Contributions of newborn temperature and height to Apgar index in parturient users of multiple drugs of abuse during pregnancy

Contribuição da temperatura e altura no index Apgar de recém-nascidos de parturientes usuárias de múltiplas drogas de abuso durante a gestação

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Abstract

Objective – To relate anthropometric data of newborns of drug-using mothers to their children's Apgar score at birth to allow rapid intervention, if necessary. Although the Apgar has become a standard routine in assessing newborns' conditions, other variables could contribute to this index to allow rapid interventions immediately after the delivery of the newborn. **Method** – A group of mother's users of tobacco, alcohol, marijuana and/ or crack-cocaine drugs during pregnancy were selected and scores were given, taking into account the type of drug, number of drugs and their associations. At birth, the anthropometric data and the Apgar index at 1 and 5 min. were evaluated in the newborns. Statistical correlation between maternal score of dependence, the anthropometric newborn data and the Apgar index were performed. **Results** – A high correlation between the Apgar index at 1 min., the maternal score of drug dependence, the newborn's height and temperature was obtained. The coefficient of determination adjusted by Stein's equation of predictors of these variables with confidence intervals of 95% were: 1) height- 36%, 2) temperature – 25,7%; 3) maternal dependence -51.2%. **Conclusions** – At delivery, the height and temperature associated to the Apgar index of a newborn from mothers addicted to drugs can predict more intense care soon after birth, avoiding neonatal losses.

Descriptors: Illicit drugs; Pregnancy; Child; Newborn

Resumo

Objetivo – Relacionar dados antropométricos de recém-nascidos de mães usuárias de drogas de abuso e o índice Apgar de seus filhos ao nascimento para permitir rápida intervenção, se necessária. Embora o índice Apgar tenha se tornado um padrão de rotina na avaliação das condições dos recém-nascidos, outras variáveis podem contribuir para esse índice para permitir intervenções rápidas imediatamente após o parto. **Métodos** – Um grupo de mães usuárias de tabaco, álcool, maconha e / ou cocaína crack durante a gravidez foi selecionado e pontuações foram dadas, levando em consideração o tipo de droga, número de drogas e suas associações. Ao nascimento, os dados antropométricos e o índice de Apgar aos 1 e 5 min. foram avaliados nos recém-nascidos. Foi realizada correlação estatística entre o escore materno de dependência, os dados antropométricos do recém-nascido e o índice de Apgar. **Resultados** – Foi observada alta correlação entre o índice de Apgar em 1 minuto, o escore materno da dependência de drogas, a altura e a temperatura do recém-nascido. O coeficiente de determinação ajustado pela equação de Stein de preditores dessas variáveis com intervalos de confiança de 95% foram: 1) altura – 36%, 2) temperatura – 25,7%; 3) dependência materna – 51,2%. **Conclusões** – No momento do parto, a altura e a temperatura associadas ao índice de Apgar de um recém-nascido de mães viciadas em drogas podem predizer cuidados mais intensos logo após o nascimento, evitando perdas neonatais.

Descritores: Drogas Ilícitas; Gravidez; Criança; Neonato

Introduction

Obstetric and pediatric literature has repeatedly shown that a considerable proportion of perinatal complications and early medical newborn illness is associated with maternal behaviors during pregnancy [1-2]. These behaviors include failure to provide prenatal care and adequate nutrition for the fetus[3], denial of pregnancy[4] and failure to protect the fetus from chemical assault by drugs and alcohol[5-7]. Particularly, substance abuse in pregnancy has been related to increased rates of preterm labor, preterm premature rupture of membranes, placental abruption[8], teratogenesis and fetal growth restriction[8-11].

The Apgar score is widely used to assess the physical condition of a newborn immediately after delivery and can be considered an indicator of adverse perinatal events[12]. Five signs are used by anesthesiologists to monitor patients' condition: skin complexion, heart rate, reflex irritability, muscle tone, and respiratory effort. Each of these signs is coded on a 2-point Likert scale, and the Apgar score is calculated as the sum of the sub-scores[13]. Apgar scores are recorded at 1 minute, 5 minutes, and sometimes 10 minutes[12]. Scores of 7 to 10 are considered in the normal range[14]. This score can be used to evaluate the newborn's response to resuscitation and may indicate hypoxia and asphyxia, among other complications in newborns[15].

This study investigates women who were admitted to the hospital with high risk pregnancy of, or who were users of multiple legal and illegal drugs. The main objective of the present study is determining which are other variables of mother and/or newborns contribute to the expression of APGAR index, to allow rapid intervention immediately after the newborn delivery. Thus, a group of mother users of tobacco, alcohol, marijuana and/ or crack- cocaine drugs during pregnancy were selected and a scored considering the type of drug,

number of drugs and their associations. At birth, the anthropometric data and the Apgar index at 1 and 5 min. were evaluated in their newborns. Thus, a statistical correlation between maternal score of dependence, the anthropometric newborn data and the Apgar index were performed.

Abbreviations: AP1- Apgar's score at the first minute; AP5'- Apgar's score at the fifth minute; BW- body weight; CP- cephalic perimeter; Dependence- maternal dependence score; GA- gestational age; H- height; HMIB-Neonatology Therapy Unit of the General Hospital; HR- heart rate; MAP- mean arterial pressure; RR-respiratory rate; SUS- Serviço Único de Saúde; T- temperature; TP- thoracic perimeter.

Methods

Ethical aspects

Prior to the collection of data, the project was submitted to the Ethics and Research Committee of the Hospital Guilherme Álvaro de Santos (CPE-HGA), according to Resolution 466 of December 12, 2012, which regulates research standards involving human beings of the National Health Council in 2012). The project was approved through Process # 46705515. 9.0000.5448 and the research addendum with opinion nº: 1,750,591. After approval in the CEP-HGA, the service mentioned in the study site was contact in advance to explain the objectives of the study. The pregnant women and the parturient was oriented regarding the purpose of the study, the guarantee of anonymity, the confidentiality of the data obtained, besides the possibility of not participating in the study, at any stage of the study, which would not imply any harm to their hospitalization and / or assistance.

Experimental design

The population of the study is not a community epidemiological sample but a group of pregnant and parturient who were referred to a pregnancy of high risk. The research was performed from December 2015 to January 2016 at the maternal-infant unit in a highly complex General Hospital located in the municipality of Santos. It is a State Hospital, considered the largest reference center in health care in the metropolitan region of Baixada Santista. This is the only public hospital in the region that serves the entire Baixada Santista and Vale do Ribeira (São Paulo state, Brazil), serving the various specialties exclusive to the Serviço Único de Saúde (SUS), which has infrastructure to meet all the needs of the municipality.

The data were collected through a questionnaire with open and closed semi-structured questions related to the objectives of the study; after the acceptance and signature of the term authorizing the analysis of the collected material since it involved the research for drugs of abuse. Data on the clinical history of the newborns were collected from the medical record of the Neonatology Therapy Unit of the General Hospital (HMIB) where the study was conducted. The exclusion criteria were being under 18 years of age and not agreeing to participate in the study.

Among sixty pregnant and parturient women invited to participate in this study, only twenty patients accepted, of which only 11 reported being users of drugs of abuse. Based in the number of the drug type, association of drugs, and probability of injuries to newborn, we attributed scores to maternal dependence (Table 1). Patient number 4 had a twin birth and therefore was included twice in the study.

Data on newborns collected from each mother immediately after birth were shown in table 2. To analyze these data, we employed in our Neonatology Unit of the HMIB the intra-uterine growth pattern developed by Margotto[16]. This is a study involving a population of healthy newborns between 29 and 44 weeks, born in the HMIB Maternity (8,271 live births between July 1, 1989 to 1/3/91) being reduced to 4,413 NB after exclusion of the main interfering factors in intrauterine growth[16].

To test the data normality the Shapiro-Wilk test was applied in all data. A Pearson correlation test was applied between the Apgar score, all newborn anthropometric data and the maternal scores.

Results

Regarding scores of maternal drug dependence, 50% of parturient women received scores between 1-3, and the other half scores greater than 4.

Table 1 shows the descriptive analysis of all variables observed: maternal dependence score (Dependence), gestational age (GA), mean arterial pressure (MAP), respiratory rate (RR), heart rate (HR), temperature (T), thoracic perimeter (TP), cephalic perimeter (CP), body weight (BW), height (H), and Apgar's score at the first (AP 1') or fifth minute (AP 5'). It was observed that 2 newborns showed normal mean arterial pressure (MAP) and 10 with 6 increased MAP. Among 12 newborns, three babies presented decreased respiratory frequency (RF). Relative to cardiac frequency (CF) only two newborns had decreased rate. One newborn presented normal temperature (T) and one low temperature, while the remaining babies showed hyperthermia. The thoracic perimeter (TP) was reduced in 7 newborns, normal in 3 and increased in 2 babies. Three newborns presented a decreased cephalic perimeter (CP) less than 33 cm, five between 33-34 cm and four with values between 35 and 38 cm. All newborns except three of them showed a decreased body weight (BW). Seven newborns showed reduced height (H), three normal and two increased. Only two babies showed reduced height in the Apgar index in both evaluations.

A Pearson's product-moment correlation was run to assess the relationship between the variables in study (Table 2) and bootstrapped 95% confidence intervals were calculated. Only correlation coefficients whose 95% confidence intervals didn't cross zero values were considered (r = 0, no correlation). Significant correlations were observed between variables: Dependence

Table 1. Descriptive analysis of the variables in study

			95%CI			
	Mean	**SD**	**Lower bound**	**Upper bound**	**N**	**SW**
Dependence	4.23	2.33	2.71	5.83	11	0.230
GA	35.31	1.74	34.14	36.48	11	0.514
MAP	32.55	2.12	31.13	33.97	11	0.195
RR	40.27	16.67	29.07	51.47	11	0.409
HR	113.09	15.62	102.60	123.59	11	0.126
T	35.45	0.82	34.90	36.01	11	0.150
TP	31.36	4.20	28.54	34.19	11	**0.002**
CP	32.36	4.20	29.54	35.19	11	**0.022**
BW	2443.18	399.78	2174.60	2711.76	11	0.943
H	42.82	6.10	38.72	46.91	11	0.062
AP 1′	7.36	2.34	5.80	8.93	11	**0.008**
AP 5′	8.73	1.19	7.93	9.53	11	**0.001**

GA: gestational age; MAP: mean arterial pressure; RR: respiratory rate; HR: heart rate; T: temperature; TP: thoracic perimeter; CP: cephalic perimeter; BW: body weight; H: height; AP: Apgar score index of newborn at 1 (first minute) or 5 (fifth minute) after birth; 95%IC: 95% confidence interval of the mean; SW: p values of the Shapiro-Wilk normality test

Table 2. Pearson's product-moment correlation coefficients between maternal dependence score, vital indices, and anthropometric measures of newborns

	DEP	**GA**	**MAP**	**RR**	**HR**	**T**	**TP**	**CP**	**BW**	**H**	**AP1**
GA	-0.358										
MAP	**-0.785****	0.089									
RR	-0.363	**0.689***	0.100								
HR	-0.399	-0.192	0.458	0.295							
T	-0.438	**0.620***	0.246	0.290	0.067						
TP	-0.246	**0.720***	0.234	0.380	-0.075	**0.644***					
CP	-0.226	**0.646***	0.223	0.281	-0.049	**0.644***	**0.949****				
BW	-0.481	**0.938****	0.141	**0.750****	-0.002	0.634*	0.681*	0.669*			
H	0.131	0.435	-0.465	0.525	-0.025	0.358	0.499	0.464	0.544		
AP1	-0.186	0.226	-0.186	0.675*	0.388	0.062	0.179	0.118	0.402	**0.729***	
AP5	-0.187	0.204	-0.094	0.724*	0.453	0.037	0.182	0.142	0.401	**0.695***	**0.974****

GA: gestational age; MAP: mean arterial pressure; RR: respiratory rate; HR: heart rate; T: temperature; TP: thoracic perimeter; CP: cephalic perimeter; BW: body weight; H: height; AP: Apgar score index of newborn at 1 (first minute) or 5 (fifth minute) after birth; *: $p < 0.05$ Pearson's product-moment correlation coefficients; **: $p < 0.01$ Pearson's product-moment correlation coefficients; gray highlights: significant r values whose bootstrapped 95%IC didn't cross zero values

and MAP; GE and BW; TP and T; CP and T; CP and TP; W and RR; AP (1′ or 5′) and H (Fig.1). Large effect sizes ($r \geq 0.5$ or $r \leq -0,5$) were observed in all considered correlations.

A hierarchical multiple regression was run to determine if the addition of more independent variables improved the prediction of Apgar score index (first min) over and above height alone. There was linearity as assessed by partial regression plots and a plot of studentized residuals against the predicted values. The assumption of normality was met, as assessed by Q-Q Plot. There was independence of residuals, as assessed by a Durbin-Watson statistic of 2,121. There was homoscedasticity, as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values. There was no evidence of multicollinearity, as assessed by tolerance values greater than 0.1. There were no studentized deleted residuals greater than ±3 standard deviations, no leverage values greater than 0.2, and values for Cook's distance above 1. The Akaike criteria for the full model was the lowest, being the "best" model among all models specified for multiple regressions. See Table 3 for full details on each regression model.

The full model of height, temperature, maternal dependence and heart rate to predict Apgar index score (first min) (Model 4) was statistically significant, $R^2 = 0.856$, $F_{(4,6)} = 8.896$, $p = 0.011$; adjusted $R^2_{(Stein's\ formula)} = 0.528$. The addition of maternal dependence to the prediction of Apgar index score (first min) (Model 3) led to a statistically significant increase in R^2 of 0.215, $F_{(1, 7)} = 7.218$, $p = 0.031$. The addition of heart rate to the prediction of Apgar index score (first min) (Model 4), however, didn't lead to a statistically significant increase in R^2 ($\Delta R^2 = 0.064$, $F_{(1, 6)} = 2.674$, $p = 0.153$). So, due to poor contribution heart rate, Model 3 is considered to be a more suitable and important predictor of Apgar index score (first min), according to the following equation:

Apgar 1= (0.368 x A) – (1.369 x T) – [(0.411 x DEP) + (0.042 X FC) + 37.158

Table 3. Hierarchical multiple regression predicting Apgar score index (first min) from height, temperature, maternal dependence score and heart rate

	Apgar score index (first min)							
	Model 1		Model 2		Model 3		Model 4	
Variable	**b**	**β**	**b**	**β**	**b**	**β**	**b**	**β**
Constant	-4.587 (-13.138, 3.963)		17.146 (-37.607, 71.898)		47.367 (-2.444, 97.178)		37.158 (-11.602, 85.917)	
Height	0.279* (0.081, 0.477)	0.729	0.310* (0.093, 0.528)	0.810	0.380* (0.202, 0.558)	0.992	0.368* (0.202, 0.535)	0.961
Temperature			-0.651 (-2.269, 0.968)	-0.229	-1.521* (-2.982, -0.059)	-0.534	-1.369 (-2.747, 0.008)	-0.481
Dependence					-0.551* (-1.036, -0.066)	-0.549	-0.411 (-0.908, 0.086)	-0.410
Heart Rate							0.042 (-0.021, 0.105)	0.281
R^2	0.531		0.576		0.791		0.856	
F	10.180*		5.441*		8.853*		8.896*	
Adjusted R^2	0.360		0.257		0.512		0.528	
ΔR^2	0.531		0.046		0.215		0.064	
ΔF	10.180*		0.860		7.218*		2.674	

95%IC (in parentheses) based on 1000 bootstrap samples. b: coefficients; : standardized coefficients; R2: coefficient of determination; R2: variation of R2 related to the former model; Adjusted R2: coefficient of determination adjusted by Stein's equation; F: F statistics value; F: contribution of the addition of a new variable to the statistic model. *: $p < 0.05$

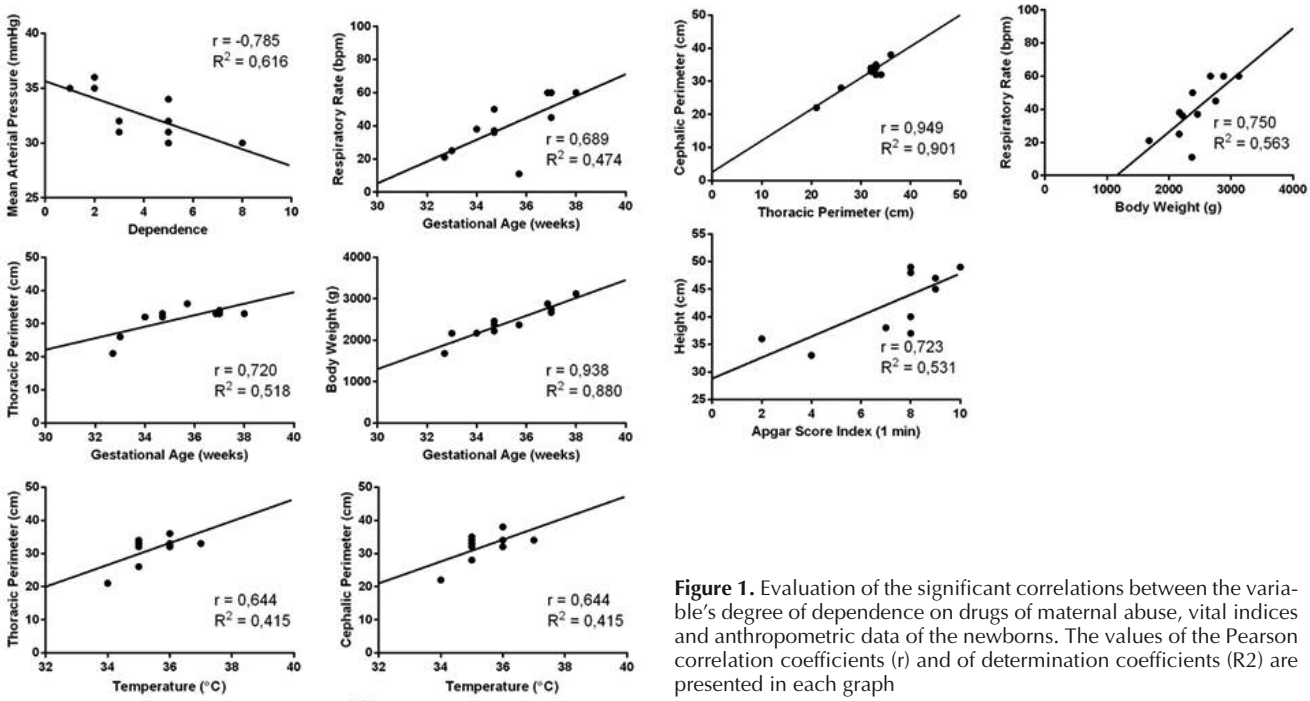

Figure 1. Evaluation of the significant correlations between the variable's degree of dependence on drugs of maternal abuse, vital indices and anthropometric data of the newborns. The values of the Pearson correlation coefficients (r) and of determination coefficients (R2) are presented in each graph

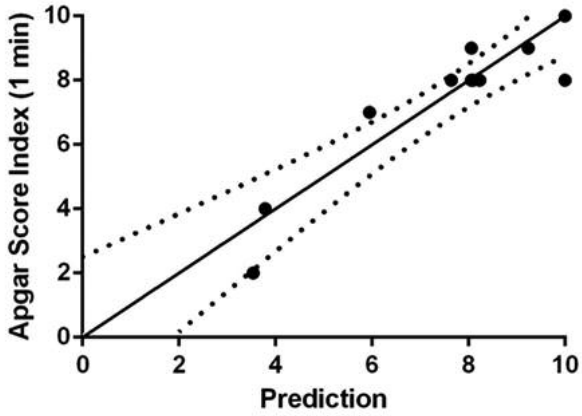

Figure 2. Evaluation of the Apgar index at the first minute based on the predictive model. The total model including height, temperature and dependence as predictors for the first minute Apgar score was significant, with R = 0.925 and R2 = 0.856. Values of Pearson coefficients (r) and of determination coefficients (R2) are presented in each graph

Equation 1. Multiple linear regression for response variable Apgar index at the first minute. A-height; T: temperature; DEP: Dependency; HR: heart rate; Apgar: evaluation index of the child at birth. R2 = 0.925; R2 adjusted = 0.528.

Regarding the quality indices of the model, it is verified that the linearity was observed by partial regression graphs. Residuals were independent, according to the Durbin-Watson test = 2.121. There was homoscedasticity, according to the visual analysis of the graph of the studied residuals versus expected non-standard values. There was no evidence of multicollinearity, according to tolerance values greater than 0.1. No outliers or influence points (high leverage values) were observed: the deleted studied residuals were not greater than ± 3 standard deviations, the point of influence values (high leverage values) were not higher than 0.2 The values of Cook's distance were not greater than 1. The assumption of normality was respected, according to the evaluation of quantile-quantile graphs. The Akaike information criteria (AIC) for the total model was the smallest among all the multiple regressions performed. Table 3 presents the details of each regression model.

The total model, including the height, temperature, heart frequency and dependence rate as the most important predictors for the Apgar index at the first minute was significant, with R2 = 0.856, indicating an optimal fit of the model to the data (Figure 2). The R2 adjusted by the Stein equation was 0.528, indicating that if the model were derived from the population (as opposed to from that sample), approximately 53% of the variance of the response variable could be explained by these selected predictor variables; this indicates a very good cross-validation. Because heart rate contributes only with 5.2% to the Apgar index, we consider only the maternal score and the newborn temperature and height as critical to contribute to the Apgar index at 1 min. The results indicate that other variables can affect the predictive model for the Apgar index at the first minute and cannot be explained solely by the variables pointed out.

Discussion

During the gestational period, fetal growth may cause significant or minimal losses to the fetus. Restrictive maternal or environmental factors acting during fetal life may reduce the final fetus size. Accordingly, these factors may cause diseases to either fetus or newborn and thus interfere with neonatal morbidity and mortality [17].

Presently, reduced BW was observed in 9 newborns and a significant positive correlation with thoracic and cephalic perimeter was observed. Also, BW showed positive correlation with newborn temperature and respiratory frequency.

The use of drugs during pregnancy can lead to fetal growth restrictions such as reduced length, head circumference and birth weight, and medical complications such as preterm birth and infections[18].

It is a current hypothesis that maternal history of drug addiction to cocaine[19] and tobacco smoking[20] during pregnancy is associated with increased incidence of apnea[19]. In addition, newborns from mothers addict to cocaine show reduced body weight[21] and this is attributed to early gestational age differences, not to drug exposure[22]. Prenatal tobacco use was also associated with reduced birth weight, length, head and chest circumferences but not with gestational age or the number of morphological abnormalities[23-24]. As reviewed by Abbott and Winzer-Serhan[25], maternal smoking during pregnancy can have deleterious effects on fetal development and long-term adverse consequences on postnatal development and maturation of several organ systems. Prenatal marijuana exposure was related to reduced gestational age and not to any growth outco-

mes[23]. Our data did not show a strong correlation with maternal scores of dependence and GA and BW either. However, a positive significant correlation was observed between GA and BW.

Our data also show that cephalic and thoracic perimeters correlate strongly with weight, but not with height. Eyler et al.[26] controlled for associated substance use (alcohol, marijuana and tobacco) and documented a reduction in head circumference in cocaine-exposed newborns. Thus, our data are in accordance with reduced newborn BW and decreased cephalic and thoracic perimeter in mothers addicted to cocaine and/or tobacco smoke.

Neonatal hypothermia is an important contributing factor to neonatal mortality and morbidity[27-28]. The World Health Organization's Maternal and Child Health program[29] issued guidelines for prevention of neonatal hypothermia as one of the elements of essential care in newborn at birth and in the 1st day of life. We observed a positive correlation between BW, temperature, thoracic and cephalic perimeters, but not height in babies of parturient drug addicts, suggesting the need for additional care for the survival of newborns.

However, among our sample of newborns of mother users of legal and illegal drugs, only two presented low Apgar index at both evaluations. In contrast, several babies presented reduced anthropometric data involved in some perinatal risk. By means of our statistical study, the most critical factors which contribute to reducing Apgar index at 1 min. were maternal grade of addiction, newborn temperature and height. Other anthropometric data revealed possible occurrence of prematurity and risk to babies' survival but had a low correlation with the Apgar index. Thus, the care immediately after birth in a parturient previously identified as a drug addict could be improved by observing newborn temperature and height.

Conclusions

At delivery, the height and temperature associated to the Apgar index of a newborn of a mother addicted to drugs can predict more intense care soon after birth, avoiding neonatal losses.

The limitation of this study is the small number of pregnant women, but the relationships obtained between the Apgar index and the anthropometric data of newborns may contribute to more intense care immediately after delivery.

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