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Electrodermal Activity Monitoring during Endotracheal Suction in Sedated Adult Intensive Care Unit Patients

Theodoros Aslanidis[1], Vasilios Grosomanidis[2], Konstantinos Karakoulas[3], Athanasios Chatzisotiriou[4]

[1] Intensive Care Unit, Department of Anesthesiology and Intensive Care Medicine, AHEPA General University Hospital, Thessaloniki, Greece
[2] Cardiothoracic Anesthesia Unit, Department of Anesthesiology and Intensive Care Medicine, AHEPA General University Hospital, Thessaloniki, Greece
[3] Department of Anesthesiology and Intensive Care Medicine, AHEPA General University Hospital, Thessaloniki, Greece
[4] Laboratory of Physiology, Medical School, Aristotle University of Thessaloniki, Thessaloniki, Greece

Correspondence:
Theodoros Aslanidis, National Center of Emergency Care, Thessaloniki Department, 4 Doridos Str., Thessaloniki, 54633, Greece
E-mail: thaslan@hotmail.com
Tel: +306972477166

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Background: Endotracheal suctioning of respiratory secretions is one of the most common causes of pain and discomfort in Intensive Care Unit environment. The electrical properties of the skin, also known as electrodermal activity (EDA), are considered as an indirect measure of autonomous nervous system.

Aim: This study explores EDA changes during endotracheal suction in sedated adult critical care patients; and compares these changes to other monitoring parameters.

Materials and methods: Skin conductance variability, selected hemodynamic and respiratory parameters, bispectral index (BIS) and ambient noise level, were monitored during 4 hour routine daytime intensive care nursing and treatment in an adult Intensive Care Unit. 4h-measurements were divided into 2 groups, based upon the sedation level (group A: Ramsay sedation scale 2-4 and group B: 5-6 respectively) of the patients. Selected recordings before and after endotracheal suction (stress events) were performed. Seven stress events from Group A and 17 from Group B were included for further analysis. Patients' demographics, laboratory exams and severity scores were recorded. Pain status evaluation before every event was also performed via 2 independent observers.

Results: In both groups the rate of EDA changes was greater than in other monitoring parameters. Yet, in group A only selected parameters were significantly changed after the start of the procedure, while in group B, every parameter showed significant change ($p<0.05$). Groups were similar for other co-founding factors.

Conclusion: EDA measurements are more sensitive to stress stimuli, than cardiovascular, respiratory or even BIS monitoring. Deeper sedation seems to affect more the intensity of EDA changes during suction.

BACKGROUND

Endotracheal suctioning of respiratory secretions is one of the most common procedures applied in Intensive Care Unit (ICU) environment.[1] Even though procedural guidelines for endotracheal suction have been developed[2-4], several local practice protocols are often used[1,5-6]. Low evidence of the existent guidelines is suggested as the reason for such discrepancy.[5]

In any way, endotracheal suction is unanimously recognized as one of the commonest causes of pain and stress during ICU hospitalization.[7,8] Therefore, measuring the effect of this particular stimulus is an important issue. Available literature is characterized by a diversity of studies' focuses. Some measure the effect of different types of suctioning (open or closed) via behavioral pain (BPS) or agitation scales[9], some measure the effect of different type of applied negative pressure on heart rate and oxygen saturation[10] and others the effect of the depth of suctioning (swallow or deep) to deferent cardiovascular indices[11-12]. Recently, there have been a few

reports about monitoring stress/pain during endotracheal suctioning via measuring selected lab markers (serum beta-endorphin and salivary alpha-amylase levels)[13], pain scales such as BPS[14], COMFORT sedation score[13], facial action coding system[14] or pupils' dynamics (digital pupillometry)[15].

Electrodermal activity (EDA) originates in the activation of skin sweat glands in response to stress or other stimuli and thought to reflect the activity of the sympathetic nervous system, or physiological arousal.[16] Though it has been studied since 19th century, the first report about application of EDA monitoring in perioperative setting was published in 2002.[17,18] Yet, the vast majority of literature is coming for operation room setting or post anaesthesia unit care and perioperative EDA measurements have been used mainly as analgesia index.[17] Only recently, there are reports about EDA measurements in adult[19-20] or peadiatric ICU environment[17,21]. Thus, the overall data are scarce.

Till the writing of the present article, EDA monitoring during endotracheal suction have been applied only in pediatric ICU population, with interesting results: when applied in children between 1-11 years old, the number of skin conductance fluctuations seems to be an objective supplement to the modified COMFORT sedation score for monitoring increased stress in artificially ventilated and circulatory stable children.[22-23] In neonatal intensive care the measurement of conductivity of the skin is an objective tool to measure pain and discomfort during invasive procedures despite the use of sedation and analgesia.[23]

The aim of the study was to measure EDA changes due to endotracheal suction stimulation in adult ICU patients under sedation, and to compare these changes with cardiovascular/respiratory effects of the same stress (suction) stimulus.

MATERIALS AND METHODS

This prospective observational study was conducted at the adult general ICU, at AHEPA General University Hospital, Thessaloniki, Greece. Twenty five (25) measurements in critically ill patients under sedation, above 18 years old, were included in the study. Other inclusion criteria were administered mechanical ventilation > 24 h and constant sedation level under midazolam or propofol continuous intravenous infusion (c.i.v.). On the contrary, patients with Ramsay sedation score (RSS) 1, diagnosed or with history of hearing problems, psychiatric disorders, neurological diseases, neuro- or myopathy, delirium, CNS or spinal cord injury, were excluded. Also as exclusion criteria were considered pregnancy, hemodynamic/respiratory instability, edema of the upper limbs (place of measurement) and the presence of sensitive electrical life-sustainable devices such as cardiac pace, renal replacement therapy devices, intra-abdominal aortal counterpulsion pump, extracorporal membrane oxygenation and artificial liver.

Skin conductance (SC) variability, selected hemodynamic and respiratory parameters were monitored during 4 hour routine daytime intensive care nursing and treatment. Measurements were divided into 2 categories according to patients' sedation level: group A – RSS 2-4 (n_a=10) and group B – RAS 5-6 (n_b =15).

Med Storm Pain Monitor System (MED Storm® Innovation AS, Oslo, Norway) was used as SC monitor.[24] Three single use Ag/Cl electrodes were attached at the palmar surface of the hand: on the thenar eminence (current), on the hypothenar eminence (measurement) and just below 2nd and 3rd digits (reference). In order to minimize artifacts, the hand least likely to move, with no intravenous or intra-arterial lines was chosen. SC was measured by alternating current of 66 Hz and an applied voltage of 50 mV. SC parameters recorded were: absolute SC (in μS), peaks/sec or number of SC fluctuations per second (NSCF), the average peak (micro Siemens seconds – μSs), the rate of increase or decrease from the start to the end of the measurement window (rise time, in micro Siemens per second - μS/s), area huge peaks (μSs), area small peaks (μSs) and the larger of the two measures (referred as area under curve - AUC, in μSs). Cut off for NSCF counting was >0.005, much more sensitive than the >0.02 μS used in relative pain monitoring literature.[20] Signal quality <80% was considered artifact and the measurement was also excluded.

Measurement window of interest was 60 sec and 60 sec after endotracheal suction, provided that 4 min before and 1 min. after the stimulus there was no other stimulus of any kind (i.e. venepuncture). In order to ensure the observational character of the study, and to waive any possible ethical considerations, suction stimulation (referred as suction 'event') was product of the daily nursing/treatment routing inside ICU environment and not artificial deliberately-created stimulus. The characteristics of the suctions included were: open, deep, with duration of 10-12 sec, applied negative pressure of 100 mmHg and no use of NaCl 0.9%.[2-4] Endotracheal suctions with different characteristics (e.g. closed, swallow)

were not included. Pre-procedural analgesia was not routinely given.[26] Five minutes before and during the procedure, pain was assessed via Critical Care Observation Pain Tool (CPOT) by two independent observes.[25] If CPOT score > 3 (by both observes) pre-procedural analgesia was administered[26] and the measurements were excluded from further analysis.

Only those suction 'events' that were within the aforementioned frames, were included for further analysis (in total 24 for both groups).

The rest of the parameters were monitored via Bedside Monitor BSM 9101K and Monitor CNS 9601 (Nihon Kohden® Ltd., Japan), and included: heart rate (HR), systolic (SAP), diastolic (DAP) and mean arterial pressure (MAP), number of ventricular premature contractions (VPC), electocardiographic ST wave deviation in II lead (ST II) and respiratory rate (RR). Since the above were used in the literature[17] as possible measures of stress, recordings were used as measure of comparison with SC parameters.

In selected measurements (goup A: 4, group B: 12) bispectral index monitor (BIS) (Covidien®, USA) was also in place.

Ambient noise level was measured at a distance of 30 cm from the head of the patient via Sound Level Meter GM13656 (Shenzhen Jumaoyuan Science & Technology® Co., China)

Data analysis was performed with MS Office Excel 2007 (Microsoft® Co, USA) and Rstudio IDE® v.1.00.136. (Rstudio Inc, USA)

Descriptive statistics are presented as weighted average ($\bar{x}$), standard deviation (s), 1st and 3rd quartile (Q_1 and Q_3 respectively) and range (min-max). Two comparison designs were applied: one examined acute changes before/after the noise stimulus and one that examined the range of change between the two groups. Shapiro-Francia or (Shapiro-Wilk for BIS) normality test was performed for the parameters of interest and then paired Student t-test or Wilcoxon signed ranked test was calculated. Results were presented as p value (Confidence Interval – CI). Statistical significance for p is set at $p<0.05$ and CI level at 95%. CPOT score is presented as $\bar{x}(s)$, while agreement between the two observers were evaluated with inter-rater reliability (*IRR*) and Lin concordance correlation coefficient ρ_c (with two-sided 95% Confidence Limits-CL). Finally, true positive value of parameters with statistical significant change ($p<0.05$) to spot stress event (we arbitrary used the 25% change as a cut-off value for each parameter) was calculated, i.e. if a stress event causes at least 25% change in the value of the parameter of interest, what is the sensitivity of each parameter to 'spot' a stress event?

RESULTS

General characteristics of patients in each group of measurements are shown in **Table 1**. Different averages of APACHE II score, Extended Glasgow Outcome Score (GOSE) and PaO_2/FiO_2 can partially account for the different sedation level. All measurements were conducted on white Caucasian patients. Ambient noise levels, 4 min before the start of the procedure were: 57.53 (4.75) dB in group A and 56.54 (2.62) dB in group B. Hemoglobin and serum electrolytes were within normal limits for both groups.

During recording time, 7 suction 'events' occurred in group A (4 had also BIS monitor) and 17 in group B (12 had also BIS monitor) that met inclusion criteria for further analysis. Main descriptive statistics before and after stimulus, for the two groups, is displayed in **Table 2** and **Table 3**, respectively.

The mean percentage of change before/after the 'event' (endotracheal suction) is also shown in **Table 4**, which demonstrates the vast amount of EDA parameters change.

Table 1. General characteristics of the patients included finally in each group

	Group A	Group B		Group A	Group B
N measurement	10	15	**APACHE II**	15.4 (1.55)	19.6 (1.66)
Sex	♂=10, ♀=0	♂=9, ♀=6	**SOFA**	6.3 (0.9)	7.9 (0.4)
Age (years)	66.5 (14.8)	63.8 (10.9)	**GOSE**	6.4 (0.9)	5.2 (0.8)
Weight (kg)	90.6 (15,1)	89.95 (12.6)	**t (°C)**	37.2 (0.3)	37.1 (0.4)
BMI(kg/m²)	28 (1.65)	30.3 (0.85)	**PaO_2 / FiO_2**	294 (69.3)	230 (81.8)

Presented form: mean (SD), rounded to the nearest decimal. SOFA: Sequential Organ Failure Assessment (SOFA) Score

Table 2. Main descriptive statistics and before/after comparison of the measurements during suction in 1st group sedation level

	Group	**A (RSS 2-4), n=7**				
	Parameter→ statistic	**HR (bpm)**	**VPC (no)**	**STII**	**SAP (mmHg)**	**MAP (mmHg)**
Before	$\bar{x}$ (s)	70.3(12.55)	0.142(0.378)	0.02(0.037)	121(19.96)	80.14(12.75)
	Q1,Q3	63.5,77	0,0	0.05,0.045	113,118	71,88
	Range	50-88	0-1	-0.05-6	108-166	68-102
After	$\bar{x}$ (s)	73.5(11.35)	0.857(0.899)	0.214(0.034)	144.1(32.87)	93(26.66)
	Q_1,Q_3	67,82	0,1.5	0.05,0.045	124.5,145.5	75.5,101
	Range	56-86	0-2	-0.05-0.07	116-214	67-144
	p	*0.097*+	*0.173**	*0.355*+	*0.022*+	*0.62**
	CI [95%]	*[-7.37,0.8]*	NA	*[-0.004,0.02]*	*[-38.5,-8]*	*[-26.8,6.2]*
	Parameter→ statistic	**DAP (mmHg)**	**RR (br/min)**	**BIS (n=4)**	**ArHP (µSs)**	**ArSP (µSs)**
Before	$\bar{x}$ (s)	59(11.46)	14.71(2.56)	40.25(39.97)	0.088(0.166)	0.027(0.072)
	Q1,Q3	50,69	13,16.5	35.25,47.5	0,095	0,0
	Range	48-75	11-18	24-52	0-0.43	0-0.19
After	$\bar{x}$ (s)	75.14(19.58)	15.43(3.49)	63(11.73)	2.94(3.1)	0.104(0.132)
	Q_1,Q_3	60.5,89	13,17.5	54,72.5	0,5.9	0,0.16
	Range	48-101	11-21	33-92	0-6.62	0-0.35
	P	*0.039*+	*0.182*+	*0.082*+	*0.1**	*0.1**
	CI [95%]	*[-31.2,-1]*	*[-1.8,0.4]*	*[-50.8,5.3]*	*[-6.6,-2.1]*	*[-0.19,-0.05]*
	Parameter→ statistic	**NFSC (µSs)**	**AvRT**	**AvP**	**AUC (µSs)**	**SC (µS)**
Before	$\bar{x}$ (s)	0.023(0.035)	0(0)	0.005(0.005)	0.088(0.166)	4.878(2.598)
	Q1,Q3	0,0.02	0,0	0,0.01	0,0.095	3.719,5.108
	Range	0-0.1	NA	0-0.01	0-0.43	1.918-10.211
After	$\bar{x}$ (s)	0.083(0.08)	0(0)	0.03(0.04)	2.94(3.09)	4.928(2.62)
	Q_1,Q_3	0.02,0.135	0,0	0.01,0.015	0.025,5.9	3.802,5.167
	Range	0.02-0.22	NA	0.01-0.14	0-6.62	1.921-10.292
	p	*0.02**	NA	*0.88**	*0.59**	*0.086*+
	CI [95%]	*[-0.13,-0.01]*	NA	NA	*[-6,-2.1]*	*[-7.7,1.4]*

+Students paired t-test
*Wilcoxon signed ranked test with continuity correction (paired)
The 95% confidence interval is providing the range of the difference of the means falls in, with (1-a=0.05) % confidence. In cases that zero in included then we can't rule out the possibility that the means are equal, up to a 1 in 20 chance of having missed a difference.
HR-heart rate, VPC - ventricular premature contractions (number), STII - electrocardiographic ST wave deviation in II lead, SAP - systolic arterial pressure, MAP - mean arterial pressure, DAP - diastolic arterial pressure, RR - respiratory rate, BIS-Bi-spectral index value and EDA parameters (ArHP, ArSP, NFSC, AvRT, AvP, AUC, SC)

Table 3. Main descriptive statistics and before/after comparison of the measurements during suction in 2nd group sedation level

	Group	B (RSS 5-6), n=17				
	Parameter→ statistic	**HR (bpm)**	**VPC (no)**	**STII**	**SAP (mmHg)**	**MAP (mmHg)**
Before	$\bar{x}$ (s)	78.78(17.17)	0.823(3.39)	0.027(0.058)	125(19.12)	76.71(12.1)
	Q1,Q3	67,83	0,0	0,0.04	113,137	67,81
	Range	56-112	0-14	-0.04-0.21	96-167	58-101
After	$\bar{x}$ (s)	81.71(18.04)	0.942(2.9)	0.026(0.05)	138.9(19.84)	86.06(14.64)
	Q_1,Q_3	70,96	0,0	0,0.04	126,155	76,97
	Range	56-113	0-12	-0.03-0.09	96-174	66-119
	P	*0.028*+	*0.711**	*0.671**	*0.0001*+	*0.032*+
	CI [95%]	*[-6.8,-0.6]*	*[-1.5,0.5]*	*[-0.01,0.01]*	*[-19.2,-7.5]*	*[-17.8,-0.9]*
	Parameter→ statistic	**DAP (mmHg)**	**RR (br/min)**	**BIS (n=12)**	**ArHP (μSs)**	**ArSP (μSs)**
Before	$\bar{x}$ (s)	56.88(10.6)	13.06(2.88)	47.82(12.44)	0(6.596)	0.49(0.742)
	Q1,Q3	51,65	12,14	42,48.5	0,0	0,0.64
	Range	37-81	8-20	35-80	0-26.46	0-1.91
After	$\bar{x}$ (s)	63.47(14.02)	15.24(3.96)	74.27(13.07)	38.87(92.74)	2.078(5.71)
	Q_1,Q_3	58,70	14,17	73,80.5	2.2,31.9	0.05,1.61
	Range	39-94	7-21		0-384.59	0-23.96
	P	*0.005*+	*0.029*+	*0.03**	*0.001**	*0.025**
	CI [95%]	*[-10.2,-2.8]*	*[-4.1,-0.25]*	*[-36.5,-17]*	*[-39.8,-2.3]*	*[-1.47,-0.06]*
	Parameter→ statistic	**NFSC (μSs)**	**AvRT**	**AvP**	**AUC (μSs)**	**SC (μS)**
Before	$\bar{x}$ (s)	0.067(0.08)	0.002(0.009)	0.03(0.063)	2.737(6.54)	7.026(5.09)
	Q1,Q3	0,0.12	0,0	0,0.07	0,1.77	3.42(9.625)
	Range	0-0.22	0-0.04	0-0.24	0-26.46	1.256-17.681
After	$\bar{x}$ (s)	0.13(0.124)	0.01(0.024)	0.14(0.286)	38.78(92.73)	7.757(5.765)
	Q_1,Q_3	0.05,0.15	0,0.01	0.01,0.08	2.22,32	3.51,11.06
	Range	0-0.4	0-0.1	0-1.07	0-384.59	1.294-18.301
	P	*0.003**	*0.033**	*0.003**	*0.001**	*0.0009**
	CI [95%]	*[-0.11,-0.03]*	*[-0.03,-0.01]*	*[-0.21,-0.001]*	*[-39.8,-2.3]*	*[-0.75,-0.04]*

+Students paired t-test
*Wilcoxon signed ranked test with continuity correction (paired)
The 95% confidence interval is providing the range of the difference of the means falls in, with (1-a=0.05) % confidence. In cases that zero in included then we can't rule out the possibility that the means are equal, up to a 1 in 20 chance of having missed a difference.
HR - heart rate, VPC - ventricular premature contractions (number), STII - electrocardiographic ST wave deviation in II lead, SAP - systolic arterial pressure, MAP - mean arterial pressure, DAP - diastolic arterial pressure, RR - respiratory rate, BIS-Bi-spectral index value and EDA parameters (ArHP, ArSP, NFSC, AvRT, AvP, AUC, SC)

Table 4. Mean change (%) for every measured parameter

% Δ	HR	VPC	STII	SAP	MAP	DAP
Group A	5.226	0	2.77	17.81	14.44	28.247
Group B	4.622	-14.28	-29.64	11.13	14.22	11.67
% Δ	**RR**	**BIS**	**SPL**	**SVV**	**ArHP**	
Group A	4.06	56	8.35	81.66	>2113.4	
Group B	20.01	61.28	13.91	41.85	>3804.6	
% Δ	**ArSP**	**NFSC**	**AvRT**	**AvP**	**AUC**	**SC**
Group A	84.21	330	25	>2113.4	1.03	200
Group B	191.06	111.88	449.2	>5638.62	8.91	240

Table 5. Agreement of the two observes of the CPOT recordings

CPOT	Group A			Group B		
Parameter	IRR* (%)	ρ_c**	ρ_c CL 95%	IRR* (%)	ρ_c**	ρ_c CL 95%
Before	85.71	0.59	[-0.11,0.89]	76.47	0.84	[0.64,0.93]
After	85.72	0.96	[0.85,0.99]	88.23	0.98	[0.96,0.99]

*Inter rater reliability
**Lin concordance correlation coefficient (with two-sided 95% Confidence Limits)

Table 6. True positive rate of parameters to spot 'stress' event (see Materials and Methods for explanations)

Group A				
Parameter	SAP	DAP	NFSC	
TPR	0.29 [0.04,0.71]	0.43 [0.10,0.82]	0.47 [0.47,1.00]	
Group B				
Parameter	HR	SAP	MAP	DAP
TPR	0.00 [0.00,0.27]	0.06 [0.003,0.29]	0.12 [0.01,0.36]	0.18 [0.04,0.43]
Parameter	RR	BIS$^+$	ArHP	ArSP
TPR	0.35 [0.14,0.62]	0.75 [0.73,0.95]	0.94 [0.71,1.00]	0.76 [0.51,0.93]
Parameter	NFSC	AvRT	AvP	AUC
TPR	0.88 [0.64,0.99]	1.00 [0.73, 1.00]	0.82 [0.57,0.96]	0.94 [0.71,1.00]
Parameter	SC			
TPR	0.12 [0.01,0.36]			

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CPOT score before was 0.143 (0.377) for both observers in group A; while in group B it was 0.4 (0.79) and 0.64 (0.93) for 1st and 2nd observer, respectively. During the 'event' the scores were: 2 (1.73) and 2.43 (1.57) for group A and 2 (2.18) and 2 (2.09) for group B. Agreement of the 2 observers are presented in **Table 5**.

Finally, the true positive rate of selected monitoring parameters is displayed as $\bar{x}$ [95% CI] in **Table 6**.

DISCUSSION

The results illustrate some interesting findings. In both groups the rate of EDA changes are much greater than any other monitoring parameters used. Yet, in cases with lighter sedation level (group A), only SAP, DAP and NFSC are significantly changed after the start of the procedure. On the contrary when measurements occurred in patients with deeper level of sedation (group B), almost every measured parameter shows significant change. In the same group, the sensitivity of EDA parameters, to spot stress events (defined as stimulus that could cause at least 25% change of the monitoring parameter) was only comparable to BIS.

The differences between the two groups may have several explanations. The authors assume that, since the patients in group A were in position of knowing that endotracheal suction is about to take place; the stimulus itself had lower stress 'load'; and this was reflected in the measurements. Apart from that, though the criteria for including the measurements of a procedure were relatively strict, performing suction to more awake patients may have affected the procedure itself in ways others than those predefined by the authors (open, deep, etc).

Electrodermal measures in ambulatory setting may vary with individual differences in age, race, and BMI.[27] Yet, in the present study, both groups were similar both in age, weight and BMI. All measurements were conducted on white Caucasian patients; hence any racial effects on EDA were also absent. Noise is also a recognized stress stimulus in ICU[28], and EDA measurements are affected from ICU noise stimuli[29]. Yet, ambient noise before the start of the procedure was similar in both groups. The same is true for main laboratory parameters. Sex may play a confounding role in EDA measurement because of monthly hormonal variations in women.[30] However, the measurements in the present study were conducted in older women. In addition, laboratory studies in ambulatory setting have been inconclusive.[27,31]

Sleep quality has been connected in the literature with several diseases.[32] Thus, quality of sleep between the two groups is possible contributing factor; however it was not evaluated in the current study.

Also, endotracheal suction could be treated as a complex 'package' of several other stimuli, like e.g. pain, agitation, and noise. Moreover, each of them may possess its own characteristics (e.g. intensity, duration, frequency for noise). The present study did not analyze the possible contribution of each of them in the final recordings.

The relatively small number of measurements and the open, observational character of the study can also be considered as limitations. Further studies in bigger samples both in 'stable' and unstable ICU patients, probably with more predefined stimuli are needed in order to have a clear idea of the role of EDA monitoring in adult ICU environment. The use of adequate analgesia and the type of sedative agent (e.g. propofol or dexmedetomidine) is a prospective that needs to be assessed. The reports from pediatric patients may suggest EDA monitor as an analgesia monitor; but even these are few.[22-23]

Finally, the exact role and physiological 'reflection' of every one of the aforementioned EDA parameters to the ANS activity is yet to be determined.[16-18]

CONCLUSION

EDA measurements are more sensitive to endotracheal suction in sedated adult ICU patients than cardiovascular, respiratory or even BIS monitoring; thus serving as a more sensitive index of stimulus-induced stress. However, future studies are needed in order to define EDA role as stress monitor and to clarify possible specific stimulus EDA response patterns in all group of ICU patients.

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ETHICS

The study is part of a thesis project, approved by AHEPA General University Hospital Research Committee and by No 16/09-07-2013 General Assembly of Special Composition of Medical School, Aristotle University of Thessaloniki (Ref. No.8220/10-07-2013).

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CONFLICT OF INTEREST

All authors declare no conflict of interest.

REFERENCES

1. Leddy R, Wilkinson JM. Endotracheal suctioning practices of nurses and respiratory therapists: how well do they align with clinical practice guidelines? Can J Respir Ther 2015;51(3):60-4.
2. American Association for Respiratory Care Clinical Practice Guidelines. Endotracheal suctioning of mechanically ventilated patients with artificial airways 2010. Respir Care 2010;55(6):758-64.
3. Chaseling W, Bayliss S-L, Rose K, et al. Suctioning an adult ICU patient with an artificial airway; Agency for Clinical Innovation NSW Government Version 2 Chatswood, 2014 NSW, Australia ISBN 978-1-74187-952-0.
4. Sole ML, Bennett M, Ashworth S. Clinical indicators for endotracheal suctioning in adult patients receiving mechanical ventilation. Am J Crit Care 2015;24(4):318-25.
5. Beuret P, Roux C, Constan A, et al. Discrepancy between guidelines and practice of tracheal suctioning in mechanically ventilated patients: a French multicenter observational study. Intensive Care Med 2013;39(7):1335-6.
6. Sole ML, Bennett M. Comparison of airway management practices between registered nurses and respiratory care practitioners. Am J Crit Care 2014; 23(3):191-9.
7. Yorke J, Wallis M, McLean B. Patients' perceptions of pain management after cardiac surgery in an Australian critical care unit. Heart Lung 2004;33:33-41.
8. Puntillo KA, Morris AB, Thompson CL, et al. Pain behaviors observed during six common procedures: results from Thunder Project II. Crit Care Med 2004;32(2):421-7.
9. Dastdadeh R, Ebadi A, Vahedian-Azimi A. Comparison of the effect of open and closed endotracheal suctioning methods on pain and agitation in medical ICU patients: a clinical trial. Anesth Pain Med 2016;6(5):e38337.
10. Yousefi H, Vahdatnejad J, Yazdannik AR. Comparison of the effects of two levels of negative pressure in open endotracheal tube suction on the physiological indices among patients in intensive care units. Iran J Nurs Midwifery Res 2014;19(5):473-7.
11. Abbasinia M, Irajpour A, Babaii A, et al. Comparison the effects of shallow and deep endotracheal tube suctioning on respiratory rate, arterial blood oxygen saturation and number of suctioning in patients hospitalized in the intensive care unit: a randomized controlled trial. J Car Sci 2014;3(3):157-64. doi:10.5681/jcs.2014.017.
12. Irajpour A, Abbasinia M, Hoseini A, et al. Effects of shallow and deep endotracheal tube suctioning on cardiovascular indices in patients in intensive care units. Iran J Nurs Midwifery Res 2014;19(4):366-70.
13. Grap MJ, Munro CL, Wetzel PA, et al. Responses to noxious stimuli in sedated mechanically ventilated adults. Heart Lung 2014;43(1):6-12.
14. Rahu MA, Grap MJ, Cohn JF, et al. Facial expression as an indicator of pain in critically ill intubated adults during endotracheal suctioning. Am J Crit Care 2013;22(5):412-22.
15. Paulus J, Roquilly A, Beloeil H, et al. Pupillary reflex measurement predicts insufficient analgesia before endotracheal suctioning in critically ill patients. Crit Care 2013;17(4):R161.
16. Aslanidis T. Perspectives of autonomic nervous system perioperative monitoring – focus on selected tools. Int Arch Med 2015;8(22):1-9.
17. Aslanidis T. Electrodermal activity: applications in perioperative care. Int J Med Res Health Sci 2014; 3(3):687-95.
18. Storm H, Myre K, Rostrup M, et al. Skin conductance correlates with perioperative stress. Acta Anaesthesiol Scand 2002;46:887-9.
19. Gunther AC, Bottai M, Schandl AR, et al. Palmar skin conductance variability and the relation to-stimulation, pain and the motor activity assessment scale inintensive care unit patients. Crit Care 2013; 17:R51.
20. Günther AC, Schandl AR, Berhardsson J, et all. Pain rather than induced emotions and ICU sound increases skin conductance variability in healthy volunteers. Acta Anaesthesiol Scand 2016;60(8):1111-20.
21. Gjerstad AC, Storm H, Hagen R, et al. Skin conductance or entropy for detection of non-noxious stimulation during different clinical levels of sedation. Acta Anaesthesiol Scand 2007;51:1-7.
22. Karpe J, Misiołek A, Daszkiewicz A, et al.Objective assessment of pain-related stress in mechanically ventilated newborns based on skin conductance fluctuations. Anaesthesiol Intensive Ther 2013; 45(3):134-7.
23. Gjerstad AC, Wagner K, Henrichsen T, et al. Skin conductance versus the modified COMFORT sedation score as a measure of discomfort in artificially ventilated children. Pediatrics 2008;122(4):e848-53.
24. Med Storm Monitor User Manual v1.0 English MA001-25, Part Number 4001, Med Storm Innovation AS, Oslo, 2010.
25. Gelinas C, Tousignant-Laflamme Y, Tanguay A, et

al. Exploring the validity of the bispectral index, the Critical-Care Pain Observation Tool and vital signs for the detection of pain in sedated and mechanically ventilated critically ill adults: a pilot study. Intensive Crit Care Nurs 2011;27(1):46-52.
26. Barr J, Gilles, LF, Puntillo K, et al, American College of Critical Care Medicine. Clinical practice guidelines for the management of pain, agitation, and delirium in adult patients in the intensive care unit. Crit Care Med 2013;41:263-306.
27. Doberenz S, Roth WT, Maslowski NI, et al. Methodological considerations in ambulatory skin conductance monitoring. Int J Psychophysiology 2011;80(2):87-95.
28. Putz-Maidl C, MacAndrew SN, Leske JS. Noise in ICU: sound levels can be harmful. Nurs Crit Care 2014;9(5):29-35.
29. Aslanidis T, Grosomanidis V, Karakoulas K, et al. Acute electrodermal activity changes to short-time noise stimulation in adult Intensive Care Unit patients. in press.
30. Goldstein JM, Jerram M, Poldrack R, et al. Hormonal cycle modulates arousal circuitry in women using functional magnetic resonance imaging. J Neurosci 2005;25(40):9309-16.
31. Carrillo E, Moya-Albiol L, González-Bono E, et al. Gender differences in cardiovascular and electrodermal responses to public speaking task: the role of anxiety and mood states. Int J Psychophysiol 2001; 42(3):253-64.
32. Tobaldini E, Costantino G, Solbiati M, et al. Sleep, sleep deprivation, autonomic nervous system and cardiovascular diseases. Neurosci Biobehav Rev 2017;74(Pt B):321-329.

Мониторинг электродермальной активности во время эндотрахеального выделения респираторных секретов у седированных пациентов пожилого возраста из отделения интенсивной терапии

Теодорос Асланидис[1], Василиос Гросоманидис[2], Константинос Каракулас[3], Атанасиос Катцисотириу[4]

[1] Отделение интенсивной терапии, Клиника анестезиологии и интенсивной терапии, Университетская больница АХЕПА, Салоники, Греция
[2] Отделение кардиоторакальной анестезии и интенсивной терапии, Университетская больница АХЕПА, Салоники, Греция
[3] Отделение анестезии и интенсивной терапии, Университетская больница АХЕПА, Салоники, Греция
[4] Лаборатория физиологии, Медицинский факультет, Салоникский университет имени Аристотеля, Салоники, Греция

Адрес для корреспонденции: Теодорос Асланидис, Национальный центр неотложной помощи, Филиал Салоники, ул. Доридос 4., Салоники, 54633, Греция
E-mail: thaslan@hotmail.com
Tel: +306972477166

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Ключевые слова: электродермальная активность, выделение секретов, интенсивная терапия, стресс

Введение: Эндотрахеальное выделение респираторных секретов является одной из наиболее часто встречающихся причин проявления боли и недомогания во время интенсивной терапии. Электрические свойства кожи, известные под именем электродермальная активность (ЭДА), принято считать проявлением косвенной оценки вегетативной нервной системы.

Цель: Данное исследование прослеживает изменения в ЭДА во время эндотрахеального выделения секретов у седированных пациентов пожилого возраста и сопоставляет установленные изменения с другими показателями мониторинга.

Методы: Изменчивость проводимости кожи, выбранные гемодинамические и респираторные параметры, биспектральный индекс (BIS) и уровень окружающего шума были мониторированы в течение четырёхчасового повседневного сестринского ухода в отделении интенсивной терапии и лечения в отделении интенсивной терапии для пожилых больных. Четырёхчасовые измерения были распределены в две группы в зависимости от уровня седации (группа А: в пределах 2 – 4 по шкале Рамзи и группа Б: соответственно в пределах 5 – 6) больных. Были осуществлены выборочные измерения до и после эндотрахеального выделения (стрессовые ситуации). Семь из стрессовых

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ситуаций из группы А и 17 из группы Б были отобраны для дополнительного анализа. Были зафиксированы демографические данные, лабораторные исследования и оценка тяжести состояния. Также была осуществлена оценка боли до наступления каждой ситуации двумя независимыми наблюдателями.

Результаты: И в обеих группах показатели изменений ЭДА являются более высокими по сравнению с другими прослеживаемыми параметрами. Независимо от этого, в группе А только выбранные параметры показали основательные изменения, а в группе Б каждый из параметров показывает основательное изменение ($p<0.05$). В группах установлены аналогичные результаты в отношении других сопутствующих факторов.

Заключение: Измерения ЭДА проявляют большую степень чувствительности на стрессовые раздражители по сравнению с сердечно-сосудистым, респираторным или даже BIS мониторингом. Состояние глубокой седации по всей вероятности оказывает более сильное воздействие на интенсивность изменения ЭДА во время выделения респираторных секретов.