0899

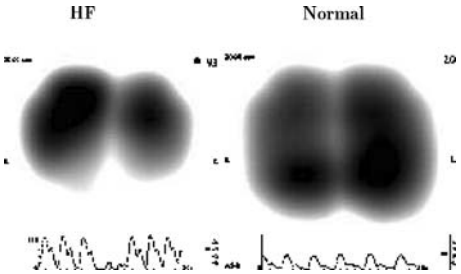
DECREASED SPATIAL DISTRIBUTION OF VIBRATION ENERGY IN LUNGS WITH ACUTE HEART FAILURE

Z. Wang*[1], R. P. Dellinger[1], S. Trzeciak[1], S. Jean[1], K. N. Gruber[2], R. Arnold[2], J. E. Parrillo[1]
[1]Division of Critical Care Medicine, [2]Emergency Department, Robert Wood Johnson School of Medicine and Cooper University Hospital, Camden, United States

INTRODUCTION. Vibration response imaging (VRI) is a novel technology using sophisticated software and 34 surface skin sensors placed on the back to record, analyze and display vibration energy of lung sounds during the respiratory cycle. It is a likely surrogate of airflow in the lungs (1). The purpose of this study is to compare VRI in acute heart failure (AHF) to those with a normal chest x-ray.

METHODS. We performed VRI in 9 consecutive AHF subjects in the emergency department (ED) and ICU and compared them to 12 controls (without pulmonary disease). Recordings were performed over 20 second periods of respiration. Respiratory cycles free of noise or artifacts were chosen for analysis and images were analyzed. The images at maximum vibration energy during inspiration were chosen and areas were compared. Areas of right and left lungs and regional areas of both lungs were calculated digitally using the program Image J. Statistical t-test was used to compare total mean lung areas.

RESULTS. The total mean areas of both lungs were 56756.9± 8231.4 and 76170.2 ±3843.2 (mean ± SD) in AHF patients and normals, respectively (p = 0.01). The mean upper region areas of both lungs were 35220.6± 3497.9and 36423.5± 2398.3 (mean ± SD) in AHF patient and normals, respectively (p = 0.11). The mean lower region areas of both lungs were 17119.7±6461.1 and 39634.5± 4651.1 (mean ± SD) in AHF subjects and normals, respectively (p = 0.01). (Figure 1).



CONCLUSION. Distribution of vibration energy was shifted away from lower lung regions in patients with AHF compared to normal subjects. Pulmonary edema predominating in lower lung regions or pleural effusion (4 subjects had radiographic support for pleural effusion) may be the physiologic explanation.

REFERENCE(S). 1. Dellinger RP, Jean S, Cinel I, et al. Regional distribution of acoustic-based lung vibration as a function of mechanical ventilation mode. Crit Care. 2007 Feb 22;11(1):R26

0900

ALARM RULES IN INTENSIVE CARE MONITORING – A DATA DRIVEN APPROACH

W. Sieben*[1], S. Siebig[2], C. Wrede[2], M. Imhoff[3], U. Gather[1]
[1]Department of Statistics, University of Dortmund, Dortmund, [2]Department of Internal Medicine I, University Hospital Regensburg, Regensburg, [3]Department for Medical Informatics, Biometrics and Epidemiology, Ruhr-University Bochum, Bochum, Germany

INTRODUCTION. The high rate of false positive or clinically not relevant alarms from patient monitors is still a concern in critical care. False alarms are an issue even with the latest generation of monitoring devices and can cause mistrust in the alarm system. This reduces the caregivers' willingness to react to them, the so-called "crying wolf effect". Better alarm rules are needed to reduce the false alarm rate. Since it is very difficult, if not impossible, to set up universal rules from expert knowledge, machine learning techniques can be applied to deduct rules from annotated data.

METHODS. Complete high-resolution monitoring data was acquired from 55 critically ill patients on the medical ICU of the University Hospital Regensburg. All alarms were annotated as "true" or "false" by an intensivist. New alarm rules were learned from the data by a classification method called "Random Forrest". A Random Forrest is an ensemble of decision trees which "vote" for the class membership of an alarm situation. Usually, a situation is classified as not alarm relevant, if more than c=50% of the trees vote for this. Misclassification of an alarm relevant situation as not alarm relevant may be considered more dangerous than vice versa. Therefore, the probability of such classification needs to be controlled. The alarm system must achieve certain sensitivity with maximum specificity. The analogy of this classification problem to statistical testing is used to choose a suitable cut off value c that enables us to adjust the sensitivity of the resulting alarm system. The database comprising 2749 annotated alarm situations was divided randomly into learning, estimation and test sets 1050 times. 1050 forests were grown on the learning samples which incorporated the new alarm rules. These forests were used to calculate the cut off value on the estimation sets. Performance of each forest was evaluated by applying it to the test set.

RESULTS. For a chosen sensitivity of 95% which was achieved on average false alarms were reduced by 46% on average. The same evaluation was also done with a chosen sensitivity of 98% where the false alarms could be reduced by 30% on average.

CONCLUSION. In our study the use of a Random Forrest approach led to a reduction of false alarms from a standard patient monitor by 46% and 30% on average with a chosen sensitivity of 95% and 98% respectively. Such data driven approach may improve future alarms systems by enhancing specificity while maintaining adequate sensitivity.

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0901

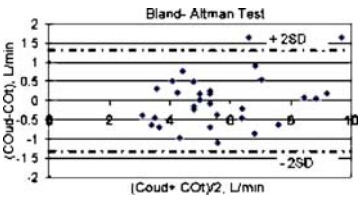
VALIDATION OF NEW CARDIAC OUTPUT ULTRASOUND DILUTION METHOD IN CARDIAC ICU PATIENTS

A. A. Eremenko*, P. N. Safarov
Cardiac ICU, National Research Center of Surgery Russian Academy of Medical Science, Moscow, Russian Federation

INTRODUCTION. Existing cardiac output (CO) dilution methods that are less invasive than pulmonary artery (PA) thermodilution have limitations. Some of them use toxic substances (LiDCO); some require a dedicated arterial catheter inserted (Pulsion). None of them can be routinely used in small children. First animal (rats, pigs, sheep) validation of a novel ultrasound dilution cardiac output (COud) method was presented at the 2006 ESICM meeting [1]. This method utilizes the decrease in blood ultrasound velocity caused by injecting isotonic saline. The purpose of this study was to compare the COud measurements with CO measured by PA thermodilution (COt) in humans.

METHODS. Twelve adult ICU patients (10–bypass surgery; 2–after implantation of Impella Recover LP 5.0 System) were studied. For COud measurements, a disposable extracorporeal AV loop filled with 3 ml of heparinized saline was connected between an existing radial artery catheter and PA catheter introducer. Reusable ultrasound sensors were clamped on the arterial and venous limbs of the loop. A peristaltic pump (Nipro, Japan) was used to circulate the blood from the artery to the vein at 8-12 ml/min for 5-7 min. Two to three (later averaged) COud measurements (HCP101, Transonic Systems Inc., USA) were obtained by injecting 20-25 ml of body temperature isotonic saline into the venous limb of the AV loop. At the end, the system was flushed with heparinized saline until the next measurement session. Five COt measurements were obtained by thermodilution (Nihon Koden, Japan). Three readings were averaged (largest and the smallest were ignored). For comparison, COud measurements were started within 3-5 minutes after thermodilution measurements.

RESULTS. A total of 31 comparison measurements were obtained. Correlation was R^2= 0.88. Linear regression was COud = 1.06 COt - 0.34 L/min. Bland-Altman test (Fig 1) did not show a significant bias (-0.01 L/min).



CONCLUSION. First clinical comparison of CO by ultrasound dilution with PA thermodilution produced good agreement. This method works with central venous and arterial catheters routinely used in ICU patients, utilizes innocuous indicator, thus can be used with patients of any age and at any time in the treatment.

REFERENCE(S). 1. Gleed RD, et al. ESICM, 2006; 32: S172.

0902

REFINING THE ENHANCED MODEL PREDICTIVE CONTROL ALGORITHM USING TIME VARIANT SAMPLING FOR TIGHT GLYCEMIC CONTROL IN THE ICU

S. J. Van Cromphaut*[1], I. van den Heuvel[1], D. Vlasselaers[1], P. J. Wouters[1], L. Chassin[2], G. Wilinska[2], R. Hovorka[2], G. Van den Berghe[1]
[1]Intensive Care Medicine, University Hospital, Leuven, Belgium, [2]Paediatrics, Addenbrooke's Hospital, Cambridge, United Kingdom

INTRODUCTION. Tight glycemic control (TGC) in critically ill patients significantly improves clinical outcome. (1,2) Currently used algorithms to implement TGC are not always efficient. We developed a second version of a fully automated algorithm based on an enhanced model predictive controller (eMPC2), following the comparison between the first eMPC with the routinely used insulin algorithm in the ICU.

METHODS. In a first study, patients were included for 72 consecutive hours and randomized either to the control group (n=10) treated by our routine insulin algorithm or to the eMPC1 group (n=10). A follow-up study evaluated an adapted eMPC2 algorithm in 16 patients for 120 consecutive hours. Target range for blood glucose (BG) was 80–110 mg/dl for all groups. Safety was assessed by the number of hypoglycemic events (BG<40mg/dl). Efficacy was assessed by calculating time-to-BG-target (BG<110mg/dl), hyperglycemic index (HGI) (3) and sampling frequency (SF).

RESULTS. There were no hypoglycemic events and time-to-BG-target was not significantly different in the 3 study groups. HGI was significantly higher at day 1 (p<0.05; Table 1), but not statistically different among the 3 groups at any time point. HGI was lower than the target of 27 mg/dl in all cases. SF was significantly higher at any time point in the eMPC1 group, whereas the eMPC2 group showed the same pattern as the standard group (p<0.05; Table 1). HGI and SF remained low on day 4 and 5 of the eMPC2 study.

TABLE 1.

	HGI (mg/dl) Standard	HGI (mg/dl) eMPC1	HGI (mg/dl) eMPC2	SF (#/d) Standard	SF (#/d) eMPC1	SF (#/d) eMPC2
Day 1	11.4 (± 2.1)	14.4 (± 2.4)	11.0 (± 3.2)	12 (± 1)	18 (± 1)*	13 (± 1)
Day 2	1.5 (± 1.0)*	1.4 (± 0.5)*	4.7 (± 1.1)*	8 (± 1)*	11 (± 1)£	8 (± 1)*
Day 3	1.1 (± 0.6)*	3.4 (± 1.2)*	3.9 (± 1.2)*	8 (± 2)*	12 (± 2)§	7 (± 1)*

**p<0.05 vs. Standard day 1; £p<0.05 vs. Standard day 2;*
§p<0.05 vs. Standard day 3

CONCLUSION. Use of eMPC in the ICU is safe and efficient in patients with prolonged mechanical ventilation. The refined algorithm eMPC2 resulted in a decreased workload, comparable to the use of our standard ICU insulin protocol. eMPC2 is a reliable tool for the implementation of TGC in the ICU.

REFERENCE(S). 1 Van den Berghe G, NEJM 2001;345:1359-67. 2 Van den Berghe G, NEJM 2006;354:449-61. 3 Vogelzang, CritCare 2004; 8:122

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