

Comparison of the Sensitivity Implantable and Surface Impedance Devices for Prediction the Evolution of Acute Heart Failure

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Importance prediction of the Acute Heart Failure development

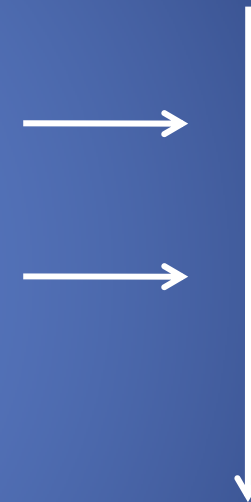
AHF development in course of AMI \approx 15 – 20%

CHF decompensations and hospitalizations \approx 40% per year

In Europe -- 15 mln CHF patients

In USA -- 5.5 mln CHF patients

AHF episodes



In USA 75% of annual budget for HF treatment (46 billion dollars) spends for hospitalizations

Methods for Prolonged Lung Fluid Monitoring

in-hospital and out-hospital patients

Pulmonary Artery Devices



Limitations:

1. Not exactly fluid monitoring
2. Invasive
3. Inaccessible in new cases

Devices for LI measurement



Limitations:

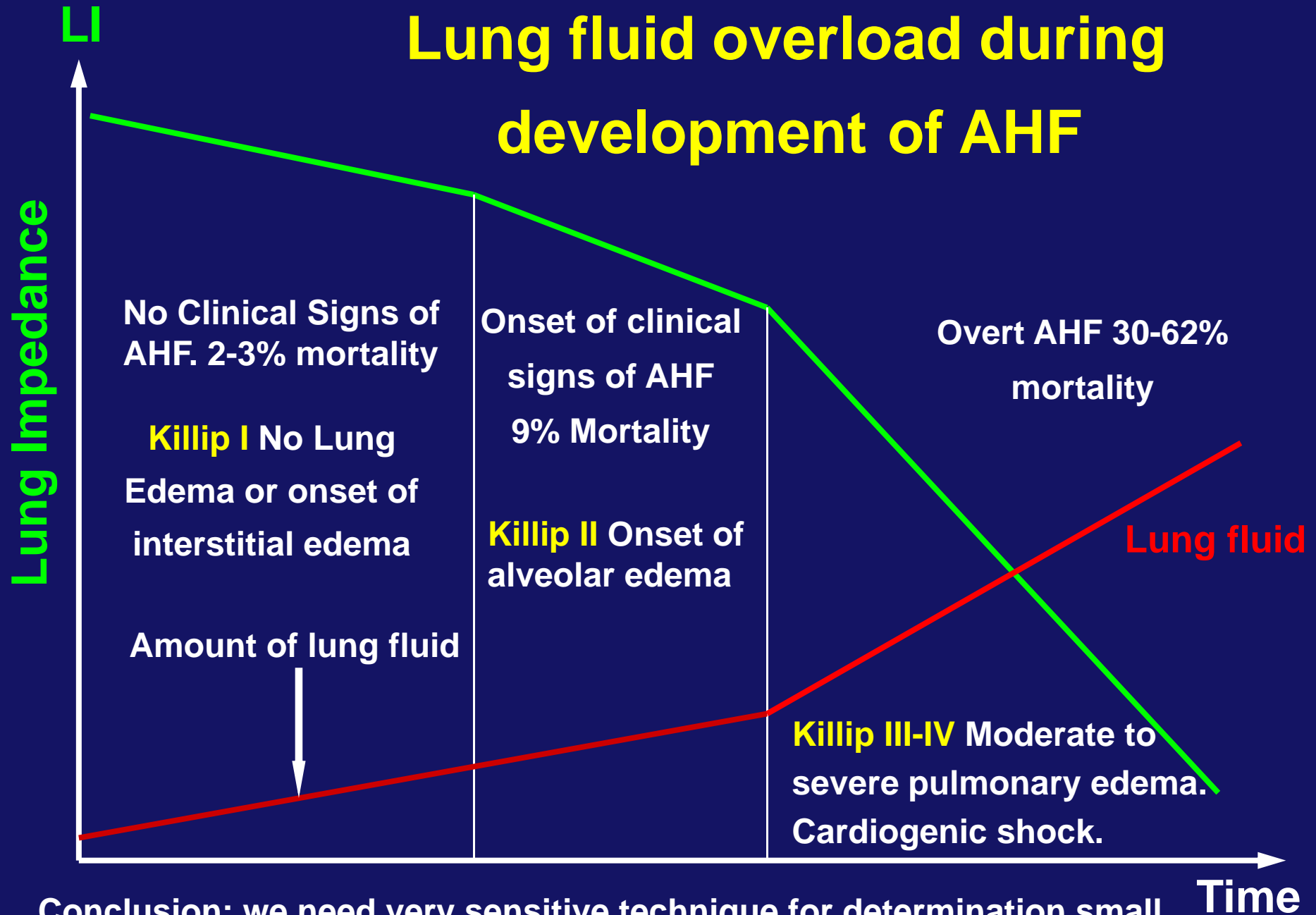
1. Implantable devices
(as “Medtronic”)

1. Invasive
2. Inaccessible in new cases and may be inserted according CRT indications only
3. **Low sensitivity – Why ?**

2. Surface thoracic devices
(as “BioZ”)

**Low Sensitivity
Why ?**

Lung fluid overload during development of AHF



Conclusion: we need very sensitive technique for determination small changes in lung fluid status for successful monitoring.

Movement energy of electromagnetic field through blood vessels

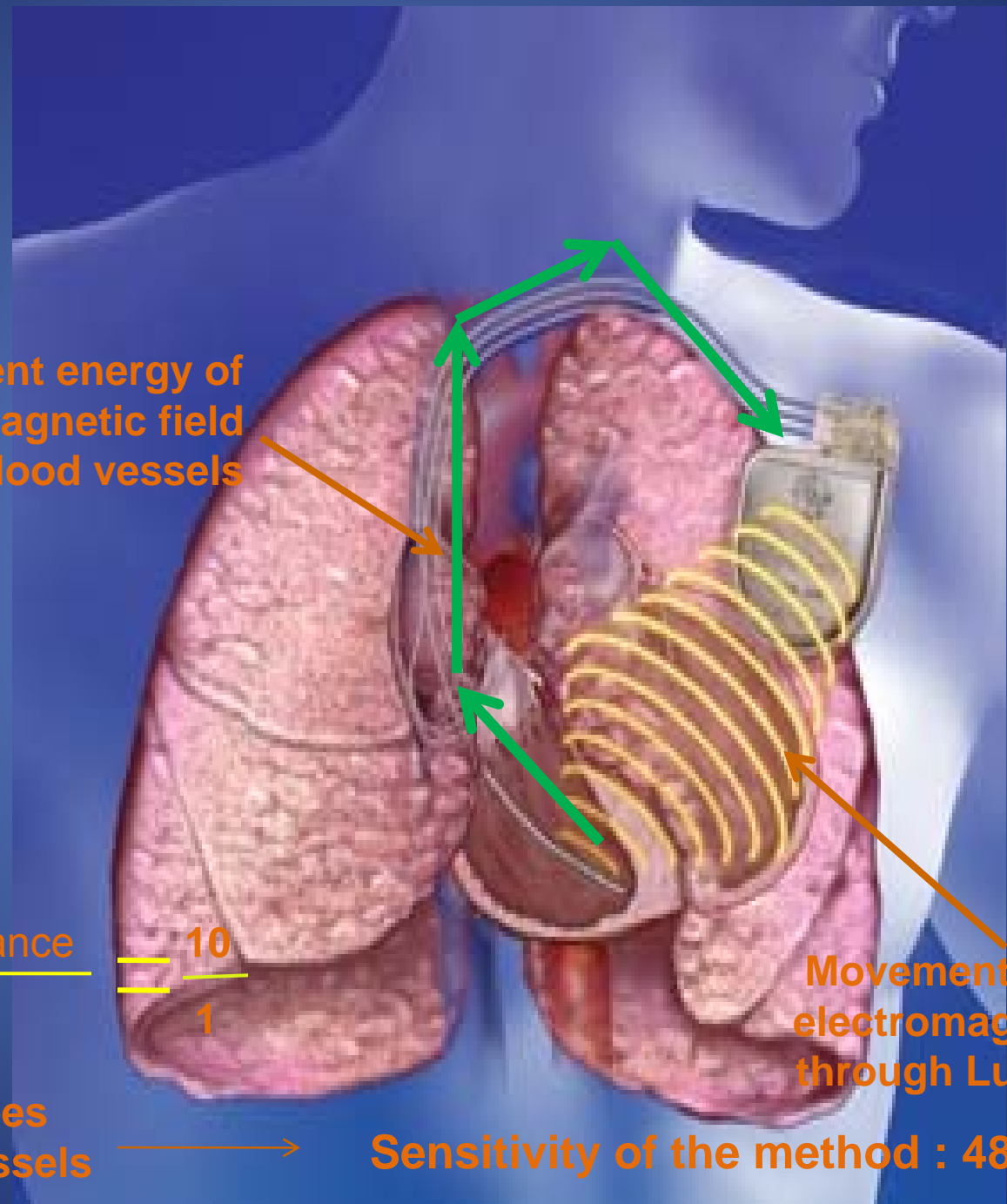
Movement energy of electromagnetic field through Lung Tissue

Lung Tissue Resistance
Blood resistance

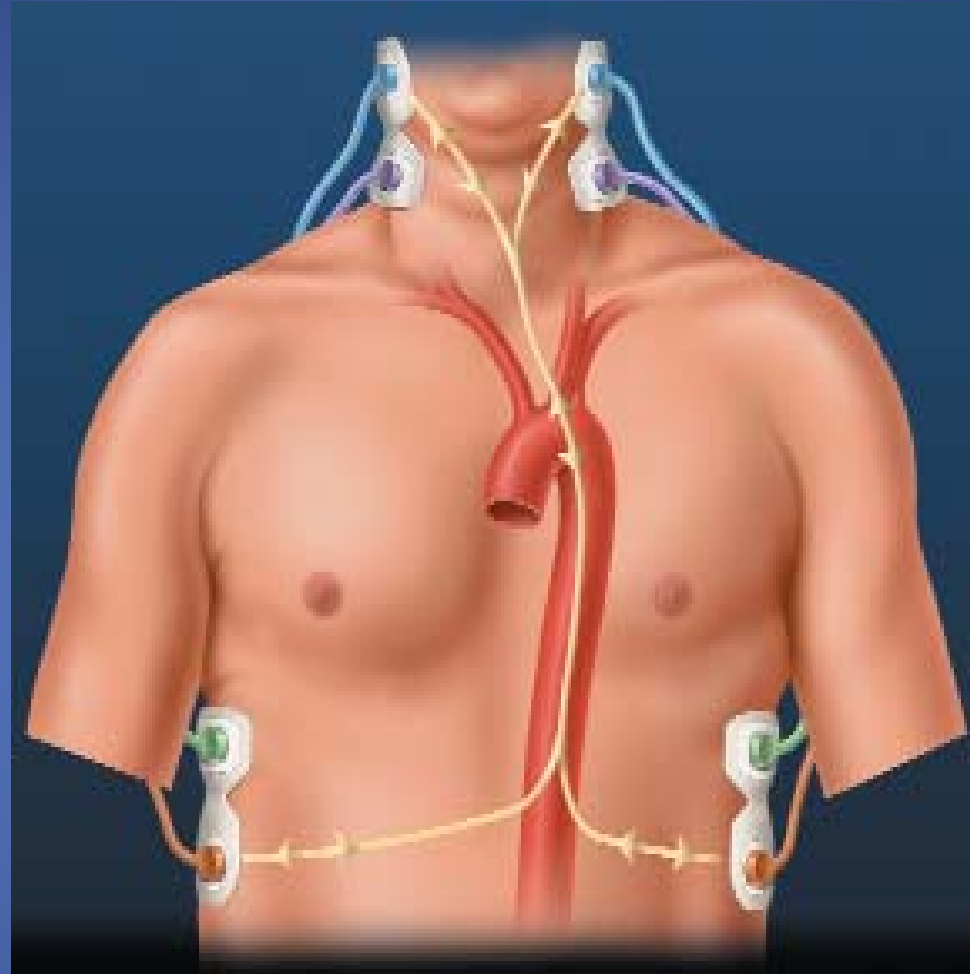


More energy goes through blood vessels

Sensitivity of the method : $48 \div 76\%$



BioZ device



Relation of the Lung Resistance to Blood Resistance 10 : 1

Most of the energy of electromagnetic field goes through big vessels. Method doesn't sensitive for measurement changes in lung fluid status especially at the interstitial stage of evolving Lung Edema .

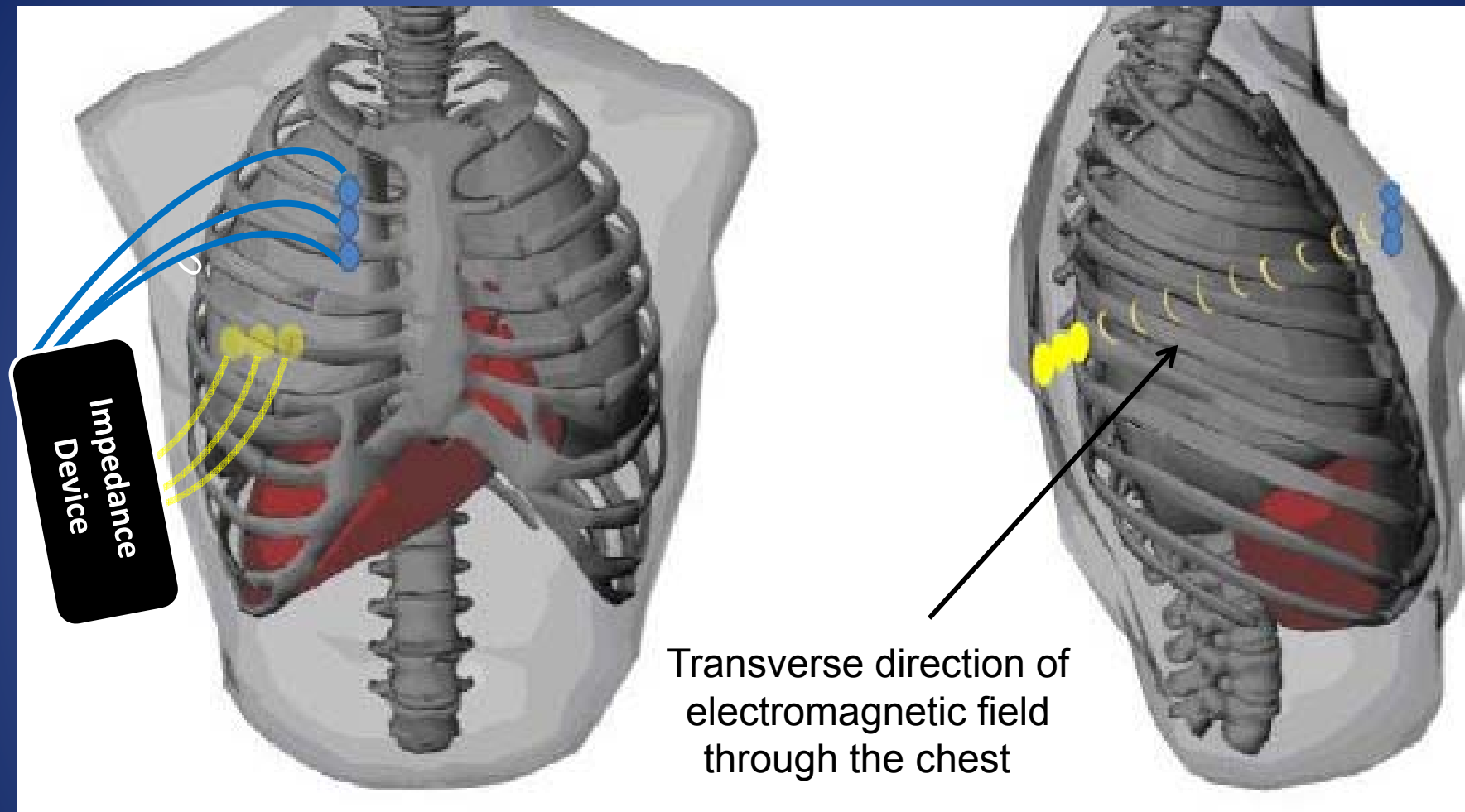
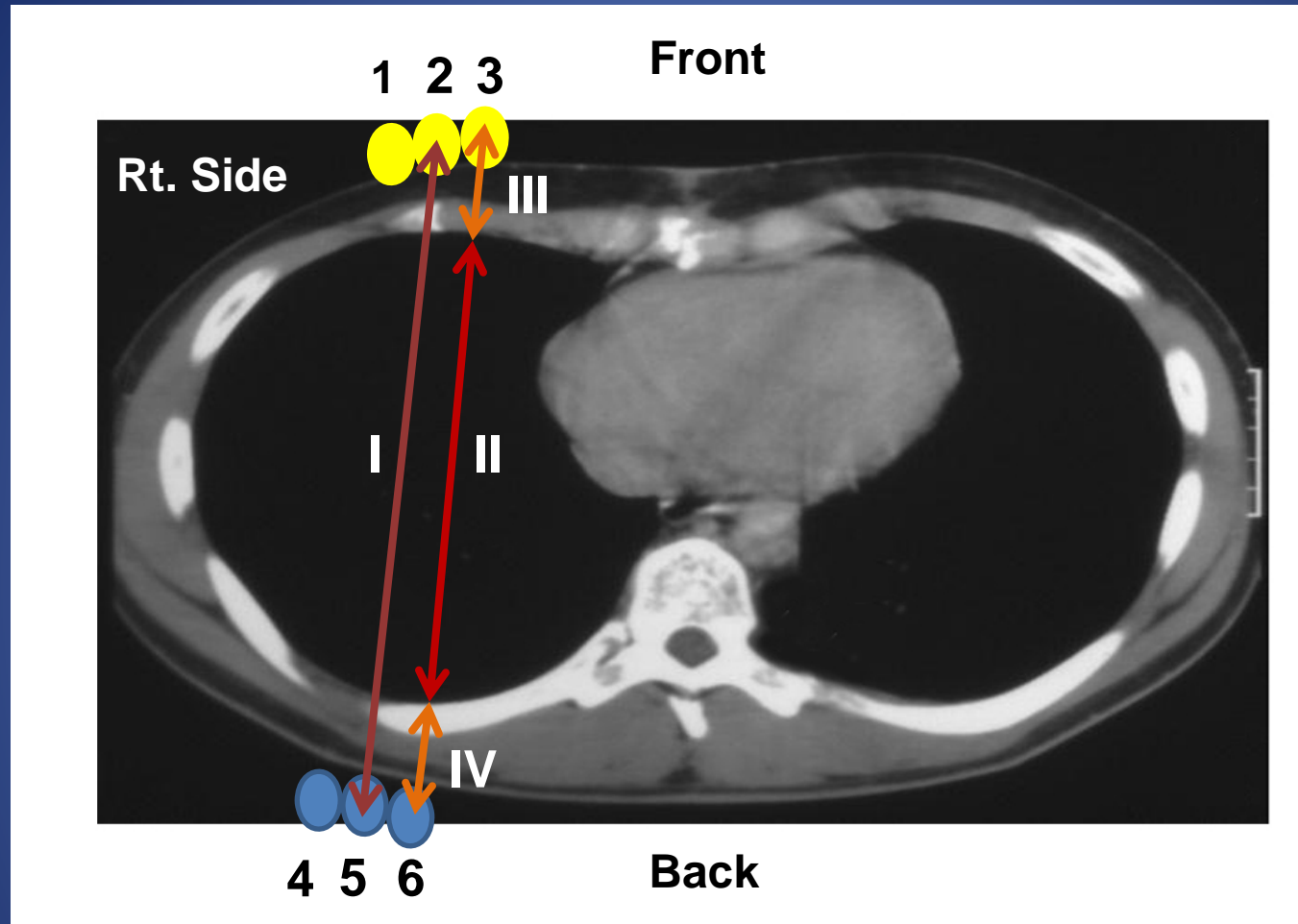


Figure of Impedance Device connection to the chest

Method of measurement. Transverse plane of chest



- I. Transthoracic Impedance (TTI).
- II. Lung Impedance (LI).
- III. Front Compartment Impedance.
- IV. Back Compartment Impedance.

$$II (LI) = I - III - IV$$

Study design

Group 1

37 healthy voluntaries

Monitoring was done 24 hours

Group 2

585 patients with STEMI at admission to ICCU have been checked

521 patients at admission had no clinical and roentgenological signs of AHF
Monitoring was done 74.2 ± 30.6 hours

Group 2A. 401 patients did not develop clinical and roentgenological signs of AHF during monitoring time

Group 2B. 120 patients developed clinical and rentgenological signs of AHF (alveolar lung edema) during monitoring time

Patients of group 2 were underwent X-ray examinations at the beginning of monitoring and according clinical necessity

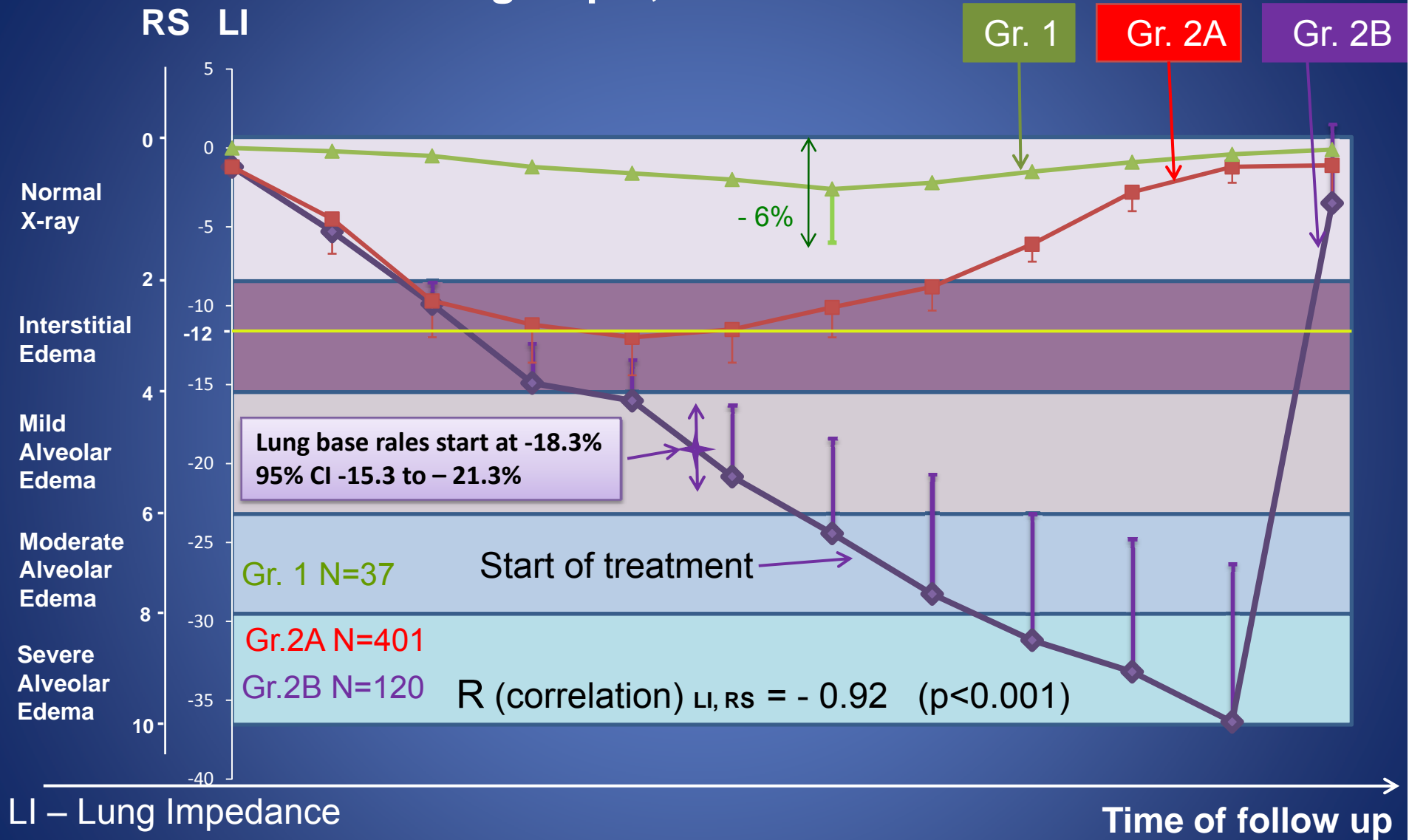
Ratio of Roentgenological Signs (RS) of Lung Edema

X-ray signs of Lung Edema	Ratio of X-ray signs	
	YES	NO
Lung vessels redistribution	1	0
Width of cardiac silhouette (>50%)	1	0
Peribronchial cuffing	1	0
New Pleural Effusion	1	0
On one side	1	0
On two sides	2	0
Kerley A or/and B line	2	0
Opacity	1	0
Glance opacity	2	0
Bat wing edema	3	0

Numerical Roentgenological Score (RS) of Lung Edema

Roentgenological Severity of Lung Edema	Roentgenological score (RS)
No Lung Edema	0 – 2
Interstitial Lung Edema	3 – 4
Mild alveolar Lung Edema	5 – 6
Moderate alveolar Lung Edema	7 – 8
Severe alveolar Lung Edema (Pulmonary Edema)	9 – 10

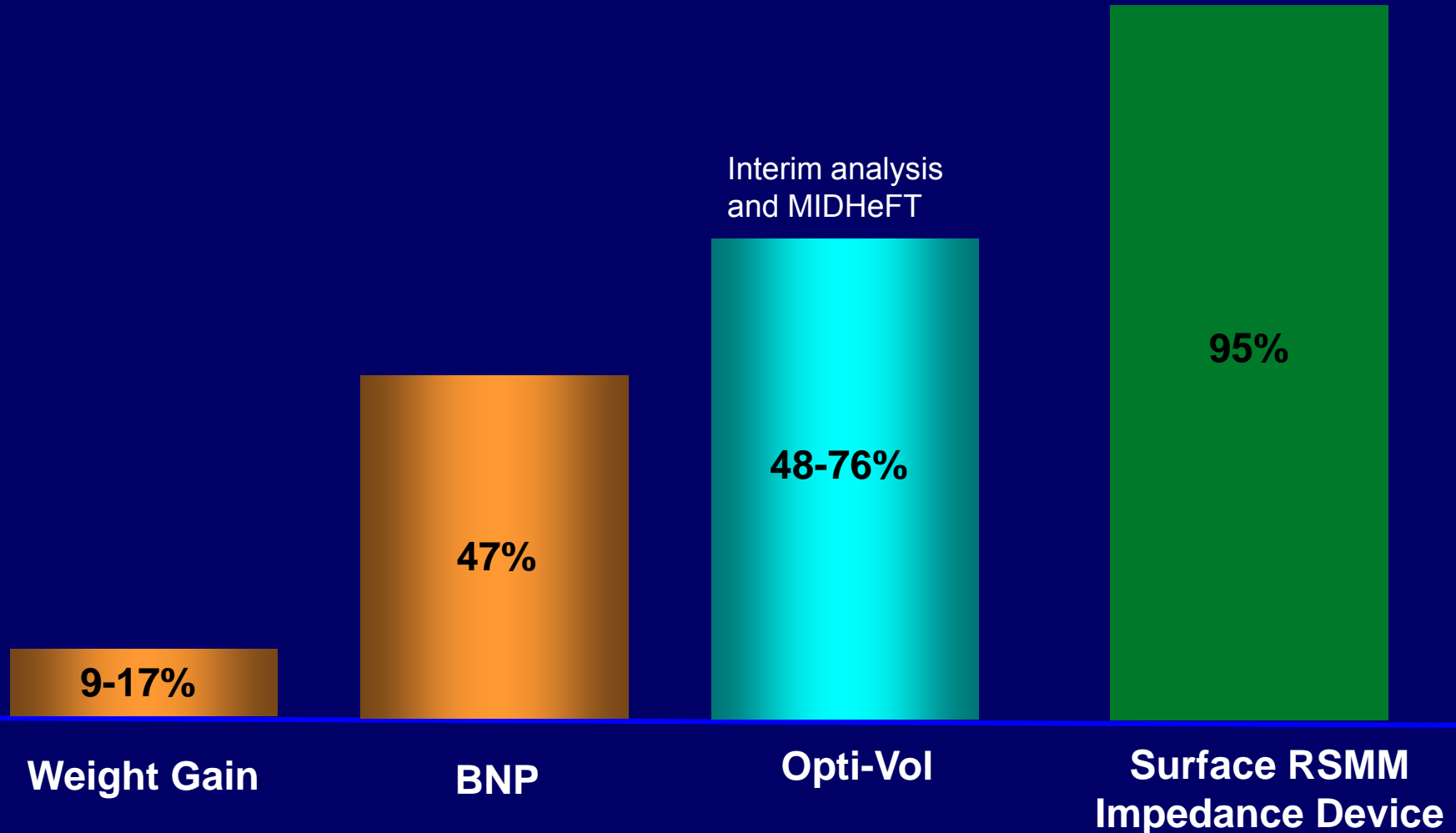
Dynamics of Lung Impedance and Roentgenological Score in group 1,2A and 2B



Positive predictive value for alveolar edema development - 95%

Sensitivity in Perspective: Right Prediction of AHF

OptiVol shows significant improvement over traditional assessment methods alone



Conclusions

- I. There is a high correlation (-0.92 , $p < 0.001$) between LI dynamics and RS during the evolution of AHF in AMI patients
- II. RS confirms that monitoring of LI by Surface Thoracic Impedance is sensitive enough for determination of interstitial stage of evolving AHF and prediction of alveolar stage of lung edema.
- III. Positive predictive value for prediction of alveolar edema using LI decrease cut point as -12% is 95% .
- IV. Using LI monitoring prediction of the beginning of the alveolar stage of lung edema may be achieved 0.5 to 8 hours before appearance of lung rales or signs of alveolar edema on X-ray. This provides sufficient time to initiate treatment in an attempt to prevent alveolar edema or alleviate its severity.
- IV. The device for LI monitoring presented today is very simple to use, non-invasive and has a higher predictive value than other methods used for the prediction of AHF.