Respiratory mechanic with elastance derived calculation of relative end inspiratory using a simulator of artificial ventilation (SimVA), comparison between real and virtual ARDS patients.

Hadrien Rozé MD, PhD [a], Rémi Dubois, PhD [b]
[a]*SAR2, Réanimation Magellan, CHU de Bordeaux, Pessac-Bordeaux, France*
[b]*IHU LIRYC, Electrophysiology and Heart Modeling Institute, Foundation Bordeaux University, Pessac-Bordeaux, France*

Simulation in intensive care is an innovative method for teaching. Respiratory settings are responsible for some morbi-mortality of our patient. For this reason we develop a simulator of artificial ventilation (SimVA) and virtual ARDS patients. Mathematical model resolved differential equations of chest and lung movements in order to match with a clinical ARDS data base. Transpulmonary pressure has been shown to improve oxygenation and avoid ECMO in ARDS patients with abnormal chest wall elastance[1]. The goal of this study was to evaluate and compare virtual ARDS patient's respiratory mechanic with the results of this study.

Method: Virtual cases had ARDS, defined by various chest wall and pulmonary compliance, total resistance, lung volumes, pressure-volume relation, pressure and volume recruitment coefficients. Patients had initially the ARDS network lung protective protocol.[2]The pressure required to distend each part of the respiratory system were calculated as follow:

$P_{L\ inspi\ rel}$ = $Pplat_{RS}$ x (1- E_{cw}/E_{rs}) where $Pplat_{RS}$ was end inspiratory plateau pressure of the respiratory system, $P_{L\ inspi\ rel}$ was the elastance derived calculation of relative end inspiratory transpulmonary pressure.

If $P_{L\ inspi\ rel}$ was below 25 cmH_20, PEEP was increased in order to reach that level of pressure.

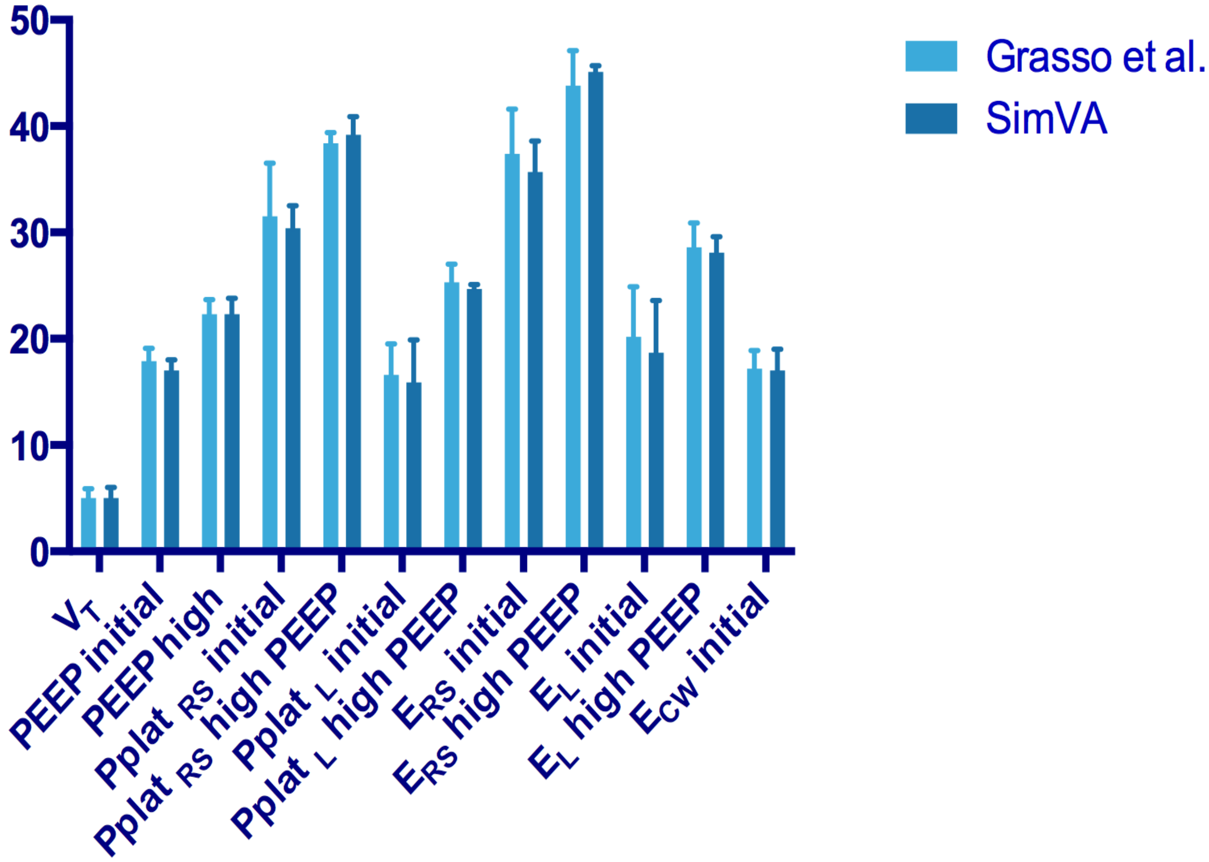
Respiratory mechanic after titration was recorded and compared to results of the study by Grasso et al.[1]

Results: 7 real patients and 6 virtual cases were compared

Protocols	**PEEP initial**		**PEEP high**	
Patients	**Real**	**Virtual**	**Real**	**Virtual**
V_T ml	5(0,9)	5(1)	5 (0,9)	5(1)
$Pplat_{RS}$ cmH_20	31,5(5)	30,4 (2,1)	38,4 (1,0)	39,2(1,7)
PEP cmH_20	17,1(1,6)	17,9 (0,7)	22,3 (3,6)	22,3 (1,5)
$P_{L\ inspi\ rel}$ cmH_20	16,6 (2,9)	15,9 (4)	25,3 (1,7)	24,7 (0,4)
E_{rs} cmH_20/L	37,4 (4,2)	35,7 (2,9)	43,8 (3,3)	45,1 (0,6)
E_L cmH_20/L	20,2 (4,7)	18,7 (4,9)	28,6 (2,3)	28,1 (1,5)
E_{CW} cmH_20/L	17,2 (1,7)	17 (2)	15,2 (2,6)	17 (2)
E_{CW} / E_{rs}	0,47 (0,08)	0,48 (0,09)	0,47 (0,08)	0,37 (0,04)
RR cycle/min	31(6,0)	31,0(1,0)	31(6,0)	31,0(1,0)
Vm L/min	11,5(4,5)	11,3(10,3)	13,0(2,0)	11,3(0,3)

E_{RS}= Respiratory System Elastance ; E_L= Lung Elastance; Ecw= Elastance of the chest wall, RR= respiratory rate; Vm=minute ventilation.

The protocols defined PEEP level, the software calculates the corresponding values of inspiratory pressures and elastances. The difference between virtual cases and patients were not significant (Table and Figure).



Discussion: Elastances and $P_{L\ inspi\ rel}$ were able to change according to PEEP settings within the same range as the study from Grasso et al.[1] These settings in real patients were able to increase significantly PaO_2/FiO_2 ratio and avoid VV-ECMO. Simulation with the software SimVA is realistic and may help to teach interactively $P_{L\ inspi\ rel}$ monitoring in different cases of ARDS patients anywhere anytime without any risk for the patient.

1. *Intensive Care Med. 2012;38:395-403*
2. *N Engl J Med. 2000;342:1301-8*