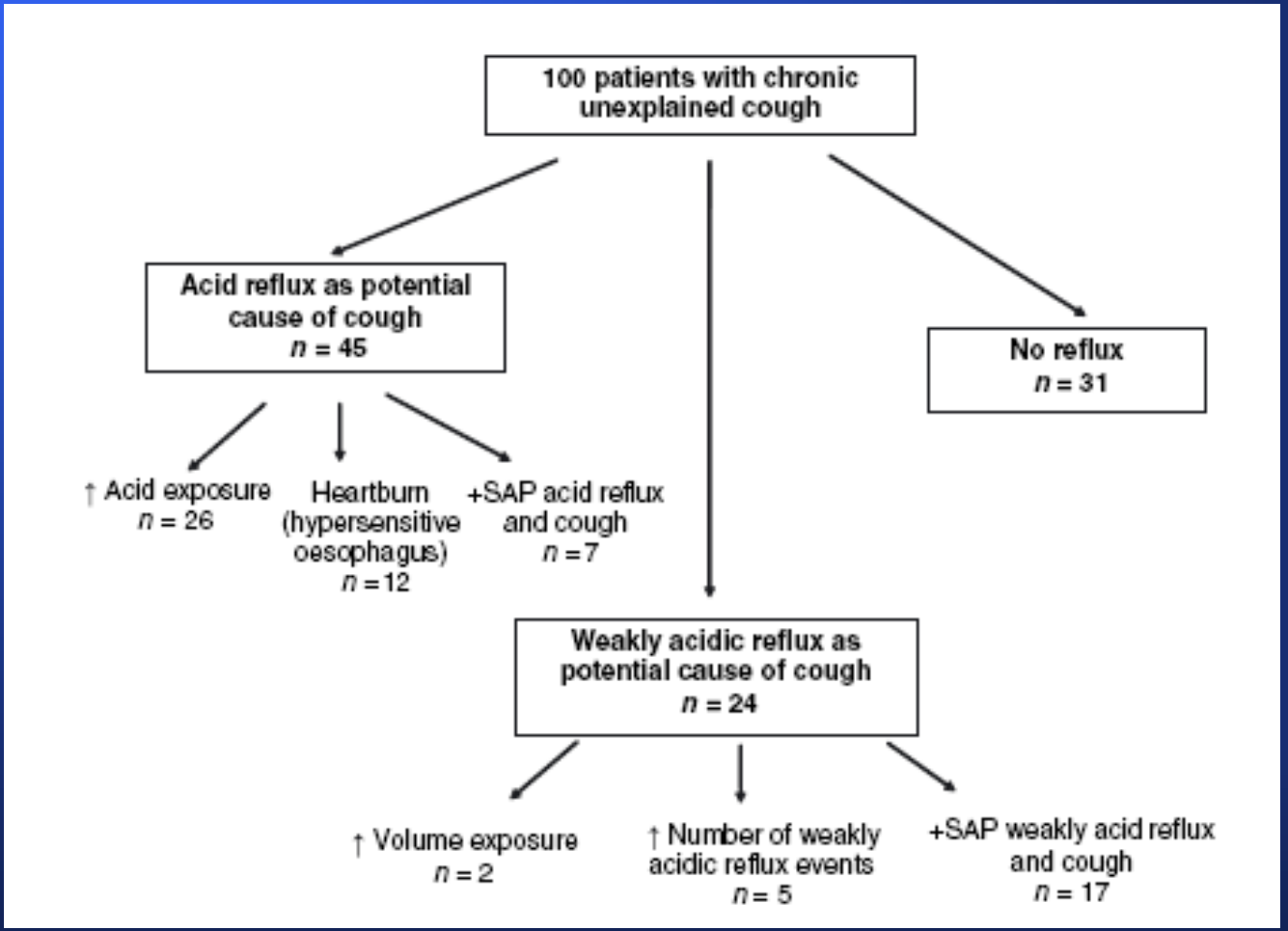


pH-impedance in patients with chronic cough



Blondeau et al 2007

pH-impedance in patients with chronic cough

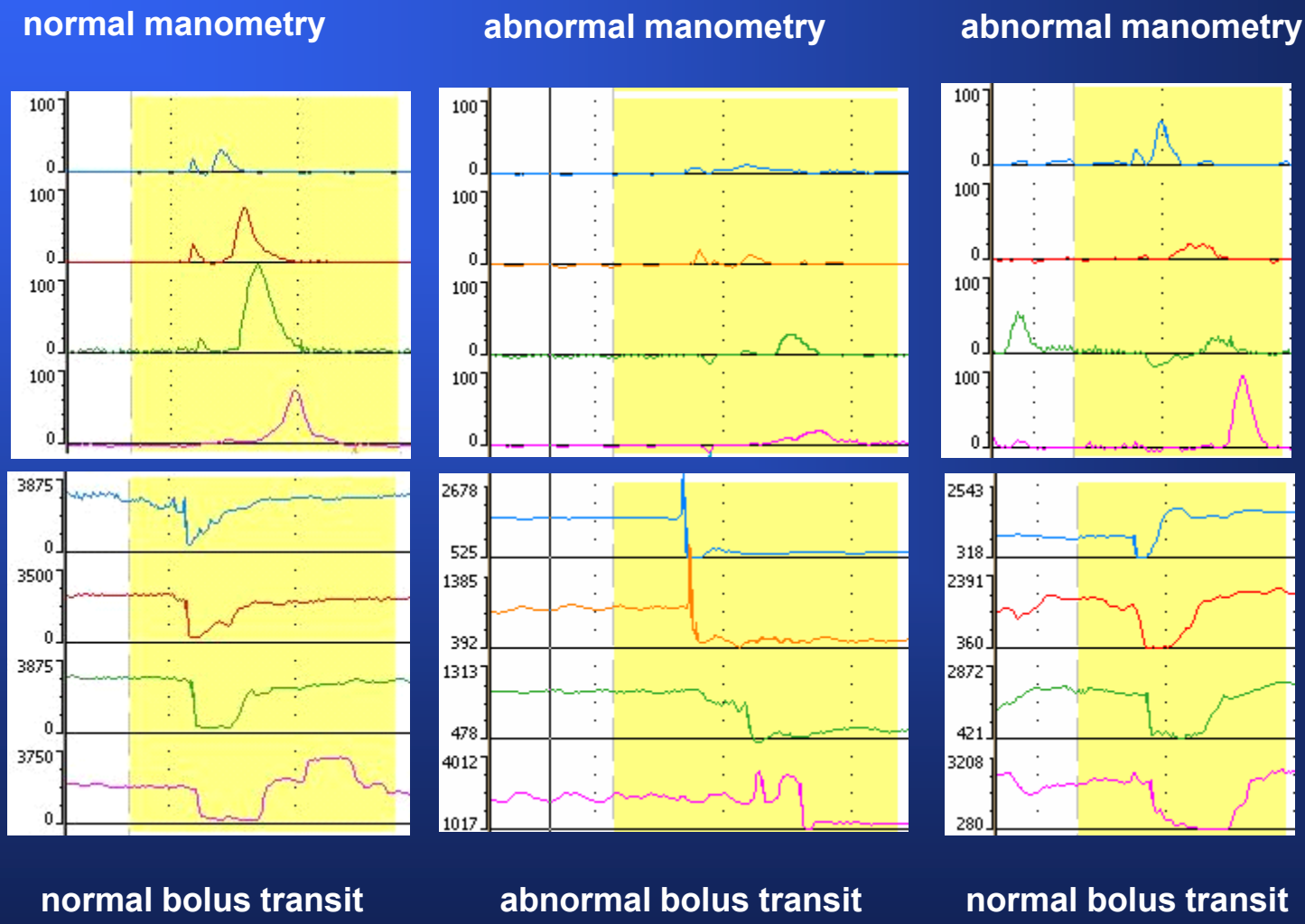


Blondeau et al 2007

Non-obstructive dysphagia

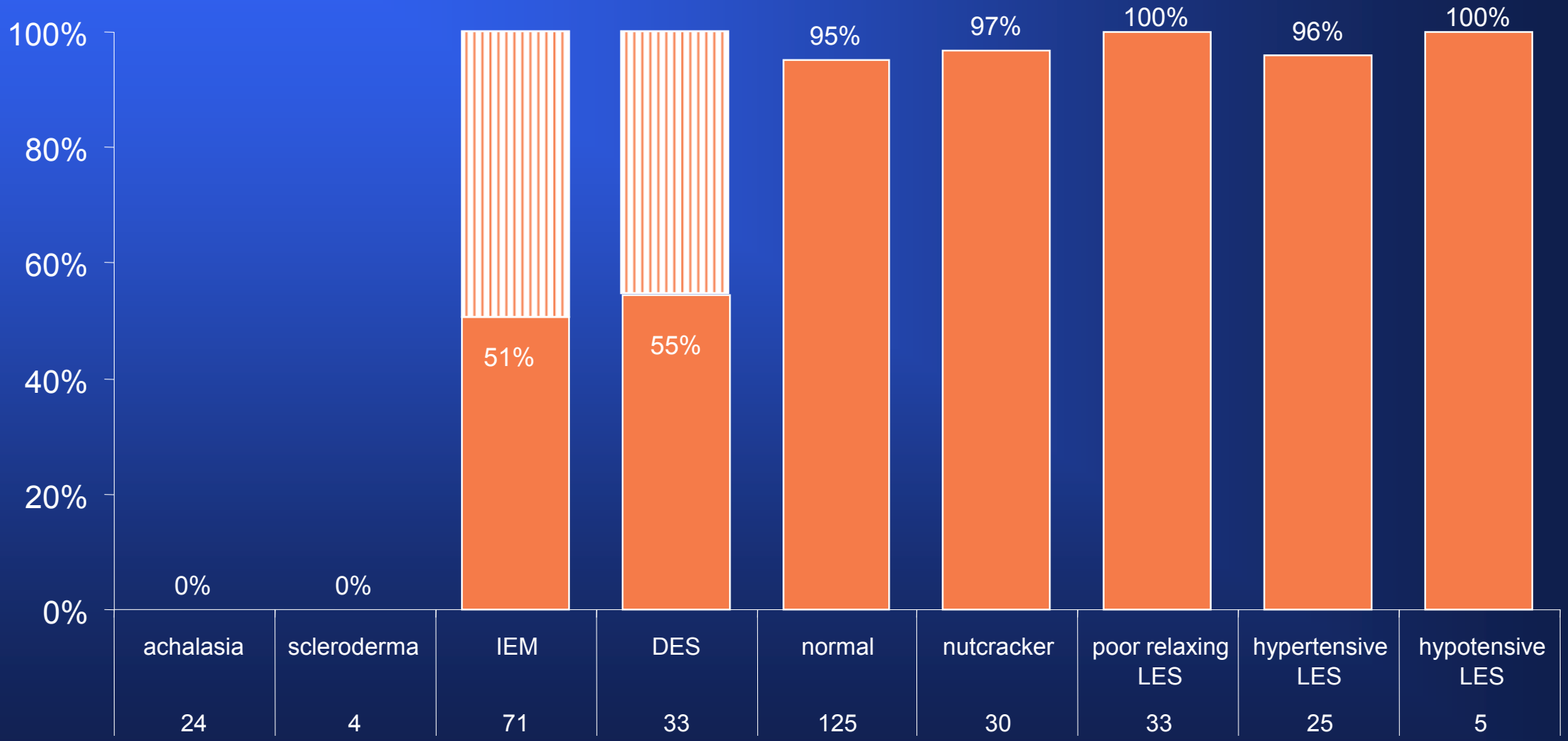
(1/2h stationary manometry-impedance with liquids and semi solids)

Relationship between abnormal manometry and bolus clearance



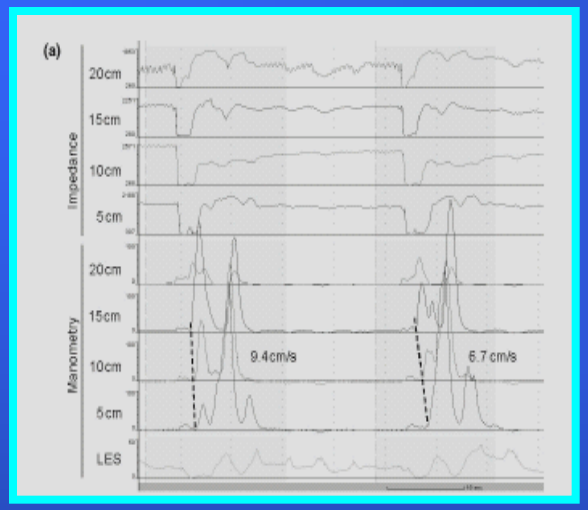
Tutuian et al 2004

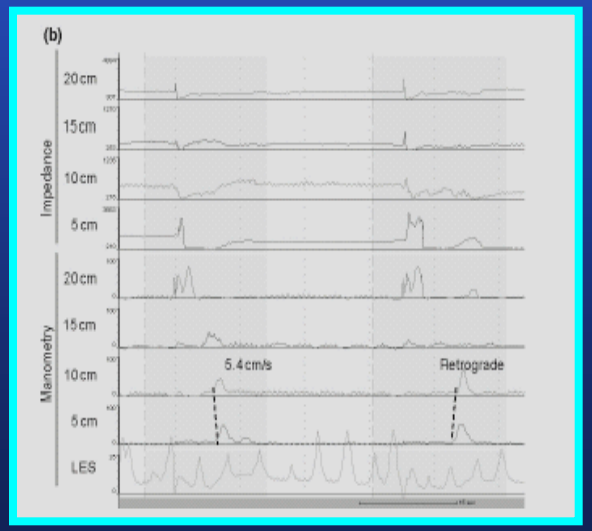
Bolus transit in esophageal motor disorders



Tutuian et al 2004

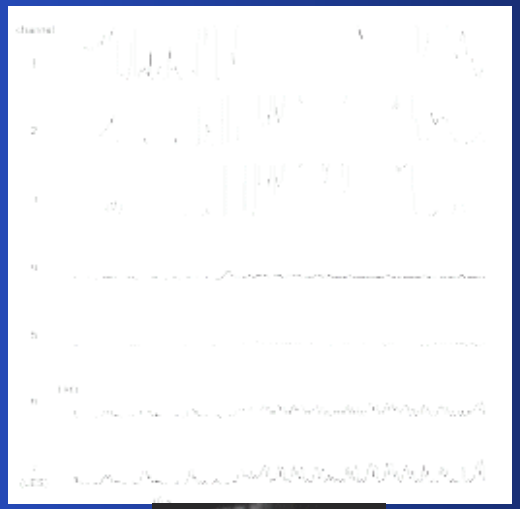
Distal Esophageal Spasm





Tutuian and Castell 2006

Achalasia



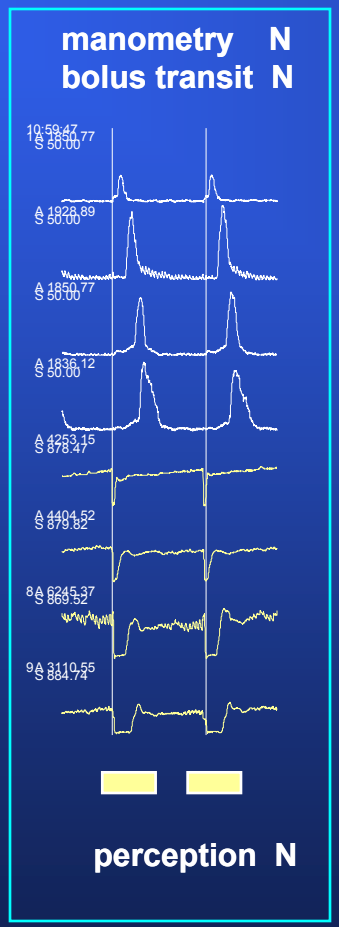
Conchillo et al DDW 2006

Bolus transit and perception of dysphagia

controls

Dysphagia score

- fluid passage
- slow passage
- stepwise passage
- partial blockade
- complete blockade



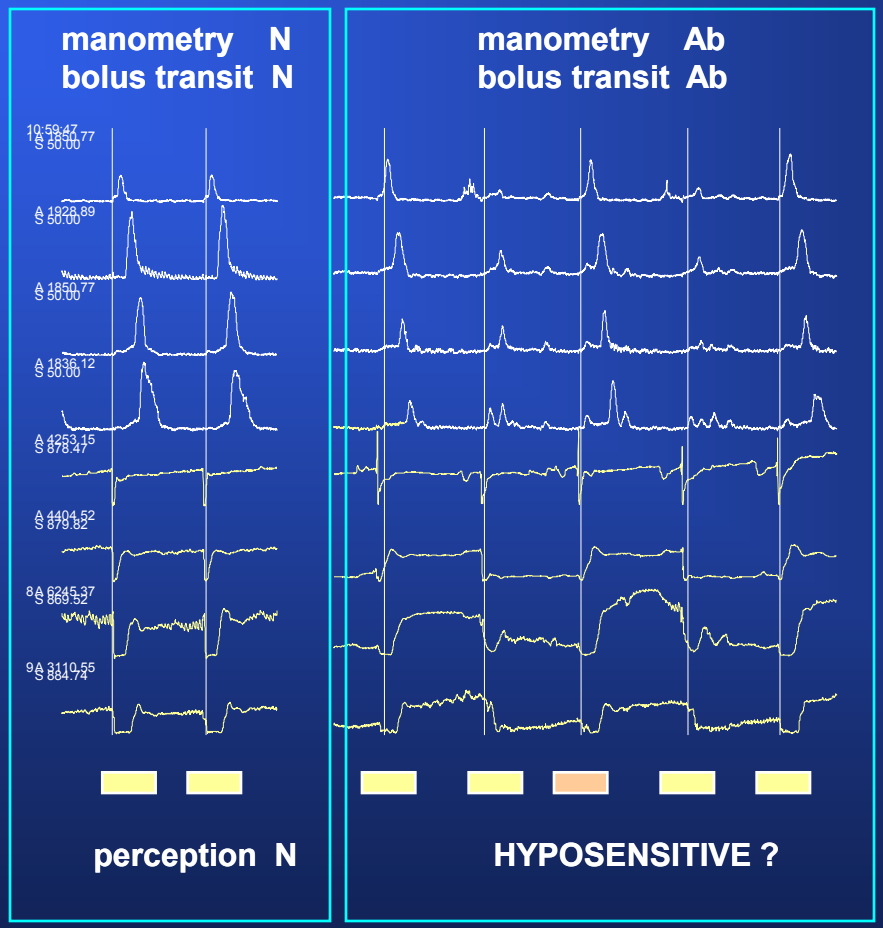
Karamanolis et al 2006

Bolus transit and perception of dysphagia

controls GERD

Dysphagia score

- fluid passage
- slow passage
- stepwise passage
- partial blockade
- complete blockade



Karamanolis et al DDW 2006

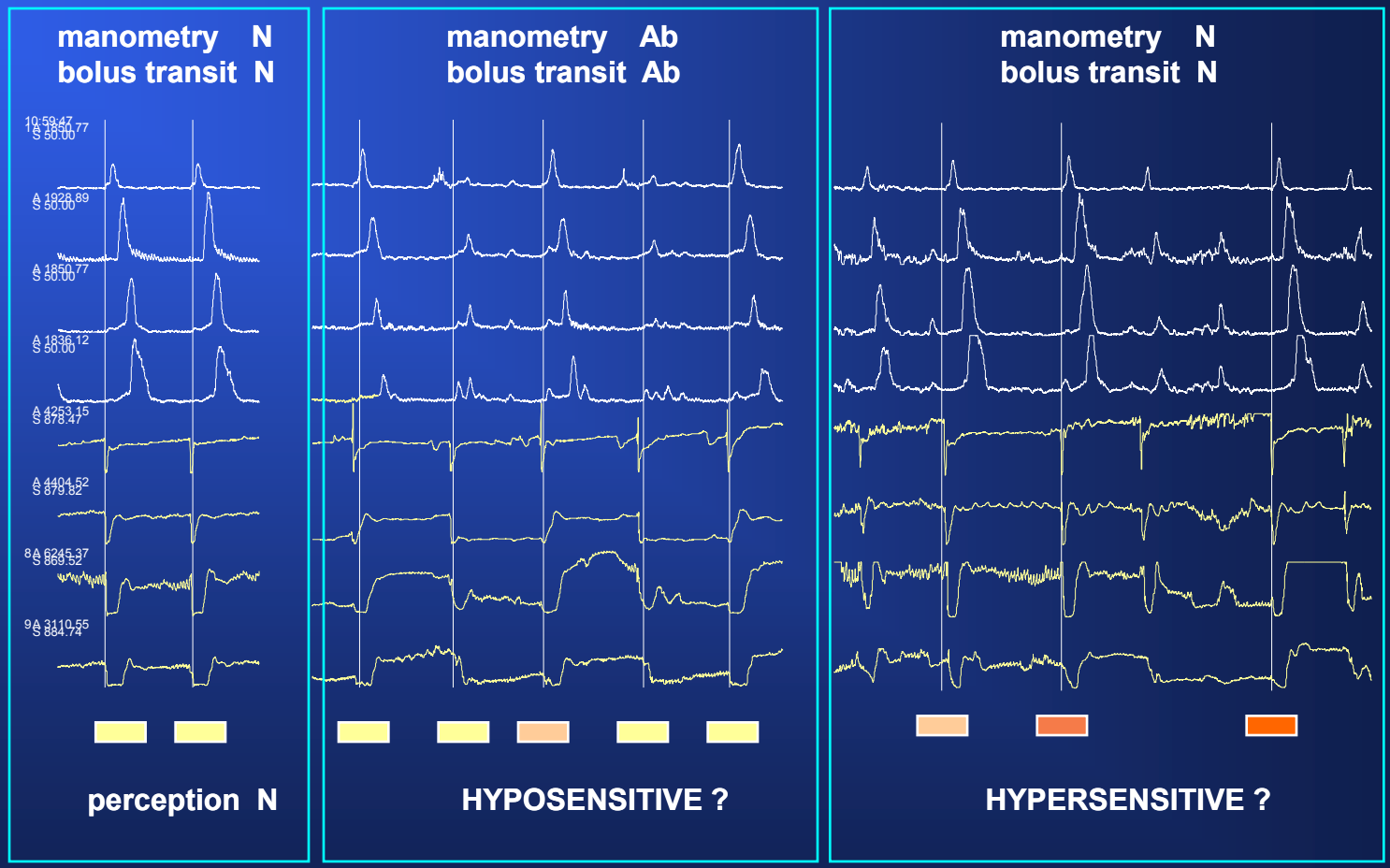
Bolus transit and perception of dysphagia

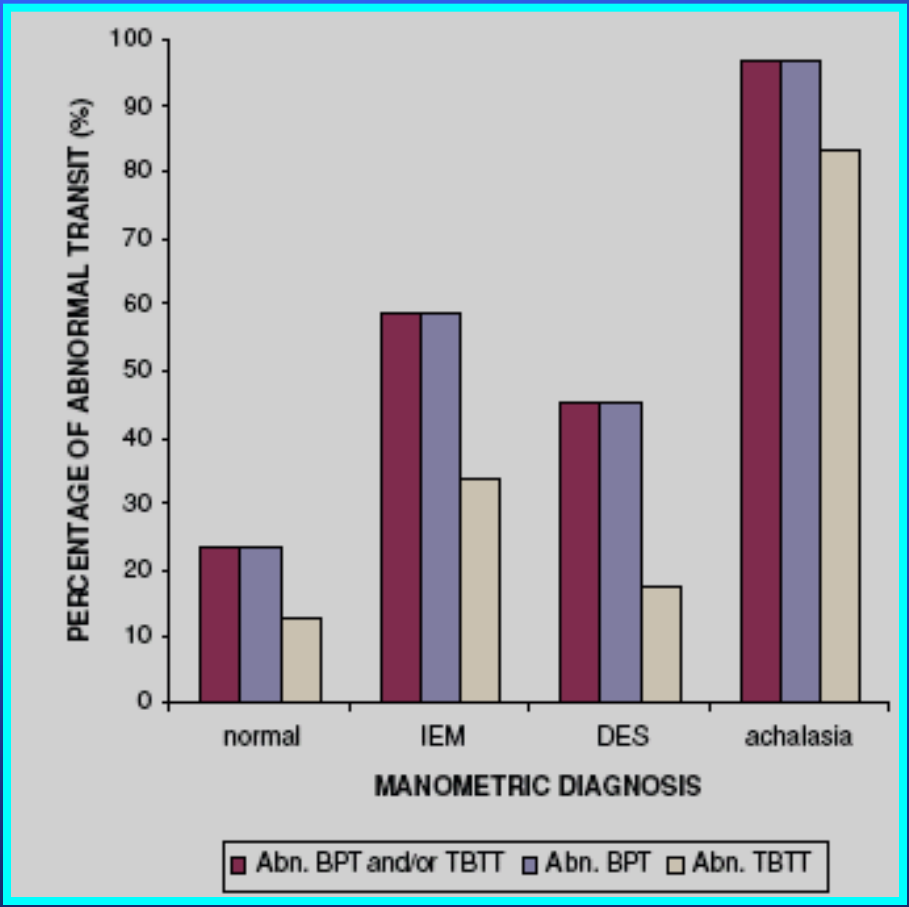
Dysphagia score

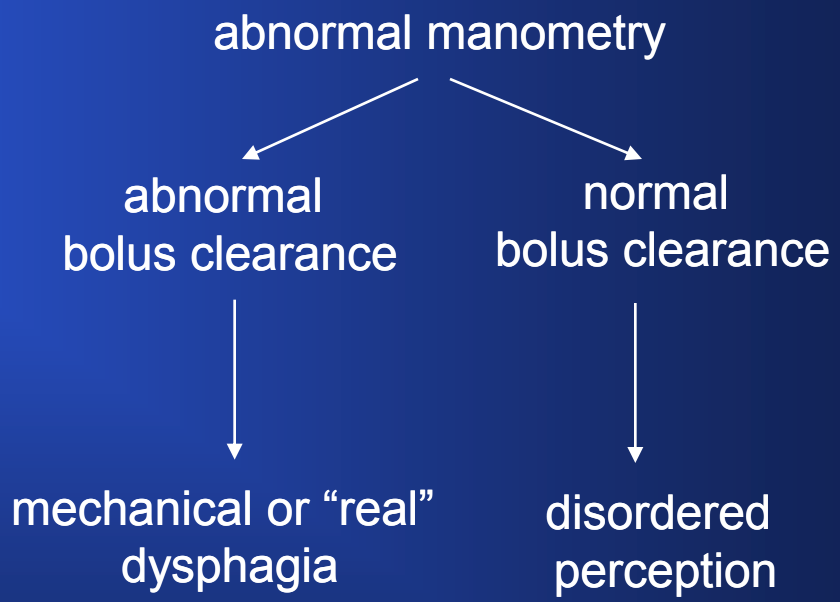
- fluid passage
- slow passage
- stepwise passage
- partial blockade
- complete blockade

controls

GERD

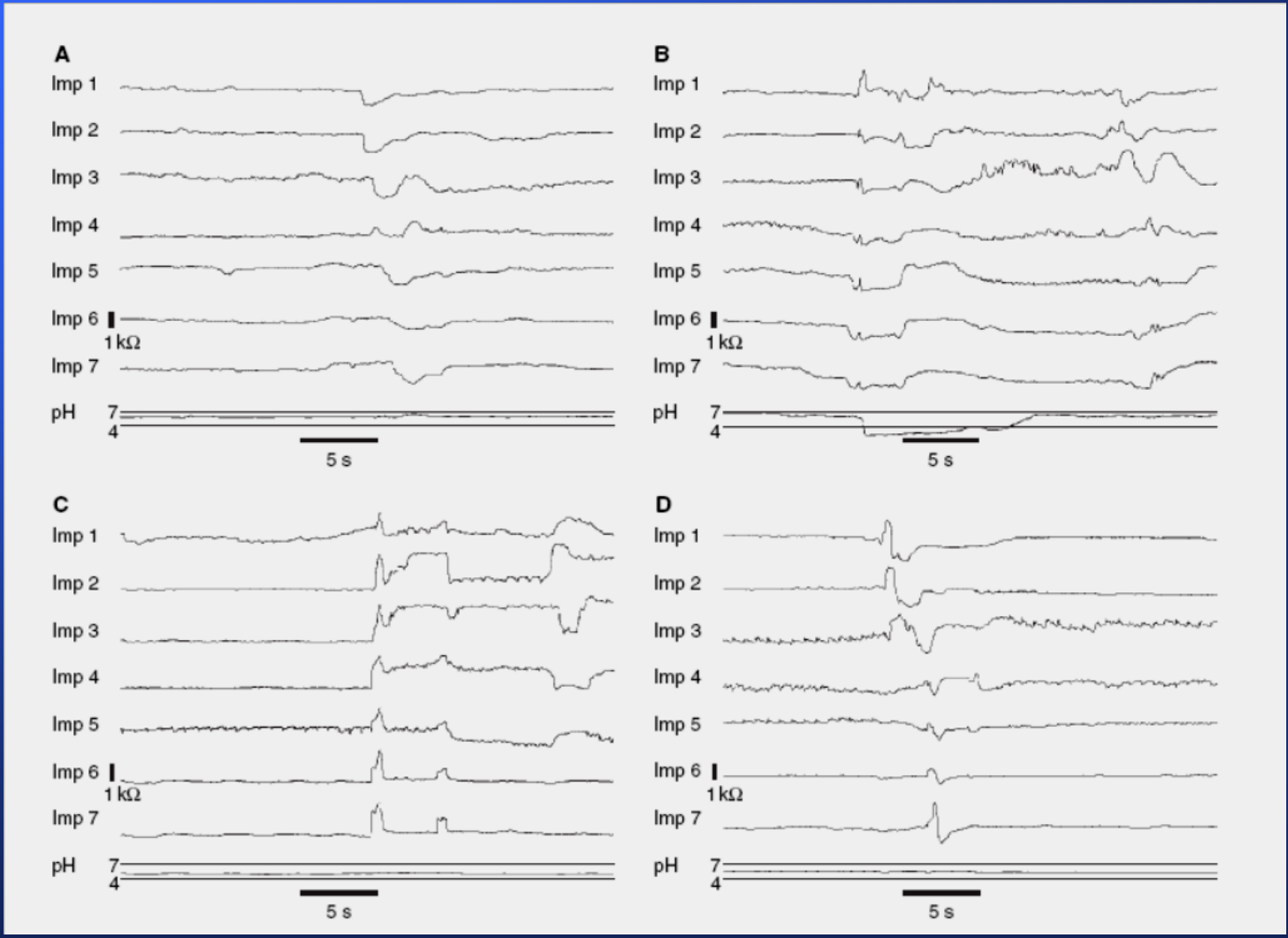






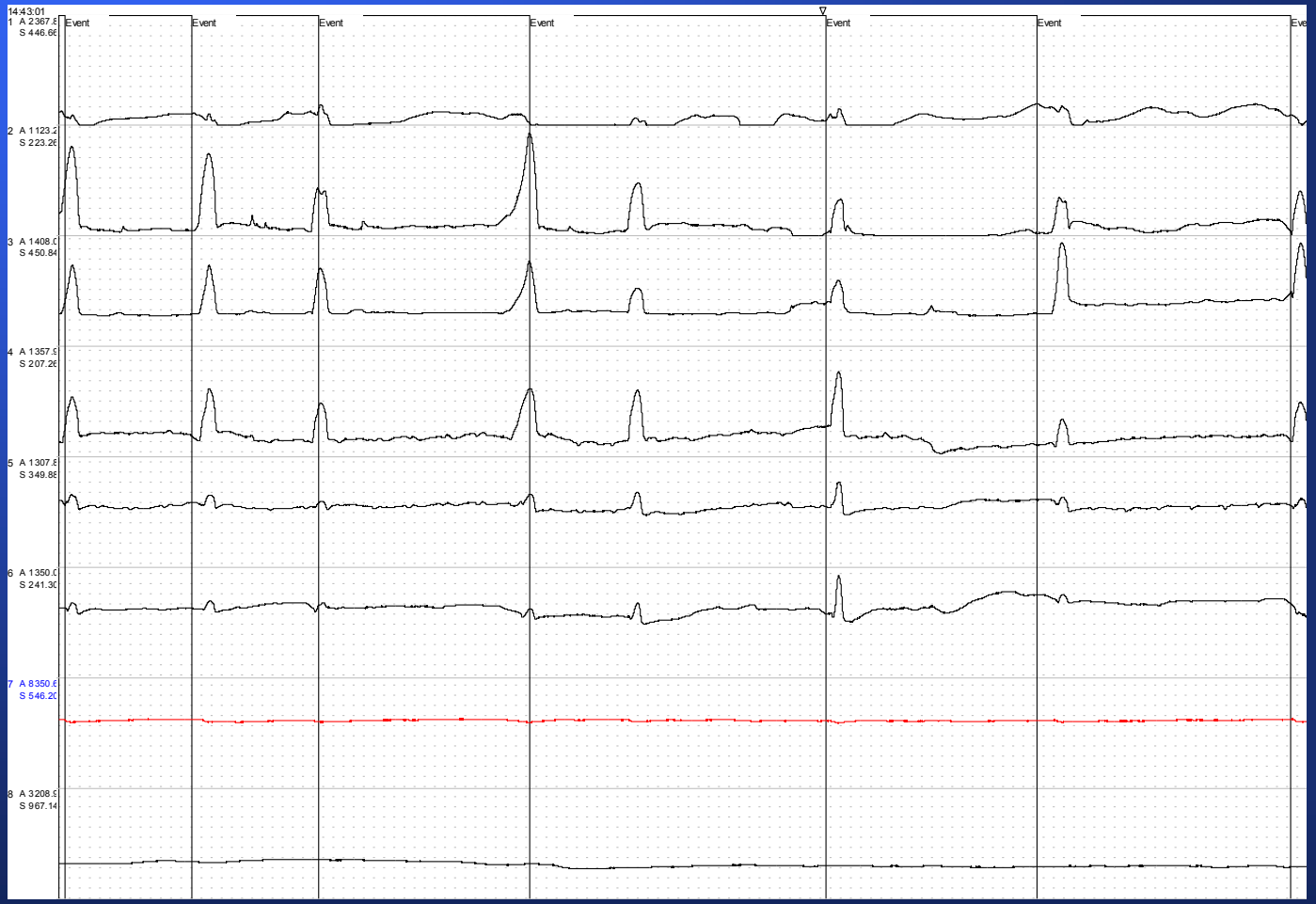
Conchillo,et al 2005

- ✓Aerophagia and belching

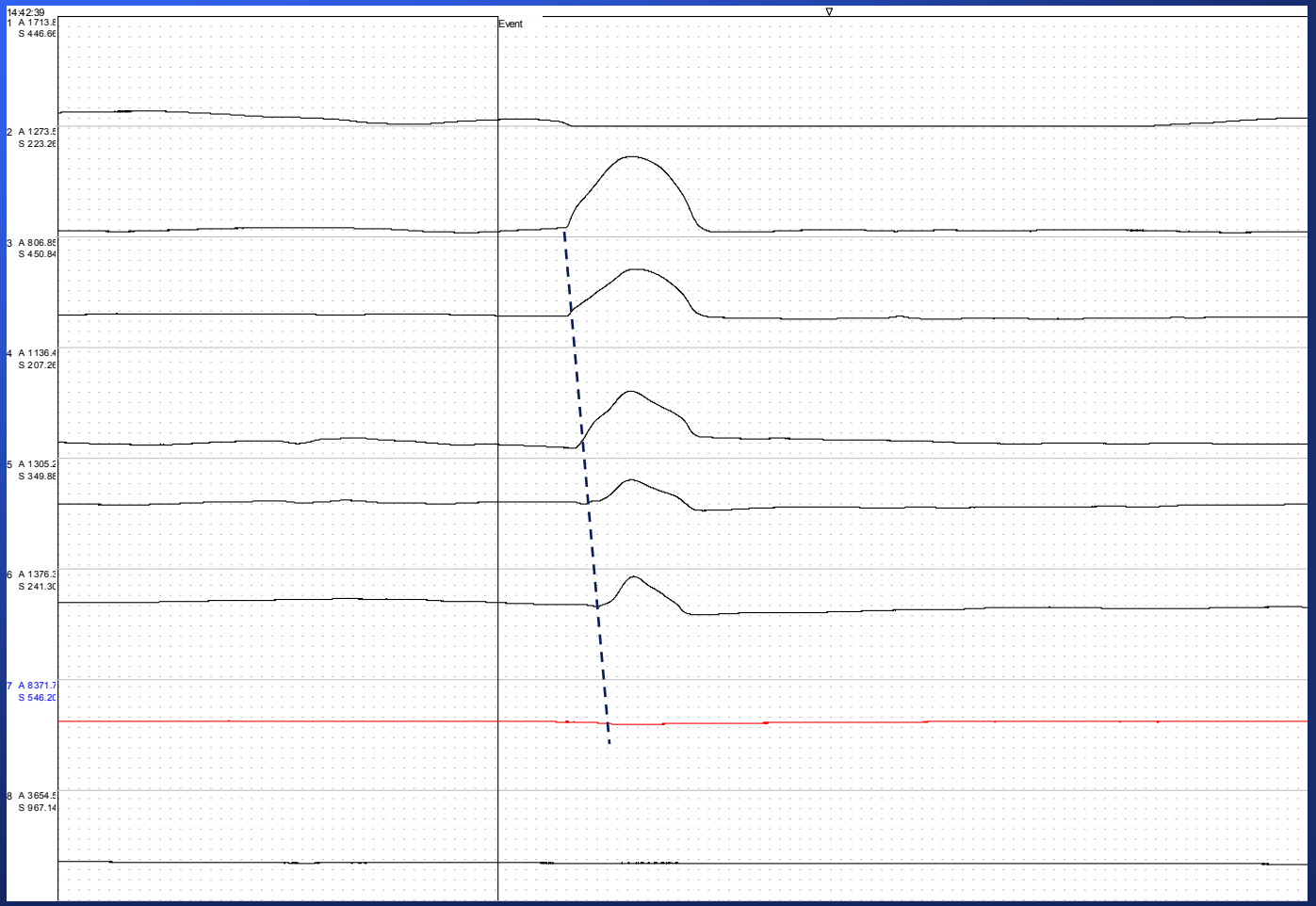


Bredenoord et al 2006

Aerophagia and belching



Aerophagia and belching



Aerophagia and belching

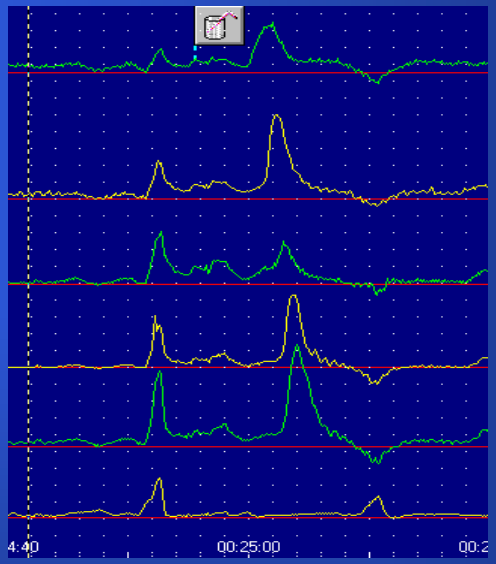
Table 1. Characteristics of Reflux Events and Swallows Observed During 24-h Monitoring in Controls and Patients with GERD

	Controls	Patients	*p*
Gas reflux	15.7 ± 2.5	22.9 ± 6.1	0.5
Liquid reflux	15.4 ± 2.1	29.8 ± 7.8	0.3
Mixed reflux	18.2 ± 2.1	33.4 ± 3.3	< 0.01
Acid reflux	19.1 ± 2.8	42.3 ± 7.6	< 0.01
Weakly acidic reflux	14.5 ± 1.1	21.0 ± 5.3	0.9
Swallows (no air)	818.2 ± 57.3	782.1 ± 89.3	0.4
Air swallows	175.8 ± 24.3	287.4 ± 45.1	0.04
Belches	32.7 ± 2.9	52.4 ± 6.6	< 0.01

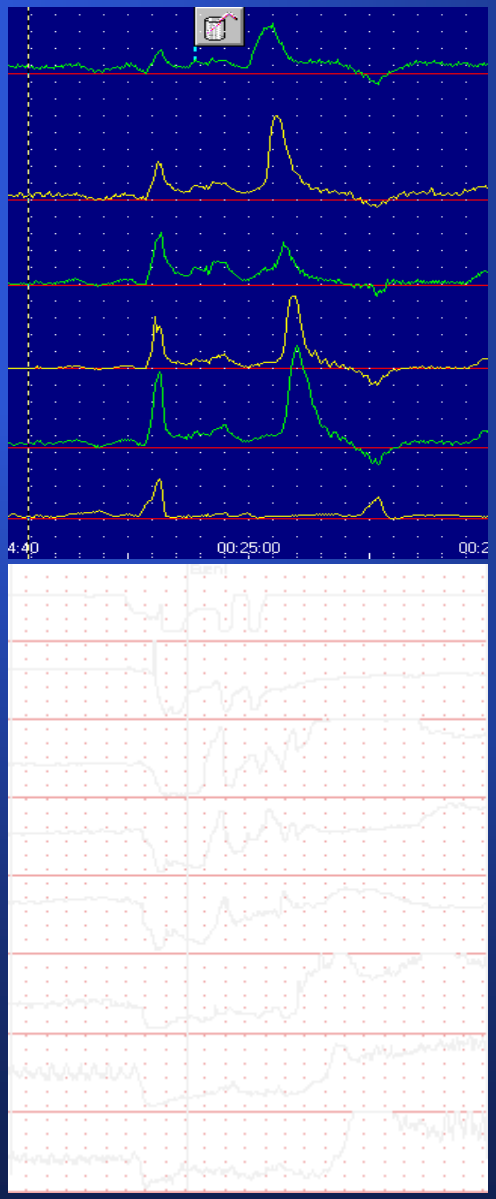
"Patients with GERD swallow air more frequently and belch more frequently than healthy subjects"

Bredenoord et al 2006

Rumination syndrome



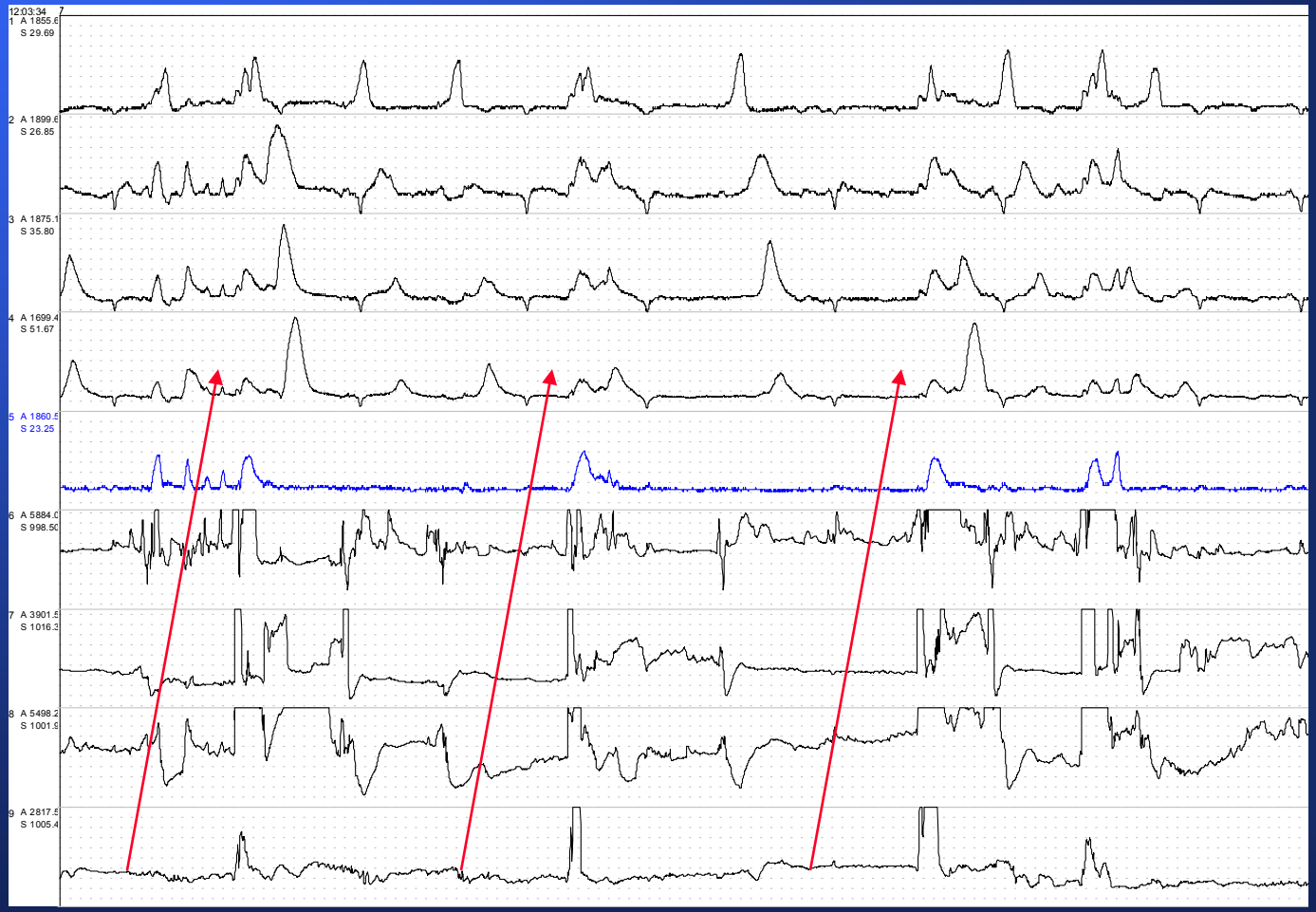
Rumination syndrome



Aprile, Dantas, Oliveira, Sifrim 2008

Rumination syndrome

Rumination syndrome vs belching



- ✓ Gastroesophageal reflux
  (24hs ambulatory pH-impedance)

- ✓ Non-obstructive dysphagia
  (1/2h stationary manometry-impedance with liquids and semi solids)

- ✓ Aerophagia and belching
  (2hs ambulatory impedance with high frequency sampling: 1000Hz)

- ✓ Rumination syndrome vs. postprandial belching
  (2hs postprandial stationary manometry-impedance)