



# Eye-tracking in neonatal intensive care: physicians' visual attention when evaluating the monitoring screen of a ventilator

Pâmella CP Franco<sup>1</sup>, Marina CM Barros<sup>1</sup>, Simone YT Assunção<sup>1</sup>, Roberto G Magalhães Jr<sup>2</sup>, Beatriz M Mello<sup>1</sup>, Rafael N Osri<sup>2</sup>, Ana Silvia M Scavacini<sup>1</sup>, Tatiany M Heiderich<sup>2</sup>,  
Mandira D Kawakami<sup>1</sup>, Milton Harumi Miyoshi<sup>1</sup>, Maria Fernanda B de Almeida<sup>1</sup>, Carlos E Thomaz<sup>2</sup>, Ruth Guinsburg<sup>1</sup>

1 - Escola Paulista de Medicina, Universidade Federal de São Paulo (EPM-Unifesp); 2- Centro Universitário Fundação Educacional Inaciana Padre Saboia de Medeiros (FEI)

neonatal@unifesp.br



## BACKGROUND

- ✓ Mechanical ventilation is a common procedure in neonatal intensive care units, utilized by 24%-49% of newborns (Chow et al., 2024)
- ✓ Adjusting ventilatory parameters is complex, and improper management can lead to clinical complications and prolonged hospital stays (Auriant et al., 2002)
- ✓ Visual tracking enables the identification of physicians' visual attention when assessing ventilator panels (Sqalli et al., 2023)
- ✓ **No studies have evaluated physicians' visual focus on ventilator panels during decision-making regarding ventilator adjustments for newborns**
- ✓ **HYPOTHESIS:** In neonatal intensive care, physicians evaluating ventilator panels, when exposed to multiple pieces of information, do not attend to all available data

## OBJECTIVE

- Assess physicians' visual attention when evaluating a mechanical ventilator panel to decide whether to adjust parameters in a newborn on mechanical ventilation
- ✓ Examine differences in physicians' visual attention when presented with clinical scenarios hypoxemia, hypercapnia, and normal blood gases
- ✓ Compare the visual attention patterns of physicians with or without specialization in neonatal/pediatric intensive care

## METHOD

- ✓ **Design:** Experimental study from Feb-Aug/2022
- ✓ **Ethics:** Unifesp IRB approval CAAE # 52924421.0.0000.5505
- ✓ **Setting:** Hospital São Paulo - Escola Paulista de Medicina - Unifesp
- ✓ **Population**
  - Inclusion criteria: trainees or trained physicians in pediatrics, neonatology or pediatric intensive care
  - Exclusion criteria: profound visual impairment, improper calibration of visual tracking equipment, or ocular signal capture below 70% of the experiment duration
- ✓ **Sample size:** calculation was based on a study on physicians' gaze tracking during newborn pain assessment showing that gaze fixation on key facial regions occurred 80% of the time (*Silva et al, 2023*). Considering an alpha risk of 5% and an error of 10%, 62 participants would be required. Accounting for a 40% loss due to ocular signal non-capture, 87 participants should be included
- ✓ **Population data collected:** sex, age, degree and specialization in pediatrics, neonatology or pediatric intensive care, years working in NICU and/or PICU, weekly workload in NICU and/or PICU, experience with the iX5<sup>®</sup> ventilator, and anxiety assessment by Beck Inventory for Anxiety

## Room and Equipment

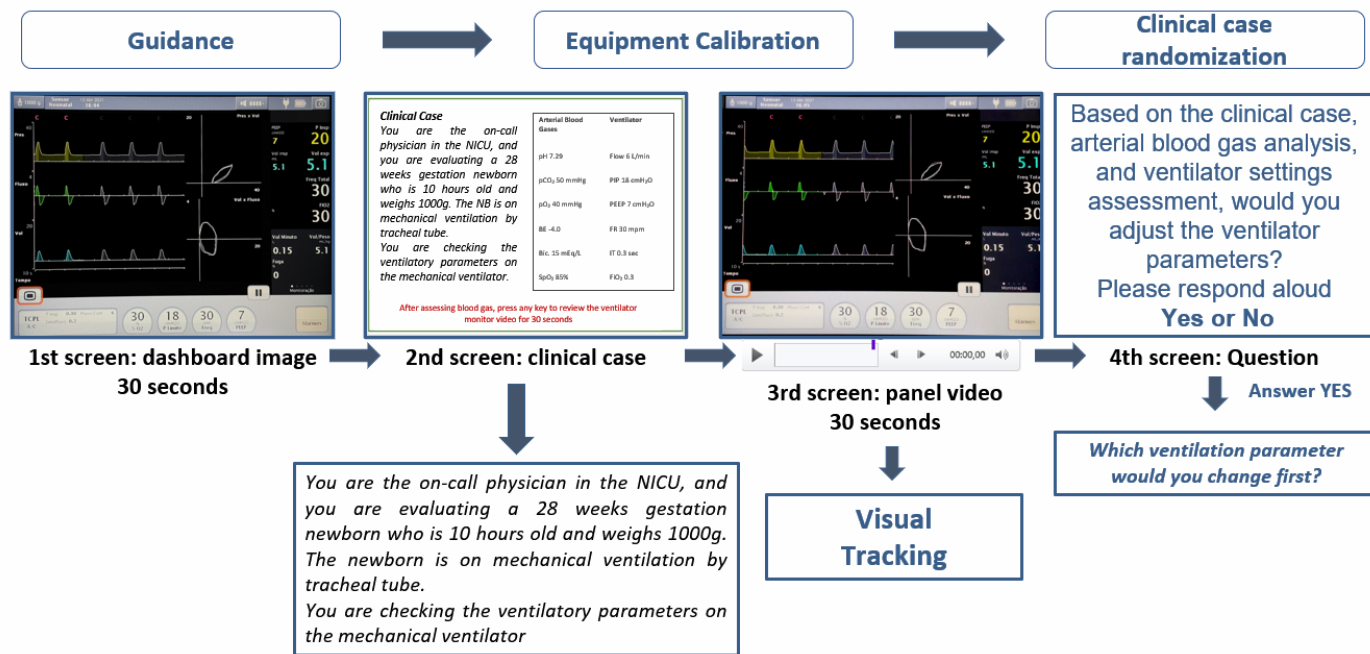


Room with artificially controlled light



Tobii model TX300 ®  
(Tobii Technology AB, Danderyd, Sweden)  
Tracking module; 23-inch TFT monitor; Infrared lighting; 2 capture cameras

## Experiment



## Statistical Methods

- ✓ **Comparison of visual tracking outcomes by clinical case:** hypoxemia, hypercapnia, normal blood gas
  - Gazed fixed on AOI (Yes or No): chi-square test
  - Number and duration of visual fixations on AOI: adjusted MANOVA: Beck Anxiety Inventory score (<4 vs. >4) and experience with the iX5<sup>®</sup> ventilator (Yes vs. No)
- ✓ **Comparison of visual tracking outcomes by level of expertise:** specialization in neonatology or pediatric intensive care medicine
  - Gazed fixed on AOI (Yes or No): chi-square test
  - Number and duration of visual fixations on AOI: adjusted MANOVA: Beck Anxiety Inventory score (<4 vs. >4), experience with the iX5<sup>®</sup> ventilator (Yes vs. No), and clinical case (hypoxemia, hypercarbia, and normal blood gas)
- ✓ **SPSS program for Win/v.20** (IBM SPSS Statistics, Somers NY)

## Clinical cases

### Hypoxemia

Arterial blood gas	Adjusted parameters
pH 7.29	Flow 6 L/min
pCO <sub>2</sub> 50 mmHg	PIP 18 cmH <sub>2</sub> O
pO <sub>2</sub> 40 mmHg	PEEP 7 cmH <sub>2</sub> O
BE -4.0	RR 30 mpm
Bic. 15 mEq/L	IT 0.30 sec
SpO <sub>2</sub> 85%	FiO <sub>2</sub> 0.3



### Hypercapnia

Arterial blood gas	Adjusted parameters
pH 7.17	Flow 6 L/min
pCO <sub>2</sub> 80 mmHg	PIP 16 cmH <sub>2</sub> O
pO <sub>2</sub> 50 mmHg	PEEP 5 cmH <sub>2</sub> O
BE -6.0	RR 40 mpm
Bic. 16 mEq/L	IT 0.35 sec
SpO <sub>2</sub> 91%	FiO <sub>2</sub> 0.3



### Normal blood gases

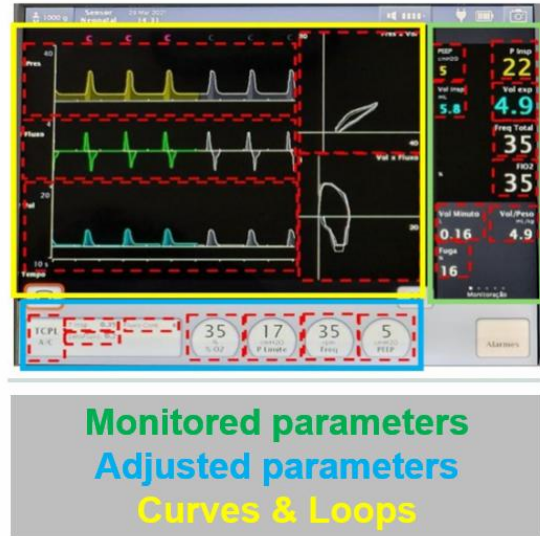
Arterial blood gas	Adjusted parameters
pH 7.32	Flow 6 L/min
pCO <sub>2</sub> 48 mmHg	PIP 15 cmH <sub>2</sub> O
pO <sub>2</sub> 67 mmHg	PEEP 5 cmH <sub>2</sub> O
BE -3.5	RR 35 mpm
Bic. 18 mEq/L	IT 0.35 sec
SpO <sub>2</sub> 94%	FiO <sub>2</sub> 0.35



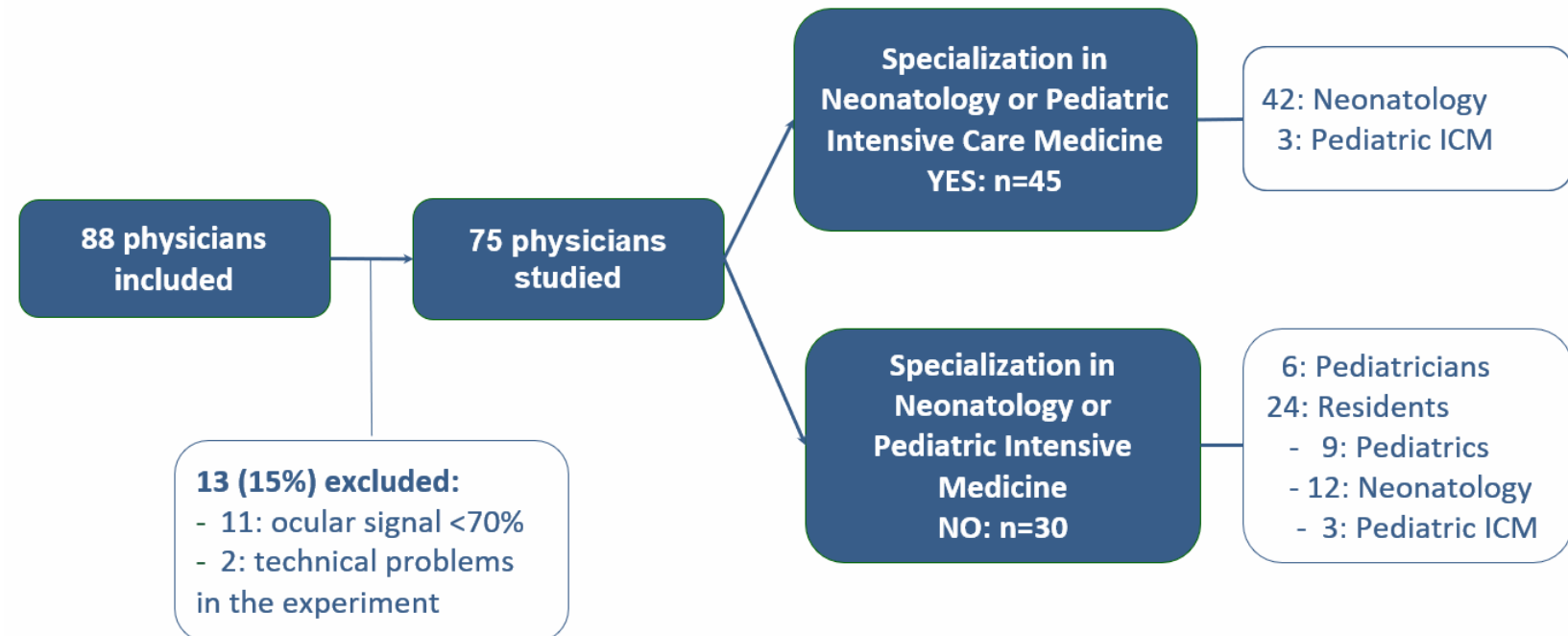
## Studies outcomes

10 seconds of the visual tracking were analyzed for:

- ✓ Areas of Interest (AOI)
  - Monitored parameters
  - Adjusted parameters
  - Curves and Loops
- ✓ Outcomes in the AOI
  - Gaze fixed (Yes vs. No)
  - Number of visual fixations
  - Time of visual fixations (seconds)



## Flow diagram of included participants



## Visual tracking of physicians during video

Eye signal capture	Gaze fixation on the AOI:
10 seconds	- Number of fixations: 32.79 ± 5.72
95.2±4.7%	- Fixation time: 7.96 ± 1.17seconds

	Monitored Parameters	Adjusted Parameters	Curves & Loops
Gaze fixation n (%)	71 (94.7)	60 (80.0)	75 (100.0)
Fixation number	8.03 ± 5.98	5.40 ± 5.00	14.72 ± 7.64
Fixation time (seconds)	2.07 ± 1.61	1.21 ± 1.29	3.71 ± 2.12

Shortest visual fixation time  
Intermediate visual fixation time  
Longest visual fixation time

## Participants' characteristics according to expertise in neonatology/pediatric intensive care

	Expert n=45	Non-Expert n=30	p-value
Female	39 (87%)	24 (80%)	0.526*
Age (years)	40 ± 9	30 ± 3	<0.001*
Years since medical graduation	15 ± 10	4 ± 2	<0.001*
Pediatric Residency	45 (100%)	21 (70%)	<0.001*
Years since residency graduation	12.9 ± 9.9	0.7 ± 1.0	<0.001*
Anxiety score ( <i>Beck et al, 1988</i> )	4.0 ± 2.8	6.9 ± 5.7	0.013*
Experience with the iX5 <sup>®</sup> mechanical ventilator	44 (98%)	18 (60%)	<0.001*
Clinical case evaluated [n (%)]			0.092
1 - Hypoxemia	20 (44%)	6 (20%)	
2 - Hypercapnia	13 (29%)	12 (40%)	
3 - Normal blood gases	12 (27%)	12 (40%)	

\*Student's t-test; \*chi-square test

## RESULTS

### Participants' characteristics

	Studied physicians n=75	Excluded physicians n=13	p-value
Female	63 (84%)	13 (100%)	0.200*
Age (years)	33 (30 – 39)	29 (29 – 33)	0.305*
Years since medical graduation	6 (4 – 14)	4 (3 – 7)	0.672*
Pediatric residency	66 (88%)	11 (85%)	0.663*
Years since Pediatrics residency graduation	4 (1.0 – 13.0)	3.0 (0.5 – 6.5)	0.889*
Neonatology/Pediatric Intensive Care fellowship	45 (60%)	6 (46%)	0.377*
Years since fellowship graduation	7 (2 – 18) <sup>#</sup>	4 (3 – 16) <sup>##</sup>	0.701*
Neonatal/Pediatric ICU weekly workload (hours)	48 (36 – 60)	60 (48 – 60)	0.507*
Anxiety score ( <i>Beck et al, 1988</i> )	4.0 (2.0 - 6.5)	4.0 (1.0 – 10.0)	0.983*
Experience with the iX5 <sup>®</sup> mechanical ventilator	62 (83%)	9 (69%)	0.267*

<sup>#</sup>43 physicians; <sup>##</sup>19 physicians; \*Student's t-test; \*chi-square test

### Visual tracking according to clinical case

	Case 1 Hypoxemia n=26	Case 2 Hypercapnia n=25	Case 3 Normal n=24	p-value*
<b>Gaze Fixation [n (%)]</b>				
- Monitored parameters	24 (92%)	25 (100%)	22 (92%)	0.346*
- Adjusted parameters	22 (85%)	20 (80%)	18 (75%)	0.697*
- Curves & loops	26 (100%)	25 (100%)	24 (100%)	
<b>Number of fixations</b>				0.465*
- Monitored parameters	7.50 ± 5.86	9.04 ± 6.50	7.54 ± 5.66	
- Adjusted parameters	5.62 ± 4.90	6.12 ± 4.99	4.42 ± 5.17	
- Curves & loops	16.69 ± 8.42	12.32 ± 6.59	15.08 ± 7.39	
<b>Fixation time (seconds)</b>				0.458*
- Monitored parameters	1.73 ± 1.46	2.48 ± 1.53	2.00 ± 1.82	
- Adjusted parameters	1.15 ± 1.05	1.56 ± 1.42	0.92 ± 1.35	
- Curves & loops	3.92 ± 2.21	3.32 ± 1.99	3.87 ± 2.17	

\*Chi-square test; \*MANOVA: adjusted for anxiety score and experience with mechanical ventilator

### Visual tracking according to expertise

	Expert n=45	Non-Expert n=30	p-value
<b>Gaze Fixation [n (%)]</b>			
- Monitored parameters	42 (93%)	29 (97%)	0.646*
- Adjusted parameters	35 (78%)	25 (83%)	0.769*
- Curves & loops	45 (100%)	30 (100%)	
<b>Number of fixations</b>			0.012*
- Monitored parameters	7.49 ± 6.01	8.83 ± 5.95	
- Adjusted parameters	3.98 ± 3.99	7.53 ± 5.64	
- Curves & loops	15.78 ± 7.84	13.13 ± 7.17	
<b>Fixation time (seconds)</b>			0.018*
- Monitored parameters	2.02 ± 1.66	2.13 ± 1.57	
- Adjusted parameters	0.80 ± 0.97	1.83 ± 1.46	
- Curves & loops	4.02 ± 2.26	3.23 ± 1.81	

#### Post-hoc analysis of the differences

Difference in adjusted parameters

- Number of fixations (p=0.004)
- Fixation time (p=0.002)

## DISCUSSION

- ✓ Physicians exhibited greater gaze fixation on curves and loops when evaluating a mechanical ventilator panel to determine whether ventilation parameters should be adjusted. This preference likely reflects the higher cognitive demand of these dynamic stimuli compared to numerical values, as they require more time for analysis
- ✓ The consistency in physicians' gaze fixation across ventilator panels representing hypoxemia, hypercapnia, or normal blood gases suggests the existence of a common gaze pattern, regardless of the specific stimulus
- ✓ Physicians without expertise in neonatology or pediatric intensive care performed more visual fixations and maintained their gaze longer on adjusted parameters. This behavior may be attributed to their limited training in extracting and interpreting information from monitored parameters, including curves and loops

## CONCLUSIONS

- ✓ When assessing a ventilator panel to determine whether to adjust the settings, physicians primarily focus on curves and loops, followed by monitored and adjusted parameters
- ✓ Physicians' visual attention does not differ when evaluating ventilator panels under clinical conditions of hypoxemia, hypercapnia, or normal blood gases
- ✓ Compared to specialists in neonatology or pediatric intensive care, non-specialist physicians focus more on adjusted parameters

Understanding physicians' visual attention during ventilator panel assessment may enhance medical training, improving the safety and the efficiency of mechanical ventilation in critically ill newborns