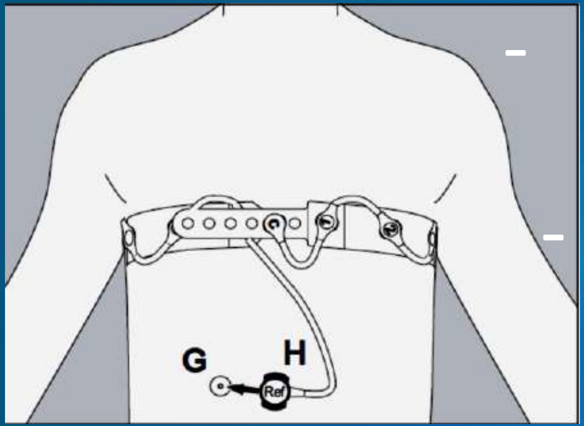
Электроимпедансная томография легких и ЭКМО при ОДН:
опыт совместного применения

С.Г. Парванян

ВЦЭРМ им. А.М. Никифорова МЧС России
Санкт - Петербург

Электроимпедансная томография



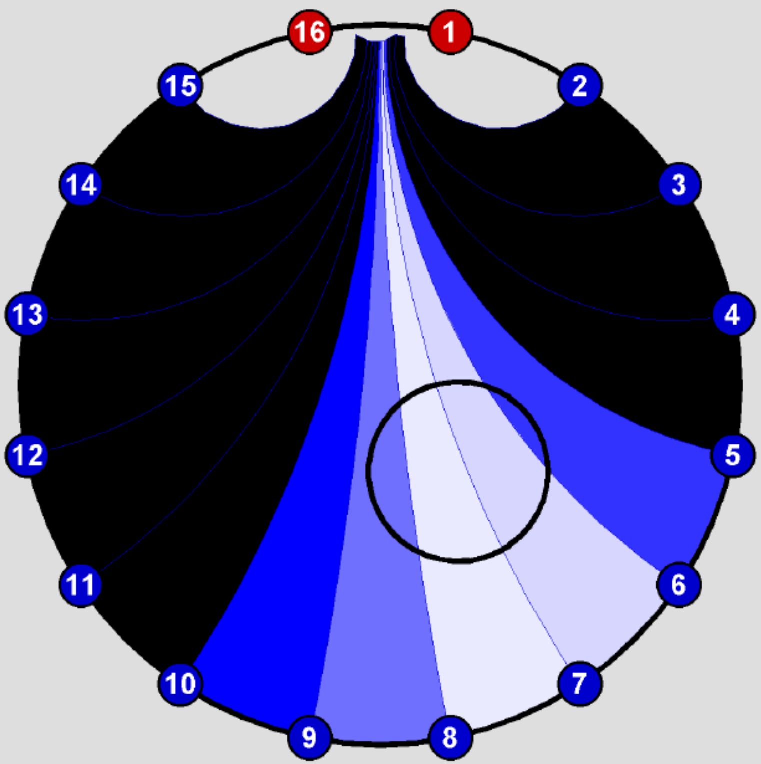
- Появление – Barber, Brown, 1980-е
- В основе – измерение колебаний электроимпеданса тканей, связанных с дыханием и работой сердца
- Наибольший интерес представляет динамическая оценка

Принцип построения электроимпедансной томограммы

Impedance distribution at the

Voltage change due

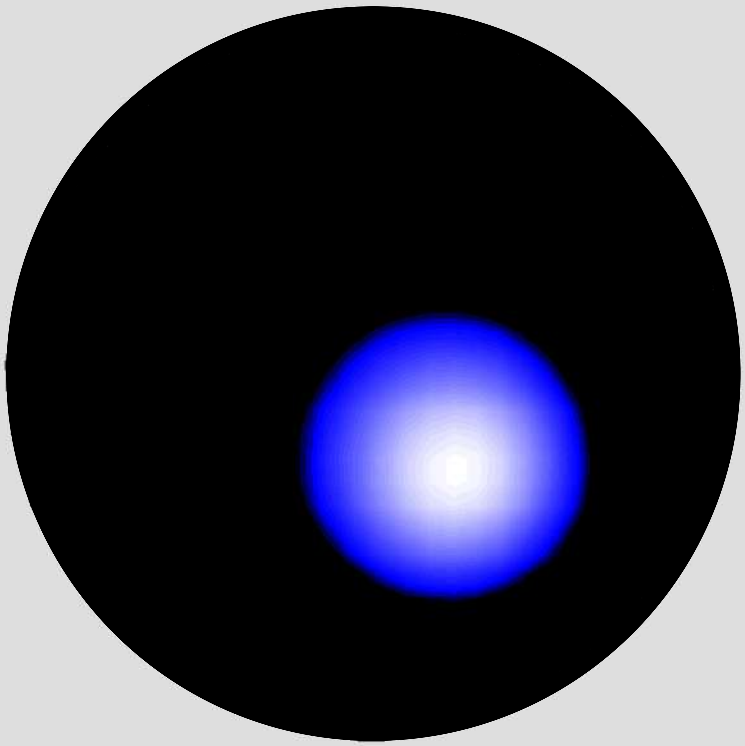
to insbiration



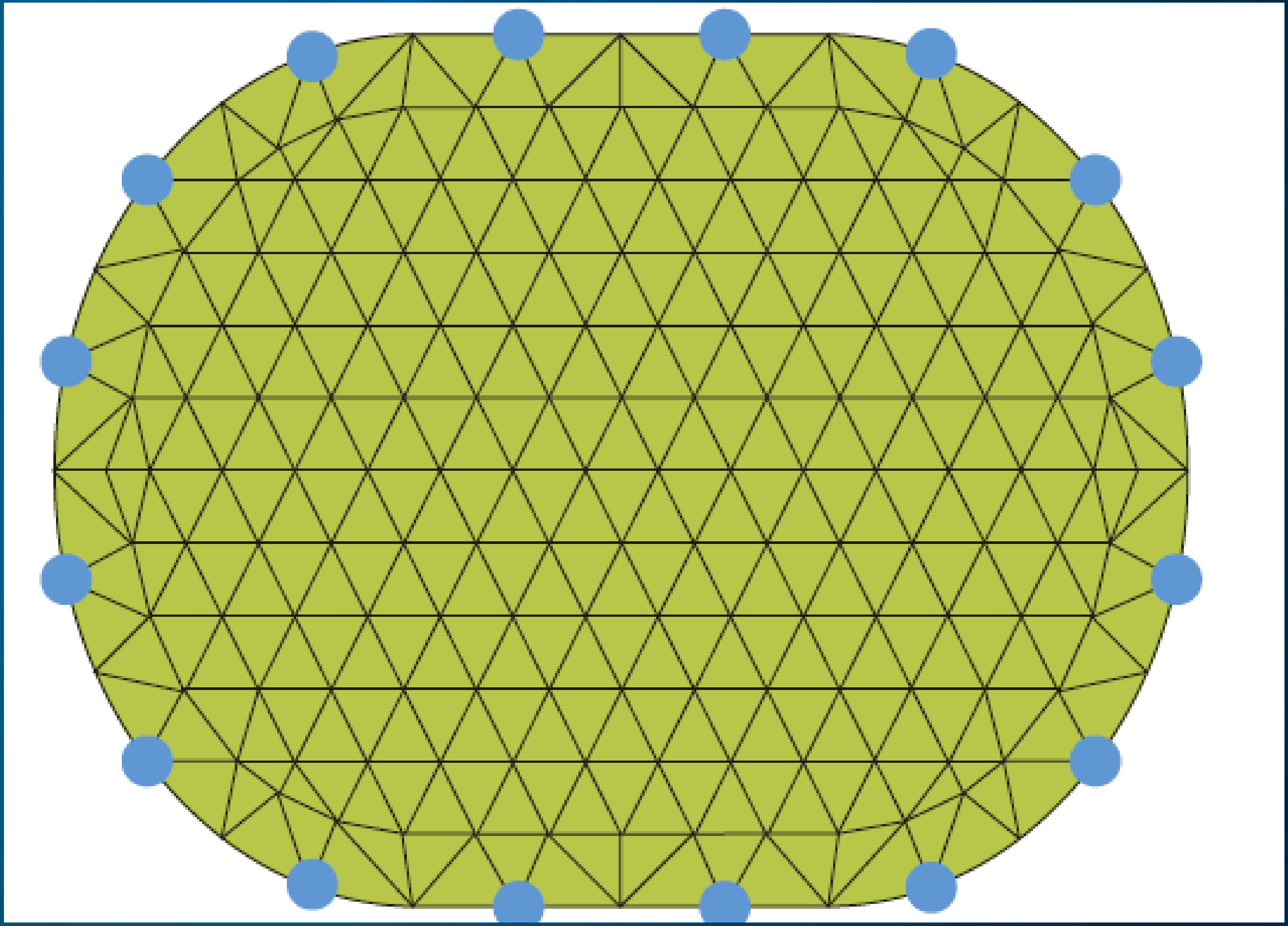
Superimposition

Resulting image

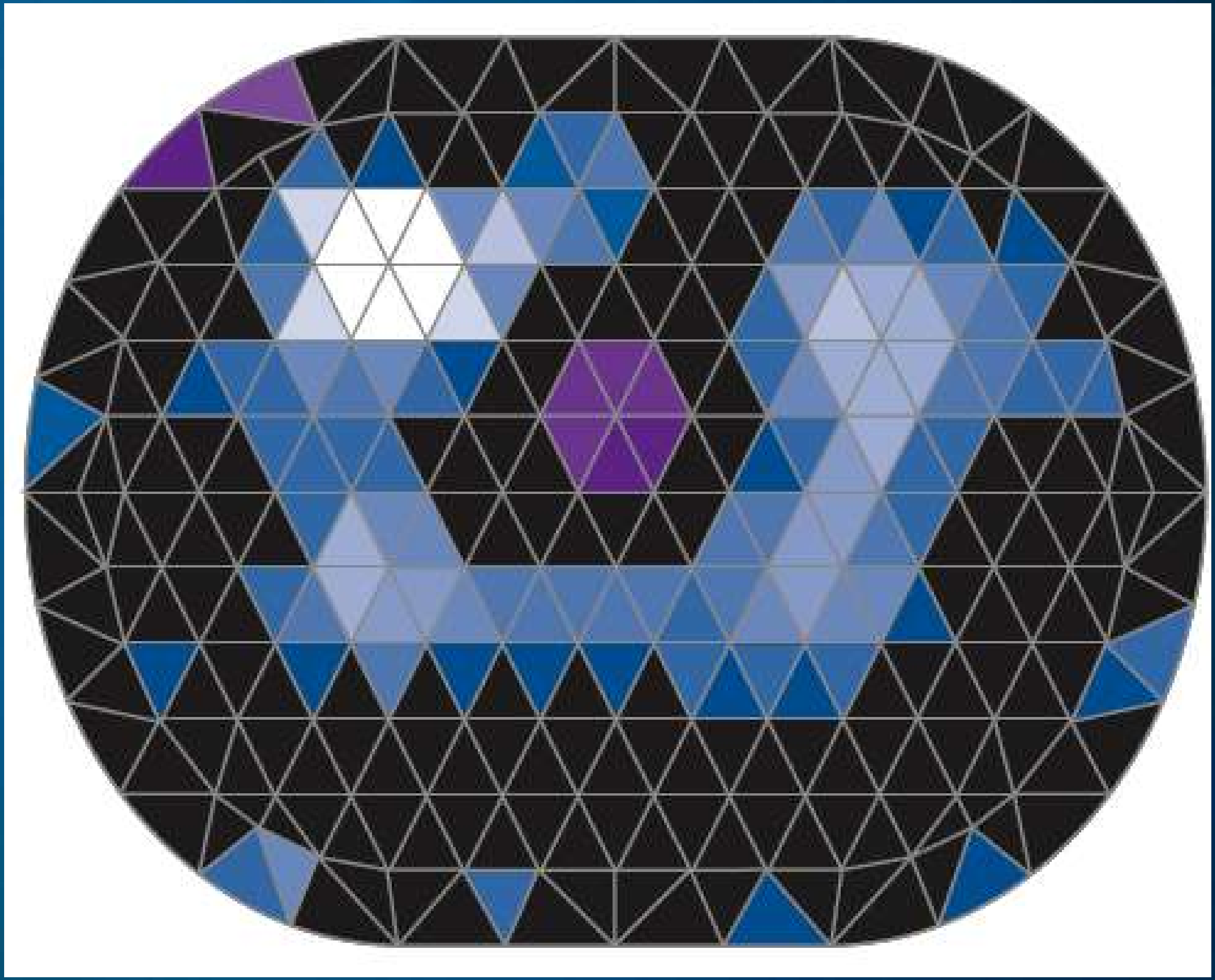
of voltage profiles



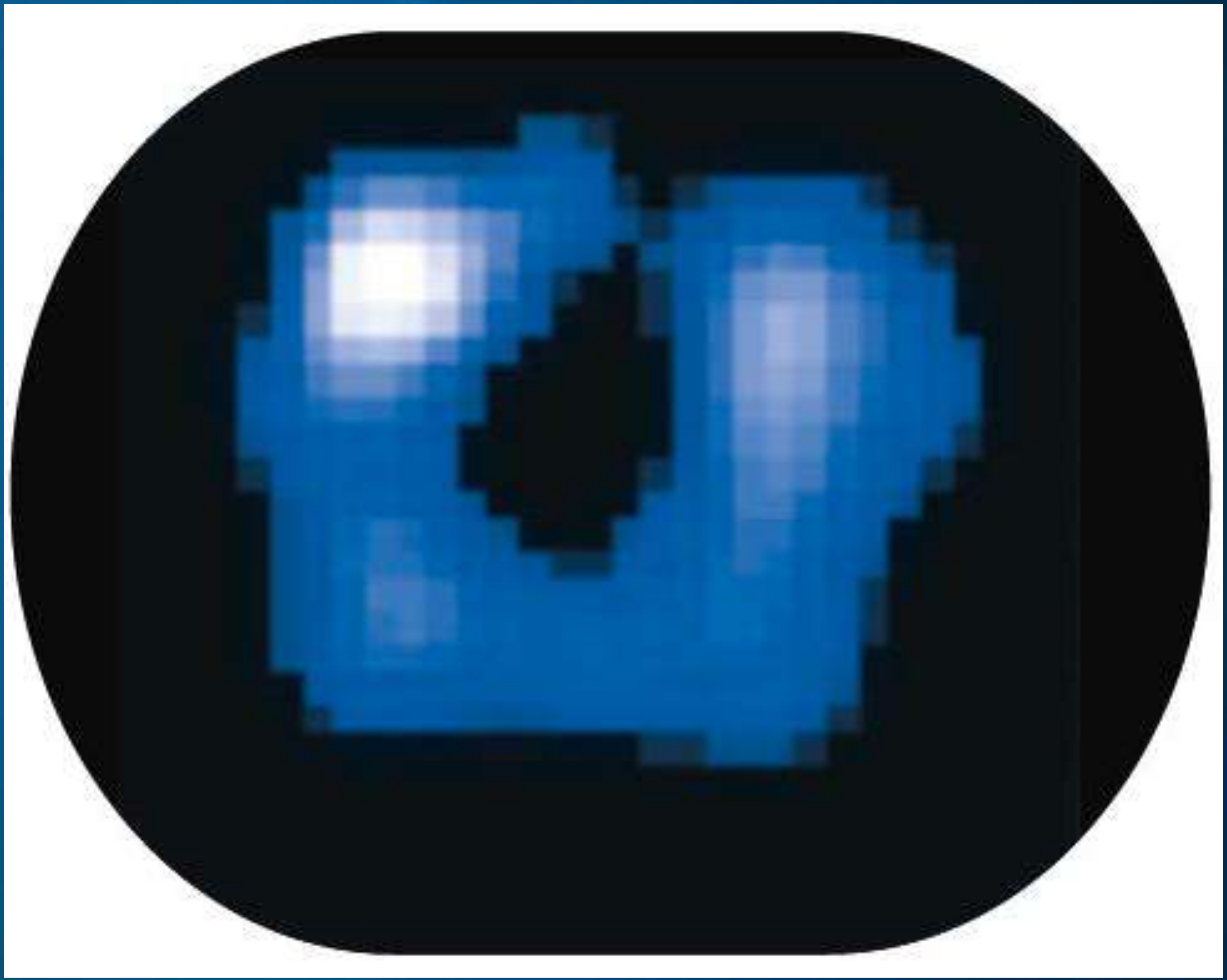
Формирование массива 36х36



Математическая обработка

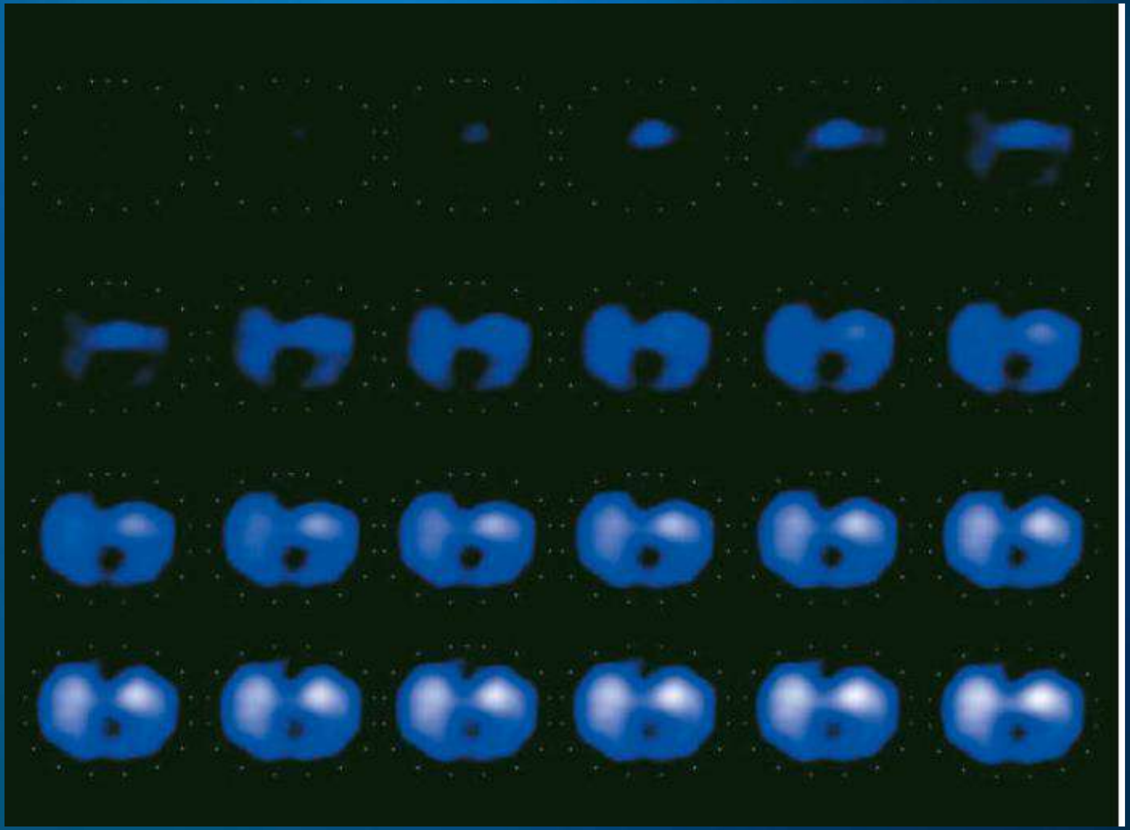


Сглаживание



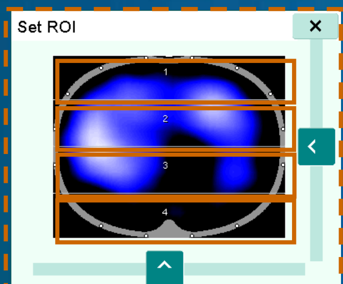
Представление результата

Обновление до 50 раз в секунду с формированием картины изменения воздушности легких в реальном времени

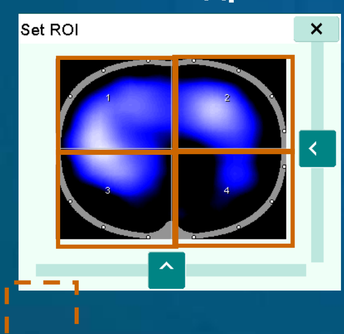


Изменение общей воздушности легких от вдоха к вдоху, и распределение по отделам

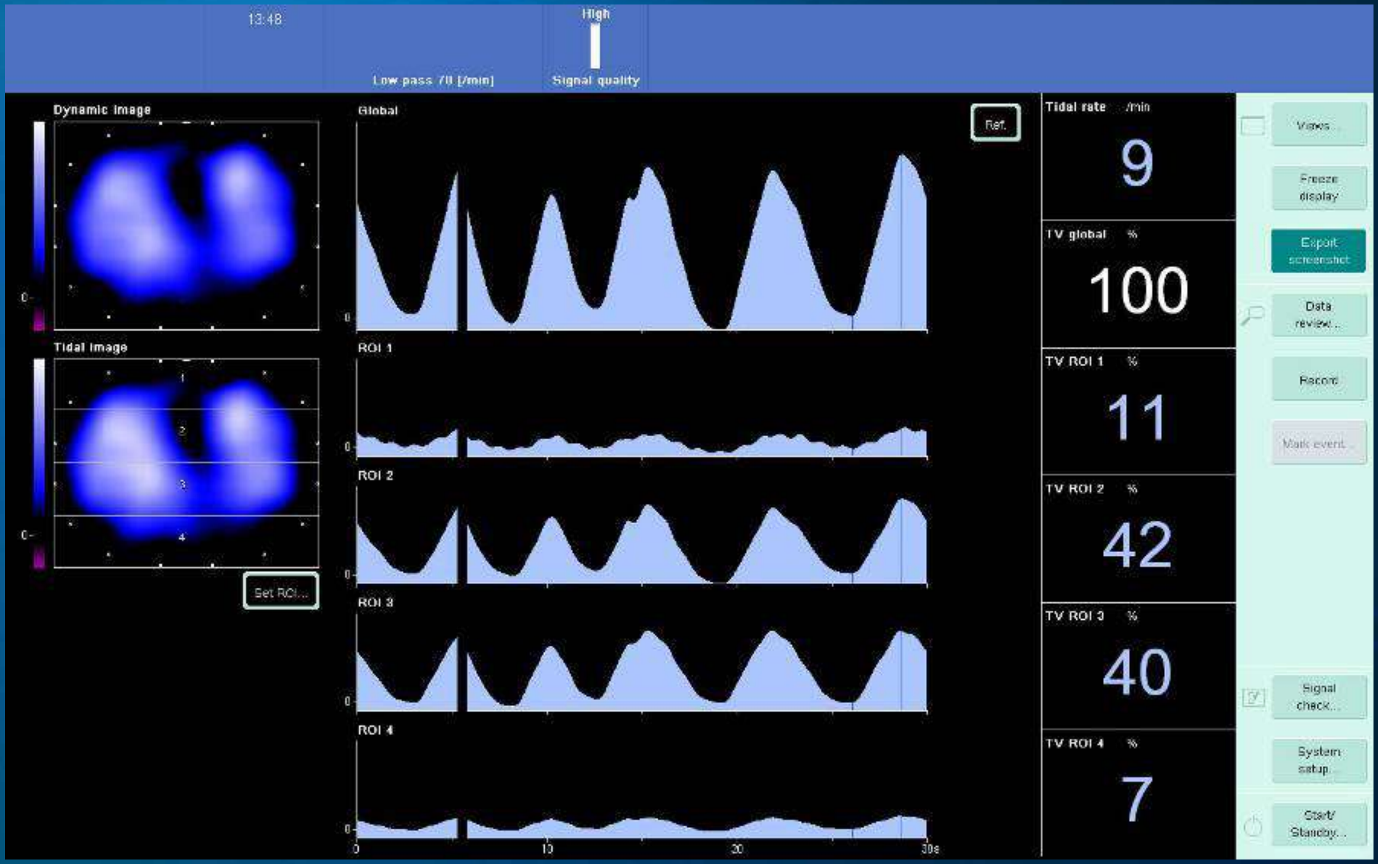
Послойно



По квадрантам



Произвольно



Динамическая оценка

- Общий недостаток электроимпедансных методик – невысокая диагностическая ценность однократного измерения
- Высокая вариабельность биоимпеданса

- Клиническую ценность представляет динамика изменений

Практическая польза у постели больного

- Динамика общей воздушности легких во времени
- Выявление неоднородности легких
- Визуализация эффектов от изменения параметров и режимов ИВЛ
- Визуализация эффективности PEEP
- Оценка рекрутабельности легких
- Подбор оптимального PEEP после рекрутмента
- Выявление участков перерастяжения легких

ОДН – начинать ли ЭКМО?

ELSO guidelines

A: Indications

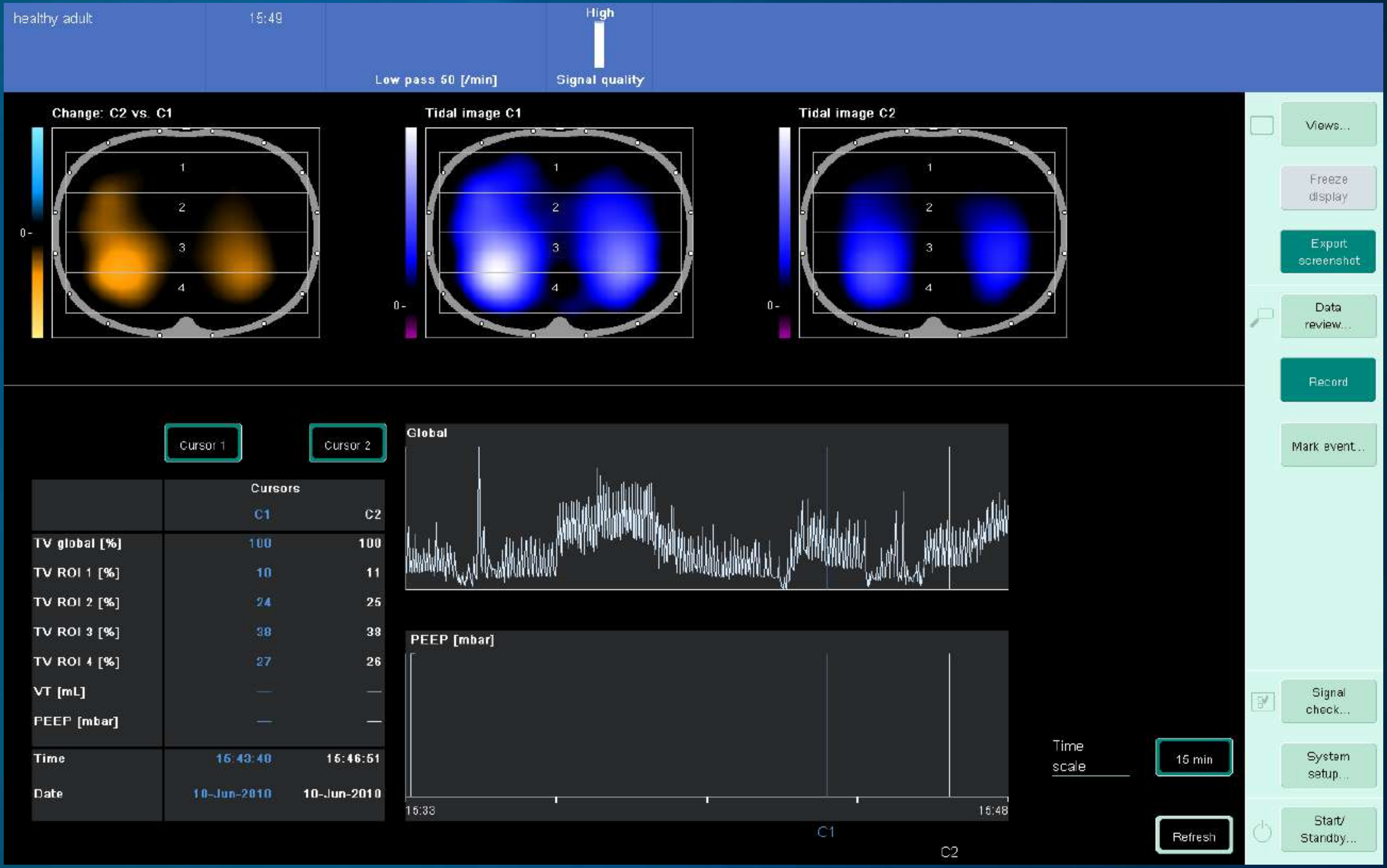
1. In hypoxic respiratory failure due to any cause (primary or secondary) ECLS should be considered when the risk of mortality is 50% or greater, and is indicated when the risk of mortality is 80% or greater.

a. 50% mortality risk is associated with a PaO2/FiO2 < 150 on FiO2 > 90% and/or Murray score 2-3.

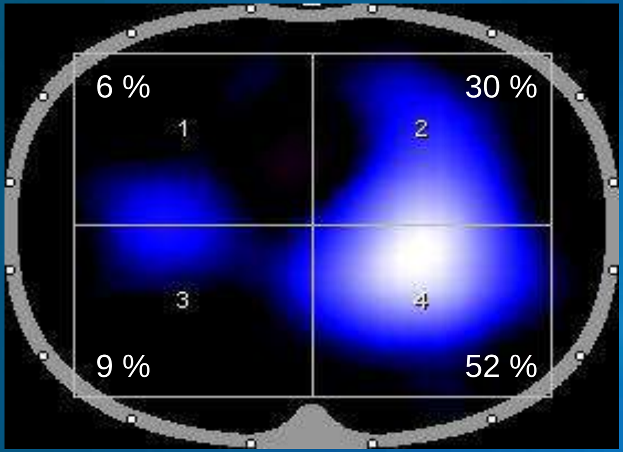
b. 80% mortality risk is associated with a PaO2/FiO2 < 100 on FiO2> 90% and/or Murray score 3-4 despite optimal care for 6 hours or more.

ongoing requirement for vasoactive drugs. All this despite optimal treatment, but in H1N1 disease progression can be very fast 9 12-24hours to arrest), so have a low threshold for" failure of optimal Rx. Survival is approximately 72% for patients on

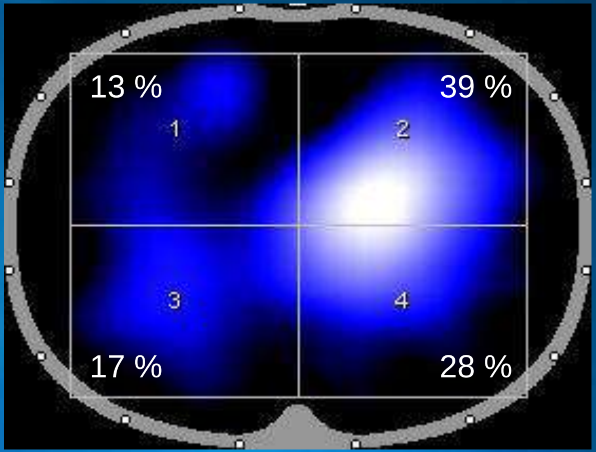
Насколько быстро теряется воздушность легких?



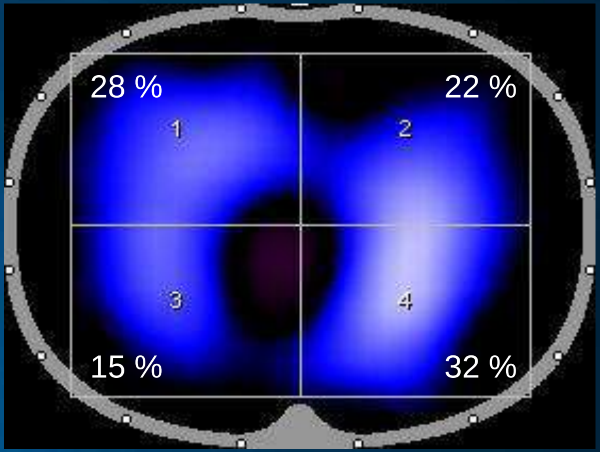
Эффективен ли рекрутмент?



До RM



10 мин после RM



4 часа после RM

Ожидать ли эффекта от поворота?

ОДН – начинать ли ЭКМО?

Насколько быстро теряется воздушность легких?

Все ли возможности респираторной терапии эффективно используются?

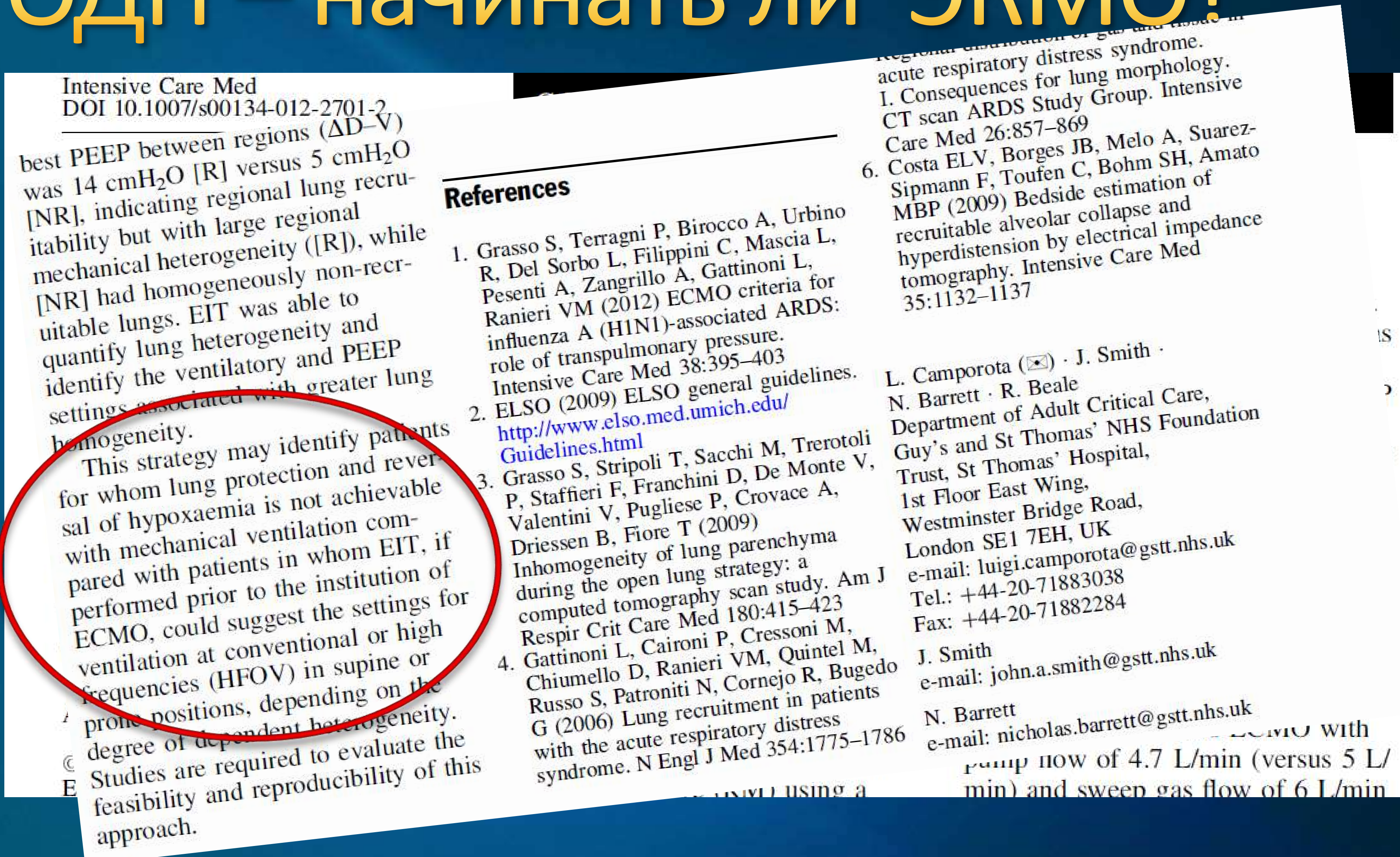
Эффективен ли рекрутмент?

Ожидать ли эффект от «prone position»

Возможно более быстрое принятие решения при пограничных ситуациях (Murray 2-3 балла)

Возможно более раннее начало ЭКМО при Murray 3-4 балла

ОДН – начинать ли ЭКМО?



Intensive Care Med
DOI 10.1007/s00134-012-2701-2

best PEEP between regions (ΔD–V) was 14 cmH_2O [R] versus 5 cmH_2O [NR], indicating regional lung recruitability but with large regional mechanical heterogeneity ([R]), while [NR] had homogeneously non-recruitable lungs. EIT was able to quantify lung heterogeneity and identify the ventilatory and PEEP settings associated with greater lung homogeneity.

This strategy may identify patients for whom lung protection and reversal of hypoxaemia is not achievable with mechanical ventilation compared with patients in whom EIT, if performed prior to the institution of ECMO, could suggest the settings for ventilation at conventional or high frequencies (HFOV) in supine or prone positions, depending on the degree of dependent heterogeneity. Studies are required to evaluate the feasibility and reproducibility of this approach.

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L. Camporota (✉) · J. Smith · N. Barrett · R. Beale
Department of Adult Critical Care, Guy's and St Thomas' NHS Foundation Trust, St Thomas' Hospital, 1st Floor East Wing, Westminster Bridge Road, London SE1 7EH, UK
e-mail: luigi.camporota@gstt.nhs.uk
Tel.: +44-20-71883038
Fax: +44-20-71882284

J. Smith
e-mail: john.a.smith@gstt.nhs.uk

N. Barrett
e-mail: nicholas.barrett@gstt.nhs.uk

... ECMO with pump flow of 4.7 L/min (versus 5 L/min) and sweep gas flow of 6 L/min

PubMed – одна публикация, 2 пациента!

Коррекция параметров ИВЛ во время ЭКМО

2. Ventilator management: Patients are on high FiO2 and ventilator settings
cannulation. The goal of ventilator management on ECLS is to use FiO2 <0.4,and nondan
"rest settings (PPlat<25)" In many patients the lung may proceed to total consolidation before recovery occurs, but this might be avoided by maintaining some inflation pressure as high pressures are decreased, and by supplying nitrogen to prevent adsorption atelectasis. Each patient is different, but a general algorithm for ventilator management is:

a) First 24 hours: moderate to heavy sedation.

Pressure controlled ventilation at 25/15, I:E 2:1, rate 5, FiO2 50% ,FiN2 50% If initial PaCO2>50, increase sweep slowly to bring PaCO2 down slowly, 10-20 mmHg/hour

Until there is some sign of lung recovery, there is no indication for recruitment maneuvers, or other vent devices or maneuvers. When there is some native gas exchange and aeration it is reasonable to begin recruitment maneuvers, (prolonged inspiration at 25 cm H2O).The use of adjunctive measures such as nitric oxide,

Коррекция параметров ИВЛ во время ЭКМО

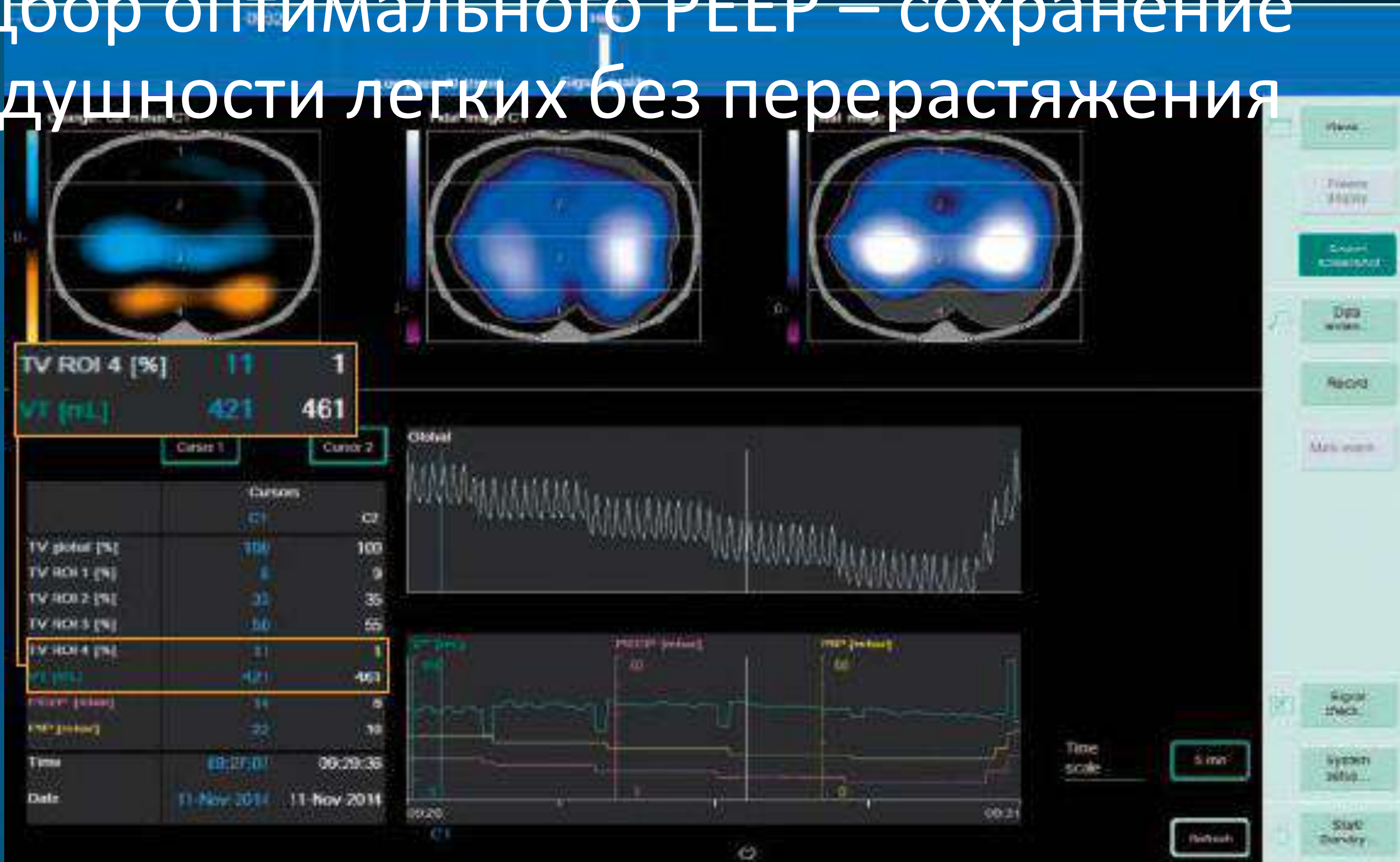
Роль агрессивной ИВЛ в формировании исхода сравнима с ролью основного процесса!

Необходимо минимизировать вентилятор-ассоциированное повреждение легких

Коррекция параметров ИВЛ во время ЭКМО

Коррекция ИВЛ во время ЭКМО

Подбор оптимального PEEP – сохранение воздушности легких без перерастяжения



PEEP

<u>Not too low, not too high, but just right!</u>

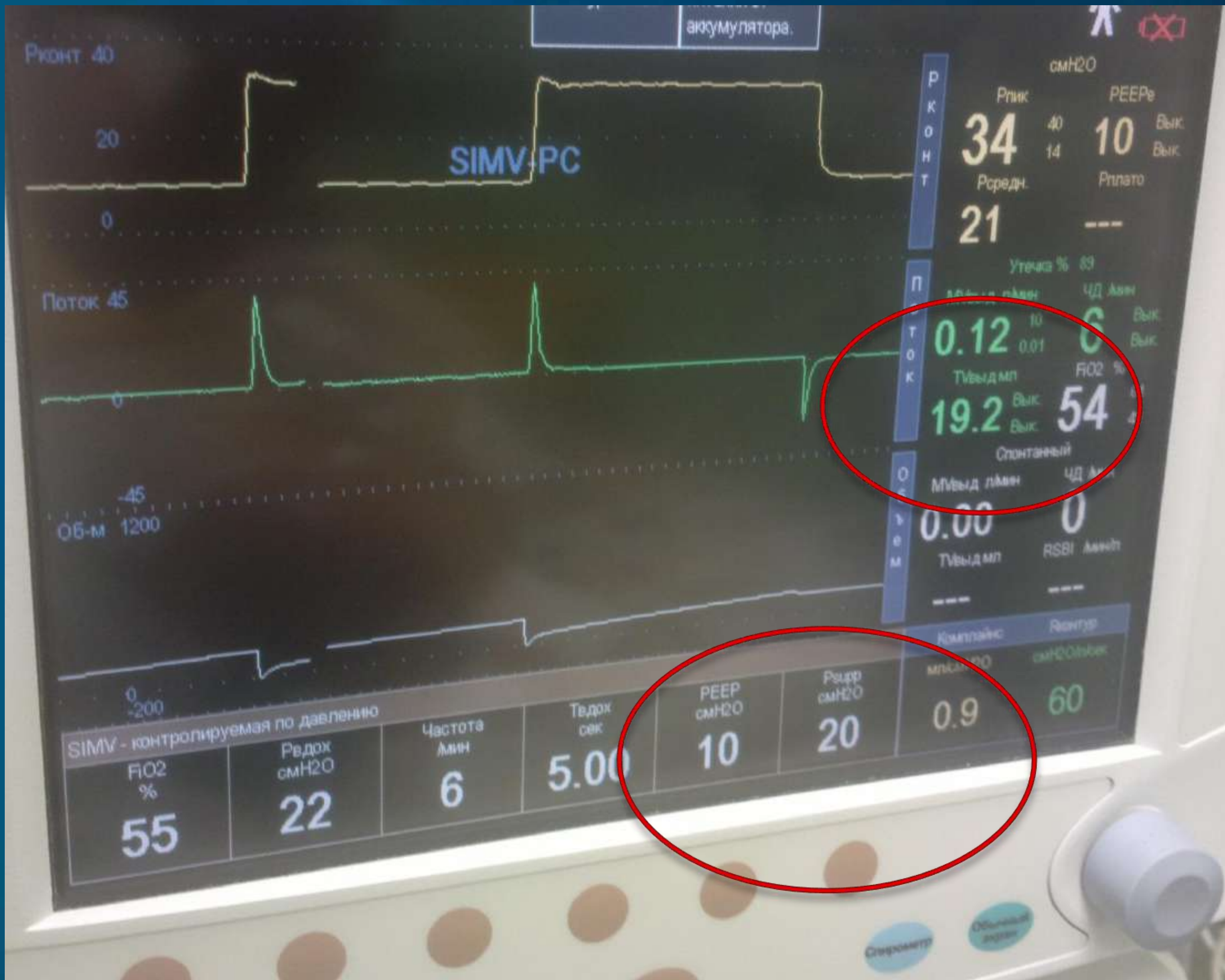
Оценка динамики течения ОДН. Прогнозирование?

Увеличивается ли воздушность легких?
Есть ли положительная динамика в течении заболевания?
Потребуется ли продолжать ЭКМО, будет ли превышена расчетная продолжительность работы контура?

Оценка динамики течения ОДН. Прогнозирование?

Показатели газообмена
Показатели респираторной механики
Динамика внесосудистой воды легких
КТ-картина
УЗИ
ЭИТ

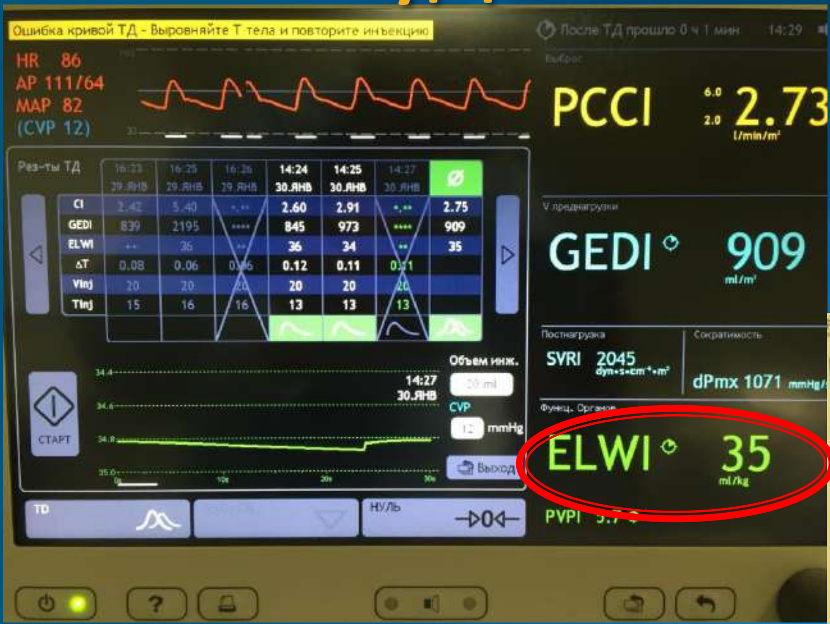
Показатели респираторной механики

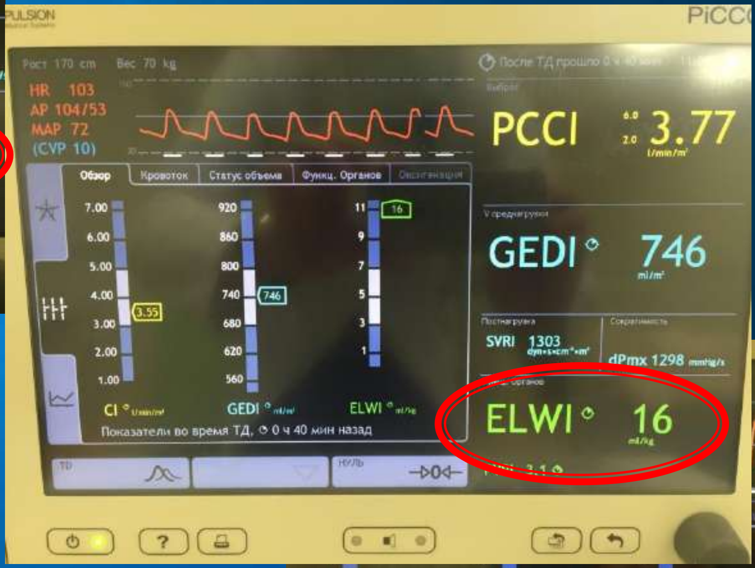


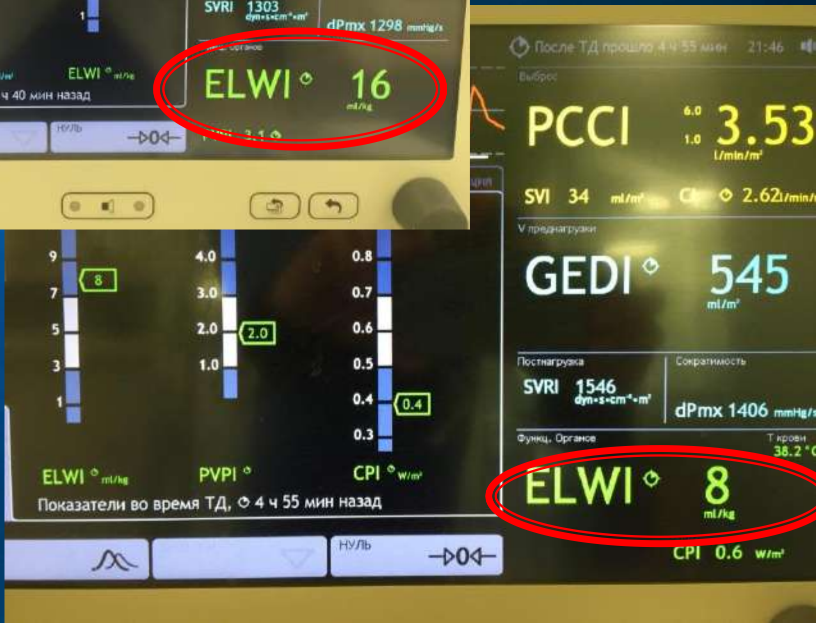
Показатели респираторной механики

ДО и комплайнс возросли – улучшение состояния легких или формирование патологических полостей???

Внесосудистая вода легких







Важный предиктор выживаемости

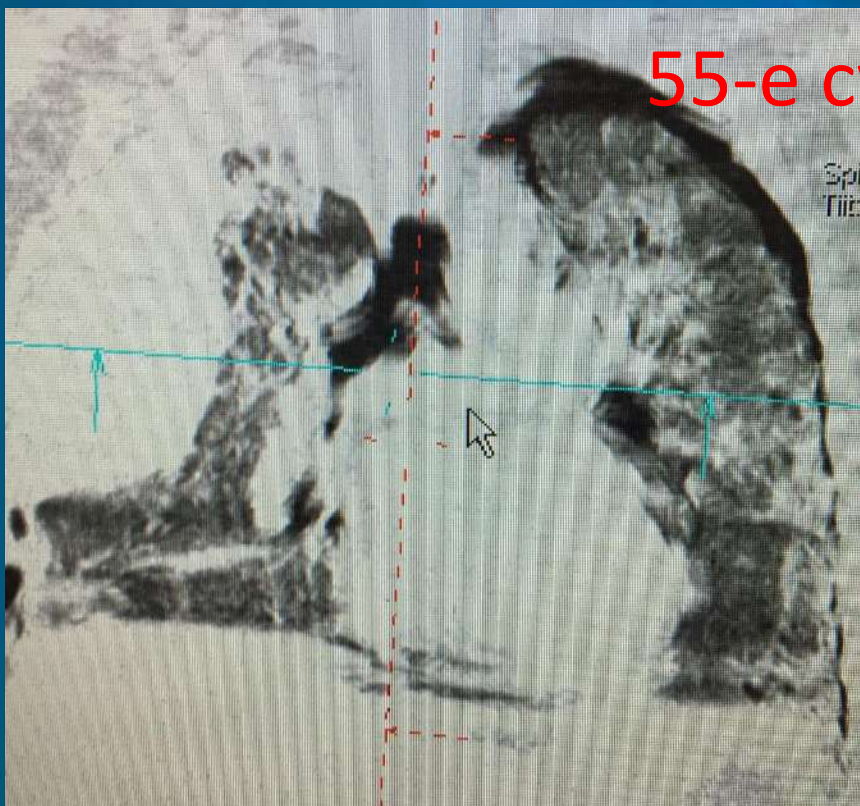
Нет прямой корреляции с улучшением газообмена

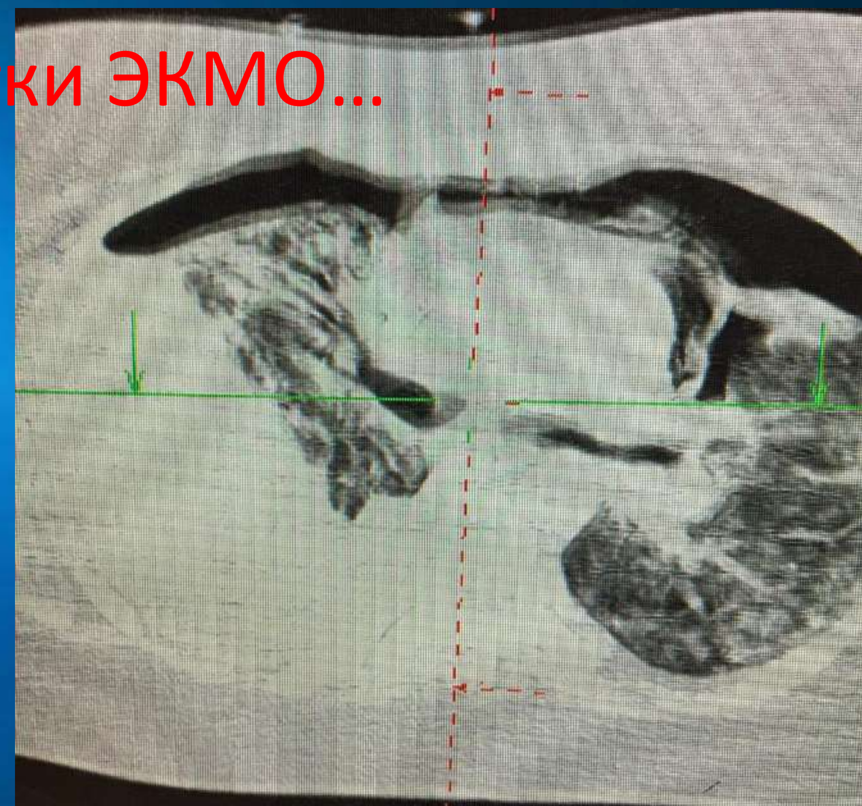
Динамика КТ

Золотой стандарт
Не прикроватная методика
Высокая лучевая нагрузка
Сложности с транспортировкой пациента

Динамика КТ

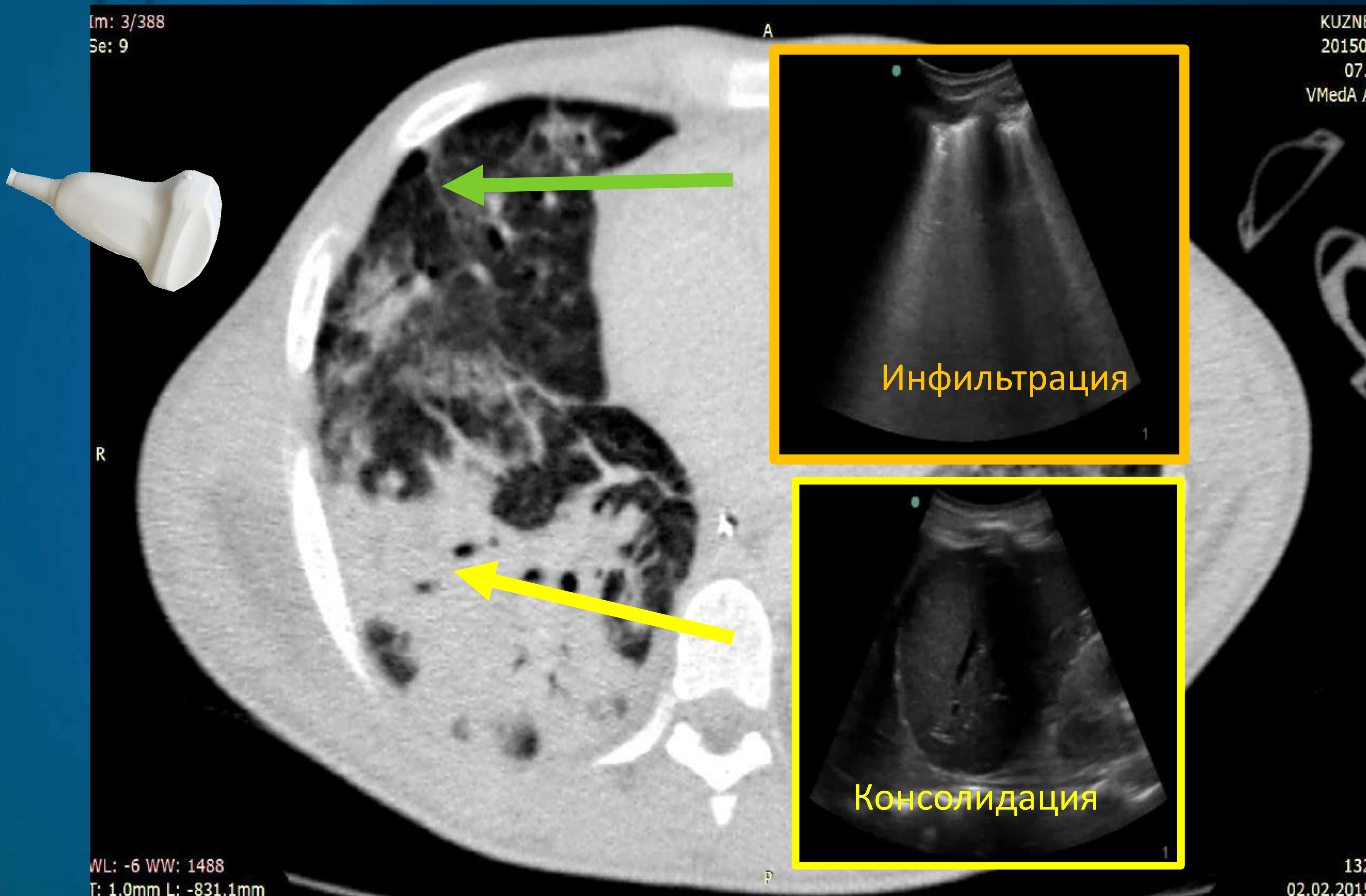
55-е сутки ЭКМО…





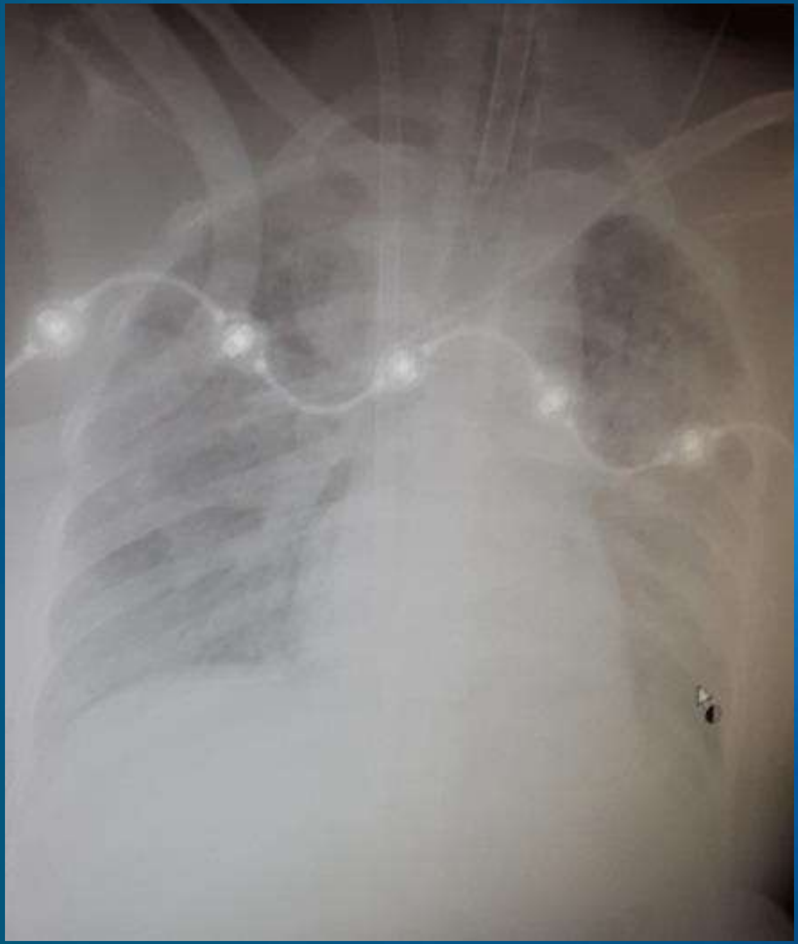
Повторные КТ необходимы, в т.ч. для выявления грубых морфологических изменений легких

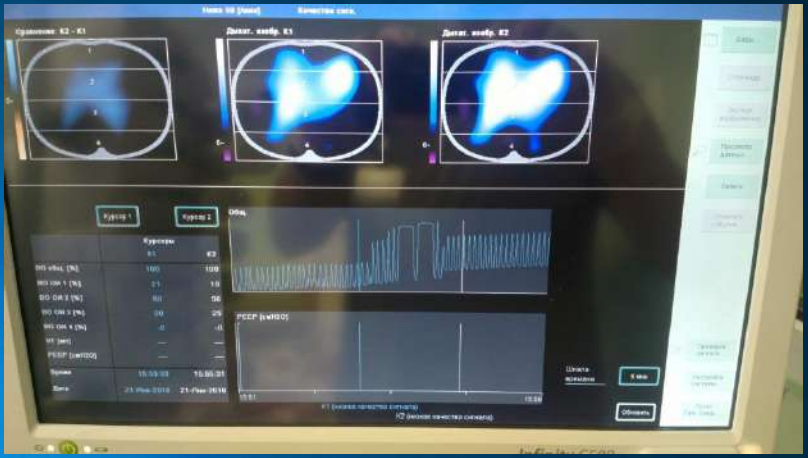
УЗ-динамика



Применение представляется перспективным.

ЭИТ – динамика ?





Ценность для прогноза не изучена.

Anaesthesist. 2015 Apr;64(4):277-85. doi: 10.1007/s00101-015-0010-1. Epub 2015 Apr 1.

[Therapy of acute respiratory distress syndrome : Survey of German ARDS centers and scientific evidence].

[Article in German]

Kredel M[1], Bierbaum D, Lotz C, Küstermann J, Roewer N, Muellenbach RM.

⊕ Author information

На закуску!

Abstract

BACKGROUND: In addition to specific treatment of the underlying cause, the therapy of acute respiratory distress syndrome (ARDS) consists of lung protective ventilation and a range of adjuvant and supportive measures.

AIM: A survey was conducted to determine the current treatment strategies for ARDS in German ARDS centers.

MATERIAL AND METHODS: The 39 centers listed in the German ARDS network in 2011 were asked to complete a questionnaire collecting data on the clinic, epidemiology as well as diagnostic and therapeutic measures regarding ARDS treatment.

RESULTS: Of the centers 25 completed the questionnaire. In 2010 each of these centers treated an median of 31 (25-75 percentile range 20-59) patients. Diagnostic measures at admission were computed tomography of the thorax (60 % of the centers), whole body computed tomography (56 %), chest x-ray (52 %), abdominal computed tomography (32 %) and cranial computed tomography (24 %). Transesophageal echocardiography was performed in 64 %, pulmonary artery pressure was measured in 56 % and cerebral oximetry in 12 %. Sedation was regularly interrupted in 92 % of the centers and in 68 % this was attempted at least once a day. A median minimum tidal volume of 4 ml/kg (range 2-6) and a maximum tidal volume of 6 ml/kg (4-8) were used. Methods to determine the optimal positive end-expiratory pressure (PEEP) were the best PEEP method (60 %), ARDS network table (48 %), empirical (28 %), pressure volume curve (16 %), computed tomography (8 %), electrical impedance tomography (8 %) and others (8 %). Median minimum and maximum PEEPs were 10 cmH2O (range 5-15) and 21 cmH2O (15-25), respectively. Median plateau pressure was limited to 30 cmH2O (range 26-45). The respiratory rate was set below 20/min in 20 % and below 30/min in 44 %. Controlled ventilator modes were generally preferred with 80 % using biphasic positive airway pressure (BIPAP/BiLevel), 20 % pressure controlled ventilation (PCV) and 4 % airway pressure release ventilation (APRV). Assisted modes were only utilized by 8 % of the centers. Recruitment maneuvers were used by 28 %, particularly during the early phase of the ARDS. Muscle relaxants were administered by 32 % during the early phase of the ARDS. Complete prone positioning was used by 60 % of the centers, whereas 88 % utilized incomplete (135°) prone positioning. Continuous axial rotation was utilized by 16 %. Spontaneous breathing tests were used in 88 % of the centers with 60 % performing these at least once a day. Supportive therapies were frequently applied and mainly consisted of nitrous oxide (44 %), prostacycline (48 %) and corticosteroids (52 %). A restrictive fluid therapy was used in 48 % and a special nutrition regimen in 28 % of the centers. Of the participating centers 22 were able to offer extracorporeal membrane oxygenation (ECMO). In this case, respiratory therapy was modified by further reducing tidal volumes (91 %), inspiratory pressures (96 %) as well as using lower respiratory rates (≤ 8/min in 31 %). Only 9 % reduced PEEP during ECMO. Regular recruitment maneuvers were used by 14 %. Positioning maneuvers during ECMO were used by 82 %.

CONCLUSIONS: Lung protective ventilation with reduced tidal volumes as well as inspiratory pressures represents the current standard of care and was utilized in all network centers. Prone positioning was widely used. Promising adjuvant therapies such as the muscle relaxation during the early phase of the ARDS, fluid restriction and corticosteroids were used less frequently. During ECMO respirator therapy was generally continued with ultraprotective ventilator settings.

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Всероссийский Центр Экстренной и Радиационной Медицины
им. А.М. Никифорова
МЧС России
Санкт - Петербург
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