POOR POSTNATAL WEIGHT GAIN AS A PREDICTOR OF RETINOPATHY OF PREMATURITY

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SUMMARY – The purpose of this study was to re-evaluate cut-off values used in screening for retinopathy of prematurity (ROP) in Croatia and to propose postnatal weight gain as an additional criterion, based on the Colorado Retinopathy of Prematurity prediction model. Medical records of 267 premature infants from the Zagreb University Hospital Centre that underwent ROP screening between January 2009 and December 2010 were reviewed retrospectively. Collected data included gestational age, birth weight, sex, weekly weight measurements and fundus examination records. Results showed the cut-off values of gestational age (GA) and birth weight (BW) used in Croatia to be appropriate and postnatal weight gain in the first 28 days could be used as an additional criterion on screening in the following way: net weight gain in the first 28 days of ≤932 g for prediction of any form of ROP and of ≤660 g for prediction of severe ROP should be added to the existing criteria of GA (≤32 weeks) and/or BW (≤1500 g). Infants with a non-physiological postnatal weight gain are exception. This is the first Croatian study to propose postnatal weight gain as an additional criterion on ROP screening and requires further validation on a larger sample of Croatian infants.

Key words: *Retinopathy of prematurity; Postnatal weight gain; Birth weight; Gestational age; CO-ROP algorithm; Croatia*

Introduction

Retinopathy of prematurity (ROP) is a vasoproliferative disease of immature retina the consequences of which (low vision and blindness) can be avoided or at least reduced if well designed screening and timely treatment are applied[1,2]. Population at risk of ROP varies greatly among countries depending on the level of socio-economic development[3]. Larger, more mature infants are developing severe ROP in countries with low/moderate levels of development compared with highly developed countries[3,4]. Hence, implementing high-income country guidelines into clinical practice of a middle-income country (such as Croatia) would

result in missing infants with ROP, which is unacceptable considering the risk of potential lifetime blindness.

With advances in neonatal care, more preterm infants survive, leading to an increased number of infants screened for ROP, especially in middle-income countries with highest ROP prevalence and wide range of preterm infants that develop ROP[3-5]. This burdens screening programs and subjects a large number of infants to repeated, stressful and sometimes unnecessary examinations[5-8]. Therefore, new models for screening are being investigated in order to safely reduce the number of infants screened for ROP[9-11]. While the current screening criteria are based mainly on two prenatal risk factors, gestational age (GA) and birth weight (BW), recent research shows that poor postnatal weight gain is a good predictor of ROP[10-15]. Two major models incorporating postnatal weight gain (WINROP and CHOP-ROP) require serial longitu-

dinal weekly weight gain calculations for an indeterminate number of weeks, which is demanding in a busy setting of neonatal unit[16]. In contrast, the latest algorithm, the Colorado Retinopathy of Prematurity model (CO-ROP) is a simple one-time application formula designed to identify infants at risk of any grade of ROP in a timely manner (4 weeks)[17]. The model assesses ROP through a combination of the following three criteria: GA ≤30 weeks, BW ≤1500 g, and net weight gain of ≤650 g between birth and 4 weeks of age. Both original[17] and validation[16,18] studies demonstrated high sensitivity in predicting ROP, rendering CO-ROP a good tool for reducing the number of examinations.

Although ROP is a growing global public health problem, it is still insufficiently appreciated and analyzed in our country[19]. Current screening criteria used in Croatia are GA ≤32 weeks and/or BW ≤1500 g, or heavier and more mature infants with an unstable clinical course who are at a high risk of ROP, as assessed by a neonatologist. For the reasons stated above, the CO-ROP criteria[17] are not applicable in Croatia without adjustment. The purpose of this study was therefore to perform a modification of the CO-ROP algorithm and to assess its sensitivity and specificity in our birth cohort. More specifically, the goal was to set population-specific cut-off values of GA and BW in Croatia and to propose the postnatal weight gain as an important third component in assessing infants at risk of retinopathy.

Patients and Methods

This study was approved by the institutional Review Board of the Zagreb University Hospital Centre and was conducted in accordance with the Helsinki Declaration. Medical records of 286 premature infants admitted to the neonatal intensive care unit at the Zagreb University Hospital Centre that underwent ROP screening examinations between January 2009 and December 2010 were reviewed retrospectively.

Data collected included sex, GA, BW, weekly weight measurements (postnatal days 7, 14, 21 and 28) and fundus examination records (ROP stage, zone, presence of plus disease, any treatment required). ROP was graded using the International Classification of ROP[20]. Exclusion criteria were missing required data, lost to follow-up due to death or transfer to another facility, and non-physiological weight gain (hydrocephalus, anasarca). Nineteen patients met the exclusion criteria and were therefore excluded from the study.

Dilated indirect fundus examinations were performed starting at one month of age or GA 30 weeks (whichever was later) and continued at 1- or 2-week intervals based on the stage of disease and zone involved. Patients with type 1 ROP according to the Early Treatment for Retinopathy of Prematurity Trial[2] (ETROP) were treated with retinal laser photocoagulation under general anesthesia. In case of inadequate treatment response, laser would be repeated and/or intravitreal bevacizumab applied for aggressive posterior ROP. Patients with type 2 ROP according to the ETROP criteria[2] were under careful observation until progression into type 1 ROP or regression of the disease. For the purposes of this study, infants who developed type 1 or type 2 ROP were grouped as 'severe' ROP. All infants who developed ROP that did not meet type 1 or type 2 criteria were grouped as 'mild' ROP.

Statistical analysis

Quantitative data were analyzed using Kolmogorov-Smirnov test and appropriate parametric statistical tests were used in further analysis. All quantitative data were expressed as arithmetic mean and standard deviation (SD), while categorical values were expressed as absolute number and corresponding share. One-way ANOVA was used to assess the significance of differences between the ROP groups. After the analysis of variance, post-hoc Bonferroni analysis was performed to assess the significance of relation between the study groups. Differences in categorical values were analyzed using χ^2-test. ROC analysis determined the cut-off value of postnatal weight gain in 28 days that had 100% sensitivity for detecting any form of ROP, as well as severe ROP. All p-values <0.05 were considered significant. IBM SPSS Statistics version 23 was used on all analyses.

Results

A total of 267 premature infants (146 females [54.7%]) were eligible for analysis. Demographic data of the included infants are shown in Table 1. The mean BW was 1375.8±394.1 g (range 620-2400 g) and

Table 1. Demographics of 267 infants screened for retinopathy of prematurity (χ²-test)

Characteristic	No ROP n=101	Mild ROP n=91	Severe ROP n=75	p value
Gestational weeks, mean ± SD (min-max)	32.1±1.8 (27.4-37.4)	30.4±2.3 (25.3-35.0)	28.3±2.5 (23.4-33.3)	<0.001*
Birth weight (g), mean ± SD (min-max)	1593.6±378.5 (680-2400)	1357.8±334.9 (750-2360)	1104.3±397.4 (620-2000)	<0.001*
Postnatal weight gain at 28 days, g, mean ± SD (min-max)	532.7±192.4 (80.0-1096.2)	431.6±185.8 (64.0-932.0)	296.5±135.3 (8.0-660.0)	<0.001*
Female, n (%)	45 (44.6)	51 (56.0)	50 (66.7)	0.014
ROP stage, n (%) 1 2 3	- - -	32 (35.2) 57 (62.6) 2 (2.2)	3 (3.0) 10 (13.3) 62 (82.7)	<0.001
ROP zone, n (%) I II III	- - -	0 (0.0) 73 (80.2) 18 (19.7)	25 (33.3) 50 (66.6) 0 (0.0)	<0.001
Plus disease, n (%) No Yes	- -	91 (100.0) 0 (0.0)	9 (12.0) 66 (88.0)	<0.001

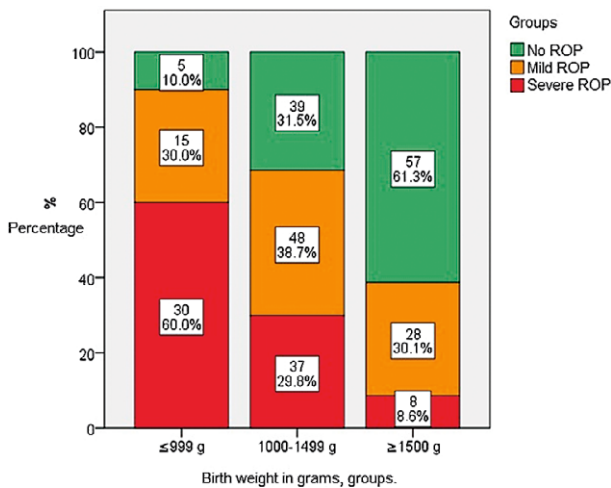ROP = retinopathy of prematurity; SD = standard deviation; *one-way analysis of variance (ANOVA)

Fig. 1. Proportion of infants without retinopathy of prematurity (ROP), with mild and severe ROP, based on birth weight categories (χ²-test, p<0.001).
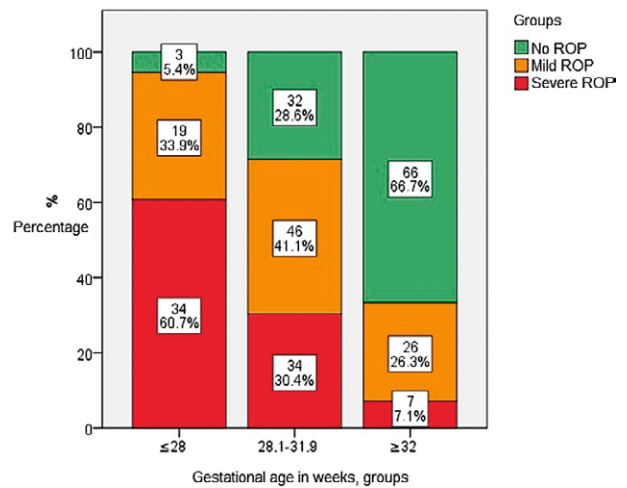

Fig. 2. Proportion of infants without retinopathy of prematurity (ROP), with mild and severe ROP, based on gestational age categories (χ²-test, p<0.001).

mean GA was 30.4±2.7 (range 23.4-37.4) weeks. Of these, 166 (62.2%) infants developed ROP, 75 (28.1%) developed severe ROP (type 1 or 2), and 101 (37.8%) did not develop any ROP. The mean GA of infants who developed ROP was 29.4±2.6 weeks, while their mean BW was 1243.2±341.9 g. Both GA and BW of

infants who developed ROP was notably lower than that of healthy infants (p<0.001), with a wide range of both parameters, i.e. GA 23.4-35 weeks and BW 620-2360 g. As expected, ROP incidence and severity were highest in lower BW and GA categories, as shown in Figures 1 and 2. On the other hand, 33.3% of infants
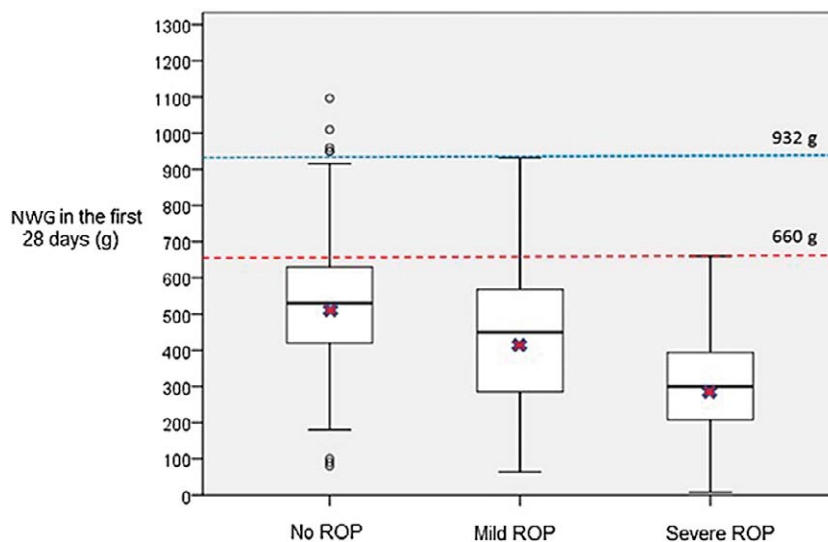
Fig. 3. Box and whisker plot of net weight gain (NWG) in the first 28 days with highlighted weight gain values for detection of any form of retinopathy of prematurity (ROP) and severe ROP (arithmetic mean is marked with 'x', other marks refer to medians, interquartile ranges, minimum and maximum ranges, and outliers).

with GA ≥32 weeks and 38.7% of infants with BW ≥1500 g developed a certain degree of retinopathy, while 7.1% of infants with GA ≥32 weeks and 8.6% of infants with BW ≥1500 g developed a severe form of ROP.

Due to transfer of out-born infants into our tertiary referral center or missing written data, there were 102/1068 (9.6%) missing weekly weights; none of the infants had missing weight at 4 weeks (28 days) of age. Infants with severe ROP had a significantly lower net weight gain on postnatal day 28 (296.5±135.3; p<0.001) compared to infants with mild or no ROP (Table 1). Moreover, this difference was also evident on postnatal days 7, 14, and 21 (p<0.001). At one month of age, all infants that developed any ROP and severe ROP were in the net weight gain category of ≤932 g and ≤660 g, respectively (Fig. 3). Therefore, these values were taken as cut-off values and added to the current national screening guidelines (GA ≤32 weeks and/or BW ≤1500 g), as suggested in the CO-ROP screening model[17]. The sensitivity, specificity, positive (PPV) and negative (NPV) predictive values, and the area under the ROC curve (AUC) of the main and secondary diagnostic criteria, and their combinations in screening of infants for any form of ROP and severe ROP are presented in Tables 2 and 3.

Table 4 shows the number of infants detected using initial screening and screening based on net weight gain at one month of age (weight gain ≤932 g as a cut-off value for any type of retinopathy and ≤660 g as a cut-off value for severe retinopathy). Using the net wet gain criterion reduced the number of infants screened by 10.1% for severe ROP and by 1.9% for any ROP compared to the current national guidelines alone.

Discussion

Our results showed the premature infants with a decreased net weight gain in the first 28 days of life to be at risk of developing retinopathy, regardless of GA and BW. Therefore, we present postnatal net weight gain as an additional biomarker in the ROP screening program, as proposed in the CO-ROP model[17]. CO-ROP is a new and simple screening model for ROP based on GA, BW, and postnatal weight gain. It is an easy and fast procedure performed only once, on the 28th day of a child's life, which correlates with the time of initial fundus examination. However, the cut-off values established in a highly developed country such as the United States of America, where the model was developed and validated, cannot be applied to the Croatian population where heavier and more mature in-

Table 2. Sensitivity, specificity, positive (PPV) and negative predictive value (NPV), and the area under the ROC curve (AUC) of the main and secondary diagnostic criteria and their combinations in screening of infants for any form of ROP

		No ROP N=101		ROP N=166		Sensitivity	Specificity	PPV	NPV	AUC
		n	%	n	%	%	(95% CI)	(95% CI)	(95% CI)	(95% CI)
GA ≤32 weeks	No	66	65.3%	33	19.9%	80.12%	65.00%	79.17%	66.33%	0.73
	Yes	35	34.7%	133	80.1%	(73.23%-85.90%)	(54.82%-74.27%)	(72.24%-85.04%)	(56.07%-75.56%)	(0.67-0.78)
BW ≤1500 g	No	57	56.4%	36	21.7%	78.31%	56.44%	74.71%	61.29%	0.67
	Yes	44	43.6%	130	78.3%	(71.26%-84.32%)	(46.20%-66.28%)	(67.58%-80.99%	(50.62%-71.22%)	(0.61-0.73)
NWG at 28 days ≤932 g	No	5	5.0%	0	0.0%	100.00%	4.95%	63.36%	100.00%	0.52
	Yes	96	95.0%	166	100.0%	(97.80%-100.00%)	(1.63%-11.18%)	(57.21%-69.20%)	(47.82%-100.00%)	(0.46-0.59)
GA ≤32 weeks and BW <1500 g	No	76	75.2%	52	31.3%	68.67%	75.25%	82.01%	59.38%	0.72
	Yes	25	24.8%	114	68.7%	(61.03%-75.64%)	(65.67%-83.30%)	(74.61%-88.01%)	(50.34%-67.96%)	(0.66-0.77)
GA ≤32 weeks and/or BW <1500 g	No	47	46.5%	17	10.2%	89.76%	46.53%	73.40%	73.44%	0.68
	Yes	54	53.5%	149	89.8%	(84.11%-93.92%)	(36.55%-56.73%)	(66.76%-79.34%)	(60.91%-83.70%)	(0.62-0.74)
GA ≤32 weeks, BW <1500 g and NWG at 28 days ≤932 g	No	77	76.2%	56	33.7%	66.27%	76.24%	82.09%	57.89%	0.71
	Yes	24	23.8%	110	66.3%	(58.53%-73.41%)	(66.74%-84.14%)	(74.53%-88.17%)	(49.03%-66.40%)	(0.65-0.77)
GA ≤32 weeks and/or BW <1500 g and/or NWG at 28 days ≤932 g	No	7	6.9%	0	0.0%	100.00%	6.93%	63.85%	100.00%	0.53
	Yes	94	93.1%	166	100.0%	(97.80%-100.00%)	(2.83%-13.76%)	(57.68%-69.69%)	(59.04%-100.00%)	(0.47-0.60)

ROP = retinopathy of prematurity; GA = gestational age; BW = birth weight; NWG = net weight gain in the first 28 days; 95% CI = 95% confidence interval

fants develop ROP. Therefore, this study analyzed cut-off values of net weight gain in the first 28 days of life, which would include all infants at risk of ROP and the possibility to include this criterion into the existing national guidelines.

In developed countries, ROP occurs almost exclusively among most premature infants and the inci-dence of ROP is considerably lower than in developing countries such as Croatia[5,19,21,22]. On the other hand, in developing countries of Eastern Europe, Latin America, India and China, the average BW and GA vary considerably, with very broad ranges[4,5,23-25]. The ranges of BW and GA in Croatia are similar to those in other developing countries, but they are very broad

Table 3. Sensitivity, specificity, positive (PPV) and negative predictive value (NPV), and the area under the ROC curve (AUC) of the main and secondary diagnostic criteria and their combinations in screening of infants for severe ROP

		NO ROP N=101		ROP N=166		Sensitivity	Specificity	PPV	NPV	AUC
		n	%	n	%	%	(95% CI)	(95% CI)	(95% CI)	(95% CI)
GA ≤32 weeks	No	66	65.3%	7	9.3%	90.67%	65.35%	66.02%	90.41%	0.78
	Yes	35	34.7%	68	90.7%	81.71%-96.16%	55.23%-74.54%	56.03%-75.06%	81.24%-96.06%	0.71-0.84
BW ≤1500 g	No	57	56.4%	8	10.7%	89.33%	56.44%	60.36%	87.69%	0.73
	Yes	44	43.6%	67	89.3%	80.06%-95.28%	46.20%-66.28%	50.63%-69.52%	77.18%-94.53%	0.66-0.79
NWG in the first 28 days ≤660 g	No	21	20.8%	0	0.0%	100%	20.79%	48.39%	100%	0.6
	Yes	80	79.2%	75	100.0%	(95.2%-100%)	(13.36%-30.01%)	(40.3%-56.54%)	(83.89%-100%)	0.53-0.68
GA ≤32 weeks and BW <1500 g	No	76	75.2%	12	16.0%	84.00%	75.25%	71.59%	86.36%	0.8
	Yes	25	24.8%	63	84.0%	73.72%-91.45%	65.67%-83.30%	60.98%-80.70%	77.39%-92.75%	0.73-0.85
GA ≤32 weeks and/or BW <1500 g	No	47	46.5%	3	4.0%	96.00%	46.53%	57.14%	94.00%	0.71
	Yes	54	53.5%	72	96.0%	88.75%-99.17%	36.55%-56.73%	48.02%-65.92%	83.45%-98.75%	0.64-0.78
GA ≤32 weeks, BW <1500 g and NWG at 28 days ≤660 g	No	79	78.2%	13	17.3%	82.67%	78.22%	73.81%	85.87%	0.8
	Yes	22	21.8%	62	82.7%	(72.19%-90.43%)	(68.9%-85.82%)	(63.07%-82.80%)	(77.05%-92.26%)	0.74-0.86
GA ≤32 weeks and/or BW <1500 g and/or NWG at 28 days ≤660 g	No	11	10.9%	0	0.0%	100%	10.89%	45.45%	100%	0.55
	Yes	90	89.1%	75	100.0%	(95.2%-100%)	(5.56%-18.65%)	(37.7%-53.38%)	(71.51%-100%)	0.48-0.63

ROP = retinopathy of prematurity; GA = gestational age; BW = birth weight; NWG = net weight gain in the first 28 days; 95% CI = 95% confidence interval

and differ significantly among regions, and even within a single city[3,5,19,26,27].

Postnatal net weight gain at one month was significantly higher in our study (932 g and 660 g) than in the CO-ROP study (650 g and 400 g)[17] for any form of ROP, as well as for severe ROP, which was expected due to the specificity of our population. We also analyzed cut-off values for the combination of GA, BW and net weight gain in the first 28 days as the criteria for inclusion in the ROP screening program (Tables 2 and 3). The sensitivity of <90% with the current criteria (GA ≤32 weeks and/or BW ≤1500 g) highlights the immense role of neonatologist in the evaluation process. Only net weight gain ≤932 g for

Table 4. Infants detected by initial screening and by using screening based on net weight gain in the first 28 days of life

	Initial screening		Screening for any form of ROP (≤932 g)		Screening for severe ROP (≤660 g)	
	Alarm	No alarm	Alarm	No alarm	Alarm	No alarm
No ROP	101	0	96	5	80	21
Mild ROP	91	0	91	0	83	8
Severe ROP	75	0	75	0	75	0
Total	267	0	262	5	238	29

ROP = retinopathy of prematurity

any form of ROP and ≤660 g for severe ROP in the first 28 days was identified as an independent criterion with 100% sensitivity. Moreover, only the combination of GA ≤32 weeks and/or BW ≤1500 g and/or postnatal weight gain in 28 days of ≤932 g showed 100% sensitivity in predicting any form of ROP. Similarly, only the combination of GA ≤32 weeks and/or BW ≤1500 g and/or postnatal weight gain in 28 days of ≤660 g showed 100% sensitivity in predicting severe ROP. As far as specificity is concerned, using all three criteria was most specific (76.23% for any form of ROP and 78.22% for severe ROP). Still, more than 20% of infants would pass unscreened, which is unacceptable. Furthermore, if only the criterion of net weight gain in 28 days had been used for ROP screening in our study, the number of examined children would have decreased by only 2%, which is significantly less than the figure reported for the CO-ROP[16-18] (~23%) or WIN-ROP (~75%) algorithm[28]. The reason for this low percentage was the generally higher prevalence of any form of ROP in our cohort.

In conclusion, in order not to miss a single child with ROP, the existing national guidelines are population-specific and appropriately high given the important role of neonatologist in assessing infants older than 32 weeks and heavier than 1500 g. However, premature infants with a decreased net weight gain in the first 28 days of life are at risk of developing retinopathy, regardless of GA and BW. Therefore, our study proposed net weight gain in the first 28 days as an additional tool in the existing screening program, in the following way: the criterion of net weight gain of ≤932 g in the first 28 days for prediction of any form of ROP and net weight gain of ≤660 g in the first 28 days for severe ROP should be added to the existing cut-off values of GA (≤32 weeks) and/or BW (≤1500 g). It is im-

portant to stress that infants with a non-physiological postnatal weight gain (edema, anasarca, hydrocephalus) are exception and need assessment by a neonatologist (out of 8 infants excluded from the study due to hydrocephalus, 4 developed type 1 ROP requiring treatment). ROP research in Croatia is still very scarce and this study is the first Croatian study to propose net weight gain as an additional criterion in the screening model. However, further analysis on a larger sample of Croatian infants, at the national level, should be conducted before considering implementation of postnatal weight gain into the existing screening criteria.

This study had some limitations, i.e. small sample size from a single tertiary hospital with high ROP-risk profile and incomplete data on net weight gain before postnatal day 28. Also, infants with a non-physiological postnatal weight gain (edema, anasarca, hydrocephalus) could be evaluated with this algorithm and were excluded from the study. Nevertheless, the strengths of our study are several. Firstly, it was the first study in Croatia to propose net weight gain as an additional criterion in ROP screening; it was conducted on a European Caucasian population and can therefore be used in a wide range of comparisons, at the European and global level. Secondly, the study was performed in a developing country that can be further characterized as a transition country, and such indications on how to improve the Croatian health system are noteworthy. Moreover, our modification of the CO-ROP model serves as an example of how each institution and country can develop its population-specific criteria, which would ensure that all infants at risk of ROP are examined. Longitudinal follow-up and adjustment of the screening criteria according to the growth and development patterns of population, together with the research of other potential risk factors

would then most definitely lead to better neonatal care system, especially for developing countries such as Croatia.

References

1. Fierson WM; American Academy of Pediatrics Section on Ophthalmology; American Academy of Ophthalmology; American Association of Pediatric Ophthalmology and Strabismus; American Association of Certified Orthoptists. Screening examination of premature infants for retinopathy of prematurity. Pediatrics. 2013 Jan;131(1):189-95. doi: 10.1542/peds.2012-2996.

2. Good WV; Early Treatment for Retinopathy of Prematurity Cooperative Group. Final results of the Early Treatment for Retinopathy of Prematurity (ETROP) randomized trial. Trans Am Ophthalmol Soc. 2004;102:233-48; discussion 248-50.

3. Gilbert C, Fielder A, Gordillo L, Quinn G, Semiglia R, Visintin P, *et al.* Characteristics of infants with severe retinopathy of prematurity in countries with low, moderate, and high levels of development: implications for screening programs. Pediatrics. 2005;115:e518-25. doi: 10.1542/peds.2004-1180.

4. Gilbert C. Retinopathy of prematurity: a global perspective of the epidemics, population of babies at risk and implications for control. Early Hum Dev. 2008;84:77-82. doi: 10.1016/j.earlhumdev.2007.11.009.

5. Zin A, Gole GA. Retinopathy of prematurity – incidence today. Clin Perinatol. 2013 Jun;40(2):185-200. doi: 10.1016/j.clp.2013.02.001.

6. Binenbaum G, Ying GS, Quinn GE, Dreiseitl S, Karp K, Roberts RS, *et al.* A clinical prediction model to stratify retinopathy of prematurity risk using postnatal weight gain. Pediatrics. 2011;127(3):e607-e614. doi: 10.1542/peds.2010-2240.

7. Clarke WN, Hodges E, Noel LP, Roberts D, Coneys M. The oculocardiac reflex during ophthalmoscopy in premature infants. Am J Ophthalmol. 1985;99(6):649-51.

8. Laws DE, Morton C, Weindling M, Clark D. Systemic effects of screening for retinopathy of prematurity. Br J Ophthalmol. 1996;80(5):425-8.

9. Binenbaum G. Algorithms for the prediction of retinopathy of prematurity based on postnatal weight gain. Clin Perinatol. 2013 Jun;40(2):261-70. doi: 10.1016/j.clp.2013.02.004.

10. Hellström A, Hård AL, Engström E, Niklasson A, Andersson E, Smith L, *et al.* Early weight gain predicts retinopathy in pre-term infants: new, simple, efficient approach to screening. Pediatrics. 2009;123:e638-e645. doi: 10.1542/peds.2008-2697.

11. Binenbaum G, Ying GS, Quinn GE, Huang J, Dreiseitl S, Antigua J, *et al.* The CHOP postnatal weight gain, birth weight, and gestational age retinopathy of prematurity risk model. Arch Ophthalmol. 2012 Dec;130(12):1560-5. doi: 10.1001/archophthalmol.2012.2524.

12. Eckert GU, Fortes Filho JB, Maia M, Procianoy RS. A predictive score for retinopathy of prematurity in very low birth weight preterm infants. Eye (Lond). 2012 Mar;26(3):400-6. doi: 10.1038/eye.2011.334.

13. Wallace DK, Kylstra JA, Phillips SJ, Hall JG. Poor postnatal weight gain: a risk factor for severe retinopathy of prematurity. J AAPOS. 2000 Dec;4(6):343-7.

14. Lofqvist C, Andersson E, Sigurdsson J, Engström E, Hård AL, Niklasson A, *et al.* Longitudinal postnatal weight and insulin-like growth factor I measurements in the prediction of retinopathy of prematurity. Arch Ophthalmol. 2006;124:1711-8.

15. Wu C, Vanderveen DK, Hellström A, Löfqvist C, Smith LE. Longitudinal postnatal weight measurements for the prediction of retinopathy of prematurity. Arch Ophthalmol. 2010; 128(4):443-7. doi: 10.1001/archophthalmol.2010.31.

16. Cao JH, Wagner BD, Cerda A, McCourt EA, Palestine A, Enzenauer RW, *et al.* Colorado Retinopathy of Prematurity model: a multi-institutional validation study. J AAPOS. 2016 Jun;20(3):220-5. doi: 10.1016/j.jaapos.2016.01.017.

17. Cao JH, Wagner BD, McCourt EA, Cerda A, Sillau S, Palestine A, *et al.* The Colorado Retinopathy of Prematurity model (CO-ROP): postnatal weight gain screening algorithm. J AAPOS. 2016 Feb;20(1):19-24. doi: 10.1016/j.jaapos.2015.10.017.

18. McCourt EA, Ying G, Lynch AM, Palestine AG, Wagner BD, Wymore E, *et al.* Validation of the Colorado Retinopathy of Prematurity Screening Model. JAMA Ophthalmol. 2018;136 (4):409-16. doi: 10.1001/jamaophthalmol.2018.0376.

19. Petrinović-Dorešić J. Retinopatija nedonoščadi – pojavnost, rizični čimbenici, liječenje i ishod. [Internet]. Sveučilište u Zagrebu; 2011 [cited 2017 Mar 5]. Available from: http://medlib.mef.hr/1006/ (in Croatian)

20. Committee for the Classification of Retinopathy of Prematurity. The International Classification of Retinopathy of Prematurity revisited. Arch Ophthalmol. 2005;123(7):991-9. doi: 10.1001/archopht.123.7.991.

21. Piyasena C, Dhaliwal C, Russell H, Hellstrom A, Löfqvist C, Stenson BJ, *et al.* Prediction of severe retinopathy of prematurity using the WINROP algorithm in a birth cohort in south east Scotland. Arch Dis Child Fetal Neonatal Ed. 2014;Jan; 99(1):F29-33. doi: 10.1136/archdischild-2013-304101.

22. Bas AY, Koc E, Dilmen U; ROP Neonatal Study Group. Incidence and severity of retinopathy of prematurity in Turkey. Br J Ophthalmol. 2015;99:1311-4. doi: 10.1136/bjophthalmol-2014-306286.

23. Chen Y, Li X. Characteristics of severe retinopathy of prematurity patients in China: a repeat of the first epidemic? Br J Ophthalmol. 2006;90:268-71. doi: 10.1136/bjo.2005.078063.

24. Vinekar A, Jayadev C, Kumar S, Mangalesh S, Dogra MR, Bauer NJ, *et al.* Impact of improved neonatal care on the profile of retinopathy of prematurity in rural neonatal centers in India over a 4-year period. Eye Brain. 2016 May 20;8:45-53. doi: 10.2147/EB.S98715. eCollection 2016.

25. Knežević S, Stojanović N, Oros A, Savić D, Simović A, Knežević J. Analysis of risk factors in the development of retinopathy of prematurity. Srp Arh Celok Lek. 2011;139(7-8):433-8. doi: 10.2298/SARH1108433K.

26. Petrinović-Dorešić J, Dorn Lj, Kuzmanović B, Bušić M. Retinopathy of prematurity – functional and structural outcome in children treated with diode laser photocoagulation. Acta Med Croatica. 2006;60(2):153-8.

27. Prpić I, Mahulja-Stamenković V, Kovačević D, Škarpa-Prpić I. Prevalence of severe retinopathy of prematurity in a geographically defined population in Croatia. Coll Antropol. 2011;35 (Suppl 2):69-72.

28. Hard AL, Lofqvist C, Fortes Filho JB, Procianoy R, Smith L, Hellström A. Predicting proliferative retinopathy in a Brazilian population of preterm infants with the screening algorithm WINROP. Arch Ophthalmol. 2010;128:1432-6. doi:10.1001/ archophthalmol.2010.255.

Sažetak

SLAB POSTNATALNI PORAST TJELESNE MASE
KAO PREDIKTOR RETINOPATIJE NEDONOŠČADI

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Svrha ovoga istraživanja bila je procijeniti granične vrijednosti koje se koriste u probiru na retinopatiju nedonoščadi (ROP) u Hrvatskoj te predložiti postnatalni porast tjelesne mase kao dodatni kriterij, po uzoru na algoritam *Colorado Retinopathy of Prematurity* (CO-ROP). Retrospektivno su analizirani podaci 267 nedonoščadi praćene u sklopu programa probira na ROP u Kliničkom bolničkom centru Zagreb od siječnja 2009. do prosinca 2010. godine. Prikupljeni podaci uključivali su gestacijsku dob (GD), porođajnu masu (PM), spol, tjedna mjerenja tjelesne mase i praćenja nalaza na očnoj pozadini. Rezultati studije pokazali su da su granične vrijednosti za gestacijsku dob i porođajnu masu koje se koriste u Hrvatskoj primjerene za ovu populaciju te da postnatalni porast tjelesne mase u prvih 28 dana može poslužiti u programu probira na ROP na sljedeći način: uz postojeće kriterije, GD ≤32 tjedna i/ili PM ≤1500 g, dodati kriterij i/ili postnatalni porast tjelesne mase u 28 dana ≤932 g za predikciju bilo kojeg oblika ROP-a odnosno ≤660 g za predikciju teškog oblika ROP-a. Iznimka su djeca s nefiziološkim porastom tjelesne mase. Ovo istraživanje je prva hrvatska studija koja predlaže postnatalni porast tjelesne mase kao dodatni kriterij u programu probira na ROP i zahtijeva dodatna ispitivanja na većem uzorku hrvatske nedonoščadi.

Ključne riječi: *Retinopatija nedonoščadi; Postnatalni porast tjelesne mase; Porođajna masa; Gestacijska dob; CO-ROP algoritam; Hrvatska*