

Respiratory Monitoring and Integrated Displays

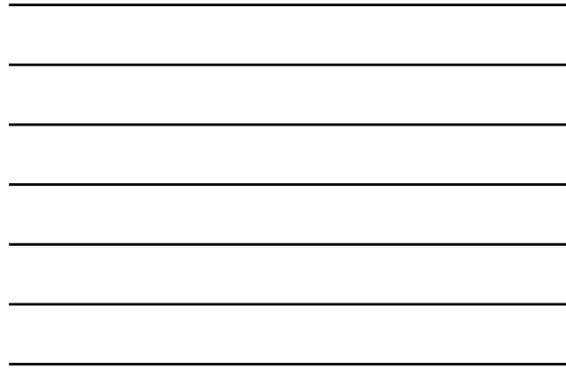
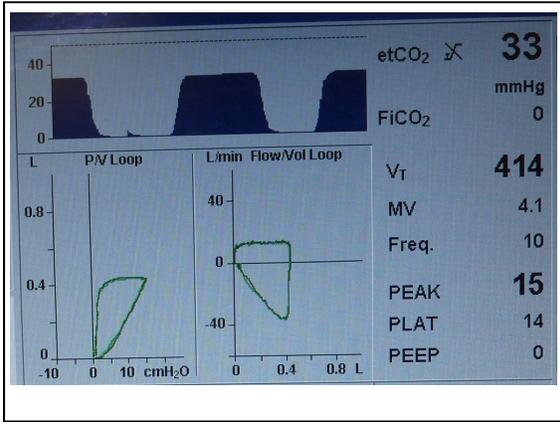
Robert "Butch" Loeb
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How it was

Volume Control	Airway pressure
TV 700, RR 10	Tidal volume
Oxygen / Nitrous	FiO ₂
	Blood Gases

How it is

Volume Control	Airway pressure
Pressure Control	Inspiratory/Expiratory Flow
Pressure Support	Inspiratory/Expiratory Volume
SIMV	Respiratory Gases
Volume guarantee	Blood oxygen saturation
APRV?	Tissue oxygen saturation
PEEP / CPAP	Blood gases
Optimized ventilation	
Minimized volume	
Permissive hypercapnia	
Oxygen / Air / Nitrous	
Risk of hyperoxia	



Time	Alarm/Event	etCO ₂ mmHg	O ₂ insp/peep	P _{lim} Agmt	MIC insp/peep	P _{lim} MV	PEAK/PEEP	Time	Alarm/Event	V _T	Freq.
13:54		29	91 / 89	1.9 / 1.8	0.2 / 0.3	13 / 5	5.8	13:54		646	15
13:55		29	91 / 87	2.0 / 1.8	0.2 / 0.3	12 / 5	10.8	13:55		765	14
14:00		24	91 / 87	2.4 / 2.1	0.3 / 0.3	10 / 5	11.3	14:00		563	20
14:10		23	90 / 88	2.6 / 2.3	0.3 / 0.3	10 / 6	11.2	14:10		562	20
14:20		22	91 / 89	2.7 / 2.4	0.3 / 0.3	10 / 6	11.1	14:20		563	20
14:15		21	90 / 89	2.8 / 2.5	0.3 / 0.3	10 / 6	11.0	14:15		549	20
14:20		20	90 / 87	2.7 / 2.3	0.3 / 0.3	10 / 5	8.0	14:20		612	13
14:25		29	90 / 86	3.1 / 2.5	0.4 / 0.4	10 / 5	5.8	14:25		563	10
14:30		30	90 / 86	3.3 / 2.7	0.4 / 0.4	10 / 5	5.7	14:30		565	10
14:35		31	90 / 86	3.4 / 2.9	0.4 / 0.4	10 / 5	5.4	14:35		537	10
14:40		31	90 / 86	3.4 / 2.9	0.4 / 0.4	10 / 5	5.5	14:40		552	10
14:45		30	89 / 85	3.6 / 3.0	0.4 / 0.4	10 / 5	5.5	14:45		548	10
14:50		32	89 / 85	3.6 / 3.1	0.4 / 0.4	10 / 5	5.5	14:50		557	10
14:55		32	89 / 85	3.7 / 3.1	0.4 / 0.4	10 / 5	5.4	14:55		536	10
15:00		33	89 / 85	3.7 / 3.2	0.4 / 0.4	10 / 5	5.5	15:00		645	10
15:05		31	89 / 84	3.7 / 3.3	0.5 / 0.5	10 / 5	5.5	15:05		547	10
15:10		31	88 / 84	3.7 / 3.3	0.5 / 0.5	10 / 5	5.5	15:10		653	10

V_T 405 Min Flow Required



Time	Temp	SpO ₂	HR	RR	EtCO ₂	FiO ₂	P _{lim}	MIC	P _{lim} MV	PEAK/PEEP	V _T	Freq.
13:54	36.5	98	70	18	29	0.21	1.9	0.2	13	5.8	646	15
13:55	36.5	98	70	18	29	0.21	1.9	0.2	12	5.7	765	14
14:00	36.5	98	70	18	24	0.21	2.4	0.3	10	5.4	563	20
14:10	36.5	98	70	18	23	0.21	2.6	0.3	10	5.5	562	20
14:20	36.5	98	70	18	22	0.21	2.7	0.3	10	5.4	563	20
14:15	36.5	98	70	18	21	0.21	2.8	0.3	10	5.5	549	20
14:20	36.5	98	70	18	20	0.21	2.7	0.3	10	5.4	612	13
14:25	36.5	98	70	18	29	0.21	3.1	0.4	10	5.8	563	10
14:30	36.5	98	70	18	30	0.21	3.3	0.4	10	5.7	565	10
14:35	36.5	98	70	18	31	0.21	3.4	0.4	10	5.4	537	10
14:40	36.5	98	70	18	31	0.21	3.4	0.4	10	5.5	552	10
14:45	36.5	98	70	18	30	0.21	3.6	0.4	10	5.5	548	10
14:50	36.5	98	70	18	32	0.21	3.6	0.4	10	5.5	557	10
14:55	36.5	98	70	18	32	0.21	3.7	0.4	10	5.4	536	10
15:00	36.5	98	70	18	33	0.21	3.7	0.4	10	5.5	645	10
15:05	36.5	98	70	18	31	0.21	3.7	0.5	10	5.5	547	10
15:10	36.5	98	70	18	31	0.21	3.7	0.5	10	5.5	653	10



Graphical Displays

- * Graphs and Charts
- * Object or Configural displays
- * Ecologic displays
- * Metaphor displays

Example Object Displays

Kinetics Flow

Right Heart Left Heart

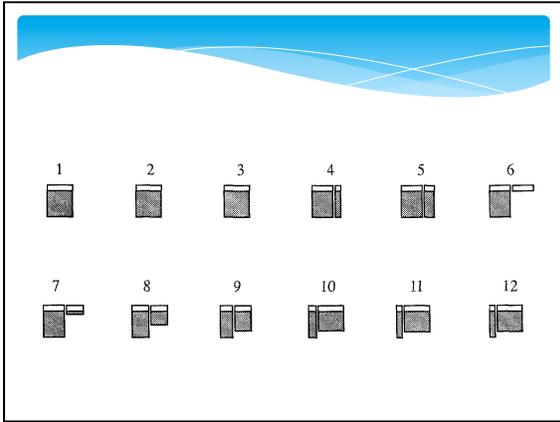
Simple Ecologic Display

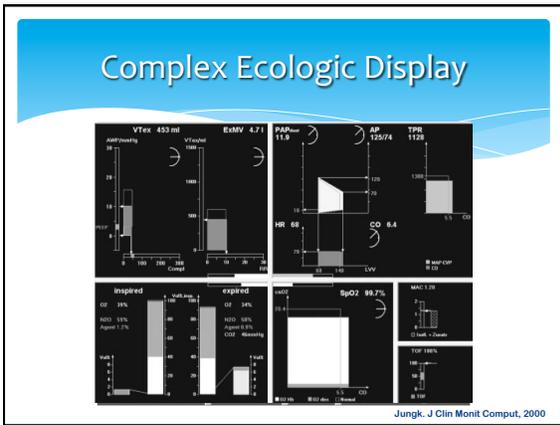
Vent rate Spont rate

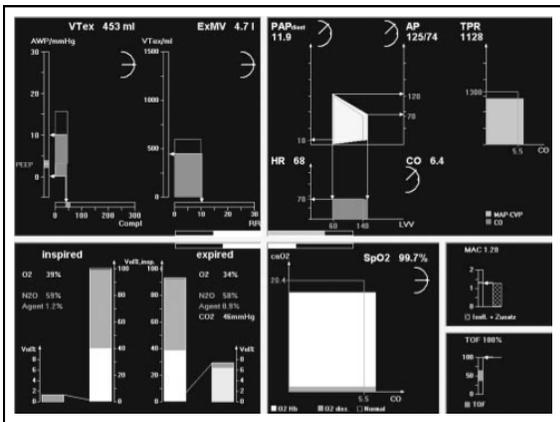
Vent volume Spont volume

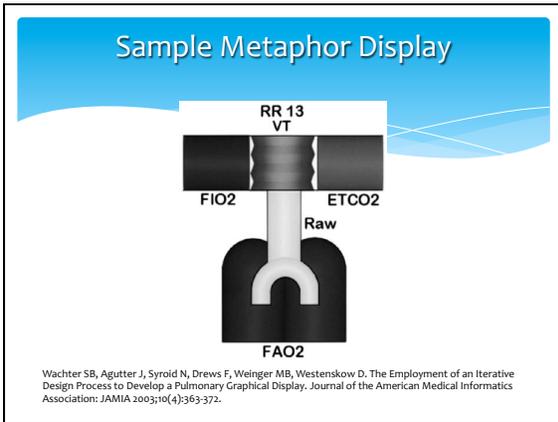
FI02

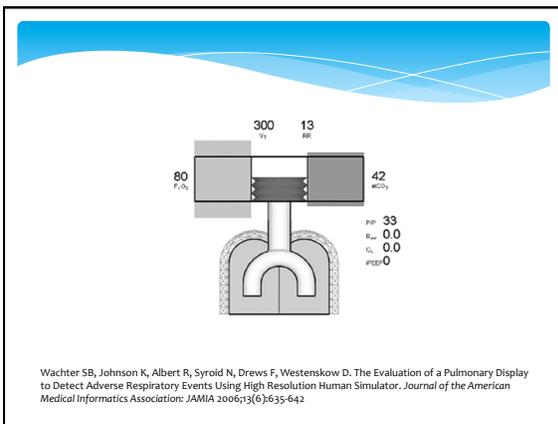
Cole, William G., and James G. Stewart. "Metaphor graphics to support integrated decision making with respiratory data." *International journal of clinical monitoring and computing* 10.2 (1993): 91-100.

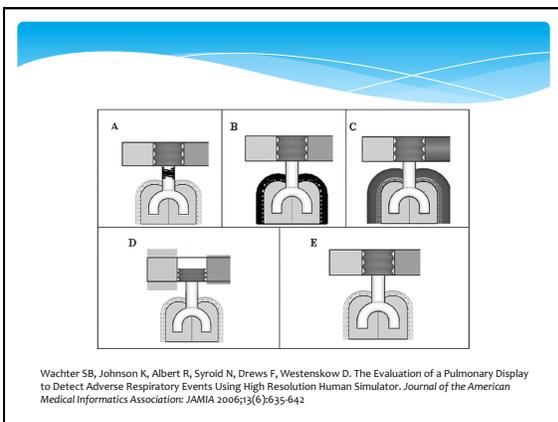












Measurable Variables

- * Airway flows and volumes
 - * Insp flow, Exp flow, Peak flow, Insp TV, Exp TV
- * Airway pressures
 - * PEEP, PIP, Pplateau, MAP
- * Respiratory rate
- * Respiratory gases
 - * Insp and Exp O₂, Insp and Exp CO₂
- * Blood gases
 - * Arterial and Mixed Venous O₂ and CO₂
- * Hemoglobin saturations
 - * SpO₂, SaO₂, SvO₂, co-oximetry, tissue oximetry
- * Circulation
 - * Arterial and venous blood pressures, cardiac output
- * MV, Raw, Cdyn, Cstat

Measurable Variables

- * Airway flows and volumes
 - * Insp flow, Exp flow, Peak flow, Insp TV, Exp TV
- * Airway pressures
 - * PEEP, PIP, Pplateau, MAP
- * RR
- * Respiratory gases
 - * FiO₂, FeO₂, FiCO₂, ETCO₂
- * Blood gases
 - * Arterial and Mixed Venous O₂ and CO₂
- * Hemoglobin saturations
 - * SpO₂, SaO₂, SvO₂, co-oximetry, tissue oximetry
- * Circulation
 - * Arterial and venous blood pressures, cardiac output
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Abstraction Hierarchy

- * Oxygenation
- * Ventilation
- * Pulmonary Mechanics
- * Pulmonary/Cardiovascular Interaction

Abstraction Hierarchy Oxygenation

- * Mixed Venous Oxygen
- * Oxygen consumption
- * Oxygen delivery
 - * Blood flow
 - * Oxygen content
 - * Hemoglobin concentration
 - * Saturation
 - * PaO₂
 - * Lung factors: Shunt, PEEP, PAO₂
 - FiO₂**
- * Hemoglobin dissociation curve, Dyshemoglobins

Abstraction Hierarchy Ventilation

- * PaCO₂ (**ETCO₂**)
- * CO₂ Production
- * CO₂ Clearance (V_{CO₂})
 - * Alveolar ventilation (E_{mixed}CO₂)
 - * Minute ventilation
 - * Tidal volume
 - * **Respiratory rate**
 - * Dead space
 - * Anatomic
 - * Alveolar

Abstraction Hierarchy Pulmonary Mechanics

- * Airway Pressure / Tidal Volume
- * Airway Resistance (**R_{aw}**)
 - * Large airway
 - * Small airway
 - * Lung volume
- * Pulmonary Compliance (**C_{dyn}**)
 - * Lung
 - * Chest wall
 - * Neuromuscular relaxation
 - * Abdominal compliance

