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Original Research Article.

Oxygen Saturation (SpO_2) in Healthy Newborns in Relation to Mode of Delivery, Delivered at a Tertiary Care Institute of Solan

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ABSTRACT

Introduction: Measurement of SpO_2 is an integral part of newborn, as both hypoxia and hyperoxia are dangerous. Normal newborn takes about 10 minutes to reach a SpO_2 of 85%- 95%. Lungs of babies born by Cesarean section contain more fluid than babies born by vaginal delivery and their SpO_2 levels may differ. Difference in SpO_2 has also been noted varying with altitudes. We studied the SpO_2 levels serially in first 24 hours in healthy newborns delivered by different modes of delivery in our institute, situated at an altitude of 1600 meters.

Methods: SpO_2 was measured in 100 full term newborn delivered by normal vaginal delivery and in 100 delivered by lower segment cesarean section in right foot serially in first 24 hours.

Results: We did not find any statistically significant difference between SpO_2 levels achieved by newborn born by different modes of delivery. However there was a delayed achievement of above 85% of SpO_2 levels in both the groups with an average delay of 7 minutes without any distress.

Conclusion: We concluded that SpO_2 levels remain unaffected by mode of delivery whether it is NVD or LSCS whereas others have reported a difference. We also concluded that achievement of targeted SpO_2 levels is delayed by about 7 minutes in newborn born at higher altitude.

Key words: High Altitude, Newborn, Pulse Oximetry, Delivery Mode.

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INTRODUCTION

Neonatal resuscitation has seen a lot of changes in last decades, resulting in improved survival, decreased morbidity and long term complications. Measurement of SpO_2 by pulse oximetry is a principal guiding line in neonatal management of NICU & SICU establishments. Oxygen supplementation of yester years has given way to room air resuscitation. All these changes have come through evidence gathered from various studies.[1-4]

Neonatal Resuscitation program reference charts, being followed globally provide a minute to minute guideline for supplementing oxygen in case resuscitation is required. However variation of SpO_2 level in relation to different parameters has been noted in different studies. Normal healthy newborn takes about 10 minutes to reach a SpO_2 of 85%- 95%.[5]

Lungs of Babies born by Cesarean section contains more fluid than babies born by vaginal delivery and their SpO_2 level differs.[6] Some have quoted it as higher and others as lower. Difference in SpO_2 has also been noted varying at different altitudes.[7]

We measured SpO_2 of normal full term newborns delivered at our institute situated at an altitude of 1600 meters, in first 24 hours and analyzed the data in view of different modes of delivery. We also looked into its progression by serial measurements with a view to look into adaptation behavior and answer the ever bothering question of supplement or not to supplement oxygen at a given point of time, as both hypoxia and hyperoxia are considered harmful for baby.[8,9]

We also analyzed the data for their achievement of ≥ 95% SpO_2, with a view to exclude life threatening critical congenital heart disease.[10]

MATERIALS AND METHODS

Present study was conducted on 200 neonates born in this institution, with 100 newborn delivered by lower segment cesarean section (LSCS) and 100 by normal vaginal delivery (NVD).

Newborns not requiring resuscitation in form of PPV after 1 minute or supplemental oxygen at 5 minutes were included in the study. Only babies born with a birth weight ≥ 2000 gm, gestation ≥ 37 weeks, without any apparent congenital anomaly were included

and all other babies were excluded.SpO_2 was recorded by pulse oximetry post ductally in right foot at 5,10, 20,30,40 minutes and then at 1, 3, 6, 12, 24 hour of birth with probe attached for at least 2 minutes before taking reading. At 5 and 10 minutes of life SpO_2 was recorded when a stable waveform was seen for 30 seconds.

Table 1: Distribution of Patients (Sex, Birth Weight & Gestation Wise)

Group	Sex		Birth Weight In Grams				Gestation As Per Lmp (Completed Weeks)				
	Male	Female	2000-2499	2500-2999	3000-3500	3500-4000	37 weeks	38 weeks	39 weeks	40 weeks	41 weeks
NVD (100)	52	48	18	47	27	8	33	20	37	8	2
LSCS (100)	58	42	20	54	22	4	28	24	26	18	4
Total 200	110 (55.0%)	90 (45.0%)	38 (19.0%)	101 (50.5%)	49 (24.5%)	12 (06.0%)	61 (30.5%)	44 (22.0%)	63 (31.5%)	26 (13.0%)	6 (03.0%)

Table 2: SpO_2 at 5 minutes

SpO_2 value	Observed value						Expected /target value	Cumulative non achievers	Cumulative achievers
Group	61-65%	66-70%	71-75%	76-80%	81-85%	>85%	80-85%		
NVD (100)	15	19	13	19	25	9	100	47	53
LSCS (100)	15	21	19	20	15	10	100	55	45
Total (200)	30 (15.0%)	40 (20.0%)	32 (16.0%)	39 (19.5%)	40 (20.0%)	19 (9.5%)	200 (100%)	102 (51.0%)	98 (49.0%)

Table 3: SpO_2 at 10 minutes

SpO_2 value	Observed value								Expected /target	Cumulative non achievers	Cumulative achievers
Group	61-65%	66-70%	71-75%	76-80%	81-85%	86-90%	91-95%	>95%	85-95%		
NVD (100)	1	6	10	7	26	30	16	4	100	24	76
LSCS (100)	1	5	5	14	24	28	21	2	100	25	75
Total 200	2 (1.0%)	11 (5.5%)	15 (7.5%)	21 (10.5%)	50 (25.0%)	58 (29.0%)	37 (18.5%)	6 (3.0%)	200 (100%)	49 (24.5%)	151 (75.5%)

Table 4: Time from birth to reach $SpO_2 \geq 95\%$ or above on room air

Group	10 min	11-15 min	16-20 min	21-25 min	26-30 min	31-35 min	36-40 min	41-45 min	46-50 min	51-55 min	56-60 min	60-90 min	Not reached
NVD	8	10	29	17	11	3	12	2	1	2	2	1	2
LSCS	4	10	11	8	29	17	12	3	1	0	1	1	3
	Cumulative achievers by 40 minutes							Cumulative nonachievers by 40 minutes				Cum. achievers by 90 min.	Cum. nonachievers by 90 min.
NVD	90							10				98	2
LSCS	91							9				97	3
Total	181 (90.5%)							19 (9.5%)				195 (97.5%)	5 (2.5%)

Table 5: SpO_2 in newborns over 24 hour period

SpO_2	0.5 hr	0.5 hr	1hr	1hr	3 hr	3hr	6 hr	6hr	12hr	12hr	24hr	24hr
	NV	CS	NV	CS	NV	CS	NV	CS	NV	CS	NV	CS
<85	0	0	0	0	1	1	1	1	1	0	0	0
85	0	0	0	0	0	0	0	0	0	1	1	0
86	0	0	1	1	0	0	0	0	0	0	0	1
87	0	1	0	0	0	0	0	0	0	0	0	0
88	1	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0
91	2	3	0	0	0	0	0	0	0	0	0	0
92	12	11	1	1	0	0	0	0	0	0	0	0
93	11	8	1	1	7	6	3	4	3	1	2	1
94	1	2	0	1	11	16	16	19	3	3	5	9
95	3	15	52	48	27	22	25	22	5	5	10	6
96	50	45	43	42	51	52	39	43	28	30	18	22
97	20	15	1	3	2	3	13	6	32	33	38	31
98	0	0	1	2	1	1	1	2	25	23	22	24
99	0	0	0	1	1	1	2	3	1	3	2	4
100	0	0	0	0	0	0	0	0	2	1	2	2
	100	100	100	100	100	100	100	100	100	100	100	100

Table 6: Birth weight and time taken to reach ≥ 95% of SpO_2 in NVD group

	Time from birth												Not reached	Total No.
Birth weight	10 min	11-15 min	16-20 min	21-25 min	26-30 min	31-35 min	36-40 min	41-45 min	46-50 min	51-55 min	56-60 min	60-90 min		
2000-2499	-	-	7	3	2	1	-	-	1	2	1	-	1	18
2500-2999	5	5	12	13	5	1	3	1	-	-	-	1	1	47
3000-3499	3	5	8	1	4	1	5	-	-	-	-	-	-	27
3500-4000	-	-	2	-	-	-	4	1	-	-	1	-	-	8
total no.	8	10	29	17	11	3	12	2	1	2	2	1	2	100

Table 7: Birth weight wise time taken to reach 95% of SpO_2 in LSCS group

	Time taken from birth												Not reached	Total no.
Birth weight groups	10 min	11-15 min	16-20 min	21-25 min	26-30 min	31-35 min	36-40 min	41-45 min	46-50 min	51-55 min	56-60 min	60-90 min		
2000-2499	1	3	-	-	8	4	4	-	-	-	-	-	-	20
2500-2999	2	5	6	5	16	9	6	1	1	-	1	1	1	54
3000-3499	1	2	5	3	4	3	1	1	-	-	-	-	2	22
3500-4000	-	-	-	-	1	1	1	1	-	-	-	-	-	4
Total number	4	10	11	8	29	17	12	3	1	0	1	1	3	100

Abbreviations: NVD: Normal vaginal delivery; LSCS: Lower Segment Cesarean Section; SpO_2: Peripheral Capillary Oxygen Saturation; Hr: Hour; Min: Minute

RESULTS

There were equal number of newborn in Normal vaginal delivery (NVD) group and cesarean section group (LSCS), 100 in each group. A male female sex ratio of 1.22: 1 was observed in sample (table 1). Male preponderance was observed in both NVD and LSCS group. Mean birth weight in NVD group was 2875 gm and in LSCS group 2800 gm, which is around national average.[11] There were no case of post maturity in data. Mean gestational age was 38.26 in NVD and 38.46 LSCS group respectively. On application of T test, there was no statistically significant difference in distribution of patients between the two groups (p value 1.0) in respect to sex, birth weight and gestation.

The SpO_2 value was recorded at 5 minutes in every newborn as shown in table 2. The target or expected value at this point of time as per NRP guidelines is 80-85%.[12] We observed that a total of 49% had reached the target value of 80-85% but a significant percentage that is 51% had not achieved the desired value at room air.(p value < .05) Newborn in both NVD and LSCS group showed similar pattern. There was no statistically significant difference between the two groups when T test was applied (p value 1.0) However there was a statistically significant number of non-achievers when 100 % were expected to show a value between 80-85% at room air only 51% achieved it.(p value <.05)

The SpO_2 level achieved by 10 minutes is shown in table 3, along with its distribution in different modes of delivery. A significant number in both the groups had achieved the target SpO_2 value by 10 minutes. It means almost 50% of non-achiever group has moved to achiever group by 10 minutes, thereby making the achiever group as 75.5%. We further measured SpO_2 serially and the movement from non-achiever to achiever group steadily increased without any oxygen therapy and without any respiratory distress or tachypnea.

We noted the time by which a newborn achieved $\geq$ 95% of SpO_2, shown in table 4. In total 90.5% newborn achieved this level by 40 minutes and only 9.5% remained who had not achieved. By 90 minutes 97.5% had achieved $\geq$ 95% of SpO_2 levels and only 2.5% did not achieve it.

On further evaluation over 24 hours, it was clear that once $\geq$ 95% of SpO_2 level was achieved it was usually maintained with a variation between 93-97%. It went on upper side up to 100 but did not fall below 93%. as shown in Table 5.

A correlation between birth weight and time taken to achieve $\geq$ 95% is depicted in table 6&7. Maximum number achieved SpO_2 of 95% in 16-20 minutes in NVD group, while maximum number achieved it by 26-30 minutes in LSCS group, thus there was a further delay of 10 minutes in LSCS group as compared to NVD group. Overall a delay of 5 minutes was noticed in about 25% cases in both the groups for achievement of target values.

DISCUSSION

Oxygen supplementation is an important component of newborn intensive care. Oxygen is a drug and needs to be used judiciously. Hypoxia causes brain damage with increased mortality and morbidity, and leads to impaired neurodevelopmental outcome. Excessive oxygen may cause retinopathy.[13] Oxygen affinity is modulated by pH, CO2, temperature and fetal hemoglobin level. Oxygen saturation is influenced by birth weight and mode of delivery in immediate extrauterine life. Post-delivery first 24 hours are very critical for the baby, as newborn is adapting to the extrauterine life. Pulse oximetry is an noninvasive easy method for measuring arterial oxygen saturation (SaO_2) in newborns and governs the need, rate and mode of oxygen delivery.[14] SpO_2 has been found to be independently related to mode of delivery and is reported to be lower in some studies in neonates born by Cesarean section and higher in some.[15] But in our study, we did not find any statistically significant difference between the two mode of delivery at any point of time. No relationship has been reported with gender as a variable. We also did not find any difference with gender as a variable. There were equal number of newborns in both the groups, 100 in each. Sample characteristics matched each other in both the groups statistically. SpO_2 measured at 5 minutes shows that whatever level they achieved their was no statistically significant difference between the two groups. However a delay in achievement of target SpO_2 level was observed in both the groups. Cumulative achievers of target value of 80-85% were 49%, and no achievers 51%. We expect all normal healthy newborn to achieve this value by 5 minutes on room air unless their transition time is delayed because of some reason. SpO_2 has been found to be lower at high altitudes.[16] There was no statistically significant difference observed between the values achieved in newborns in NVD or LSCS group, hence we attributed this delay to higher altitude. Only 50.46% had achieved the desired SpO_2 value by 5 minutes, which is almost a 50% failure rate, when considered statistically it is highly significant and cannot be attributed to chance. (p value < 0.5). When SpO_2 was observed at 10 minutes 24.5% were lagging behind the target value of 85-95%. However a significant proportion, almost 50% of non-achievers of target SpO_2 at 5 minutes had moved to achiever group by this time. So there was a steady shift towards achiever group and 75% of new born had achieved their target by 10 minutes in comparison to 50% at 5 minutes time. We concluded that a delay of 5 minutes is normal at higher altitudes as they achieved this on their own and did not present with any respiratory distress or tachypnea. No oxygen was supplemented. Hence we concluded that newborn at higher altitudes take more time in transition phase. This delay can be attributed to higher altitude and associated lower ambient temperature on hills. This fact should be kept in mind while supplementing oxygen at higher altitudes. SpO_2 alone need not be the only guiding factor, rather overall condition of the baby, its behavior, feeding, tachypnea, distress all should be considered. We recommend that Instead of an absolute value, a flat line over a period of time or fall in SpO_2 should be the guiding factor where as a slow but steady rise should be considered normal at higher altitudes. It takes longer time to achieve targeted SpO_2 levels at higher altitudes as those 24.5 % who remained, also slowly moved to achiever group by 30-40 minutes. Only 2.5% did not achieve it and they either developed respiratory distress or tachypnea on room air and needed oxygen support. No statistically significant difference was observed in between the SpO_2 levels progress of NVD and LSCS group over 24 hour period.

Higher altitudes are associated with lower ambient temperature especially in winters. Recommended delivery room temperature of 26-28 degree Centigrade is commonly not maintained especially in winters, in developing countries like India due to scarce resources, availability of electricity, knowledge aptitude and practices of persons. In our study the ambient room temperature was maintained around 24.5°C. Separate relationship of SpO_2 with ambient room temperature as a variable over day and night in 24 hour period was not studied.

SpO_2 has also been suggested as a screening tool for identification of congenital heart disease.[17,18] While considering this fact, it appears that reverse is also true, meaning thereby that achievement of $\geq$95% of SpO_2 on room air and its persistence beyond nearly rules out any complicated congenital heart disease and can be used as a sign of normal circulatory transition from fetal to extrauterine life and non-achievement in absence of respiratory distress a marker of congenital cyanotic heart disease. In our study we found that SpO_2 value can be used both as

positive & negative screen to exclude critical heart disease. Achievement of ≥95% SpO_2 within few hours of birth, was taken as a negative predictor of critical congenital heart disease, and non-achievement in absence of respiratory distress a marker of critical congenital cyanotic heart disease. In our study those who did not achieve a level of ≥90% SpO_2 by 30-40 minutes were supplemented with oxygen. One in each group did not improve with oxygen supplementation. Both on further investigation at cardiac center were found to have multiple complicated congenital cardiac defects undetected in antenatal USG. 2 newborns, one in each group did not respond to oxygen therapy and their saturation remained around 84-88% with or without oxygen therapy. No improvement in SpO_2 levels with oxygen and its Non maintenance ≥ 90% even with oxygen supplementation was the earliest sign of cardiac anomaly observed. Both of them died at cardiac centers on follow up. We also concluded that a SpO_2 value of on room air ≥ 95% has a negative predictive value of being free from serious cardiac problem, a lower value and non-improvement with oxygen therapy is a strong pointer towards serious cardiac structural defects. SpO_2 normally stabilizes after 24 hours.[19,20] In our study we found that SpO_2 stabilized within few hours and once a level of ≥ 95% was achieved, usually within 6 hours of birth, significant dips in SpO_2 were not seen over 24 hours unless baby developed some respiratory problem Table 6.[21] Further measurements of SpO_2 levels showed that once a saturation of ≥ 95% was reached at room air, it did not fall, it went further up to 96-100% level and remained consistent with only slight variations, with a lower limit being 93%.

Room air resuscitation has replaced the 100% oxygen resuscitation of yester years, yet the question of when to supplement oxygen and when not, to those neonates who do not require resuscitation efforts initially and yet have not achieved the target SpO_2 saturation on minute to minute basis remains unclear. Both hypoxia and hyperoxia are unwanted and the dilemma continues. As even a brief oxygen exposure triggers long term effects and may influence cell growth & development. Walking on this tight rope of decision making and balancing the issue is a skill which needs support of evidence based approach, we have tried to gather that. The question of room air versus oxygen for resuscitation has been answered by many but should SpO_2 be the only guiding factor later for oxygen supplementation on minute to minute basis still remains. Rao & Ramji published that there is a large variation of saturation of oxygen in normal newborn in 1st 10 minutes. But what are the guiding factors beyond this 10 minutes time?. We have tried to gather evidence regarding this, although the number of newborns studied is limited. We found that a steady rise of SpO_2 on room air should be the guiding factor and not an absolute value in first few hours after birth. Those who are not able to make a successful transition develop other signs like tachypnea or respiratory distress, retractions etc. while others may continue to make a slow progress and should be given more time to adjust. This phenomenon was observed in both NVD and LSCS group. Time was noted when newborns achieved ≥ 95% of SpO_2 level for the first time (table 4) It is clear that 90% had achieved this by 40 minutes of age and by 90 minutes all except 1% had reached it with or without oxygen support Oxygen support was needed for varying period of time. Those who did not reach it even with oxygen supplementation had cardiac reason for that.

There were 7 newborn in NVD group and 11 in LSCS group who needed oxygen support at 30-40 minutes to maintain target SpO_2 levels. Out of which in NVD group 2 needed it , but by 3 hours of life they were on room air, 2 were LBW and they needed support till 6 hours of life, 2 developed Meconium pneumonitis and needed support till 24 hours and further, 1 never maintained saturation and was referred to cardiac center.

In LSCS group 11 needed oxygen support at 30-40 minutes. 2 maintained saturation by 3 hours and were out of oxygen therapy. 2 lbw needed oxygen till 6 hours. 2 developed Meconium pneumonitis and needed oxygen till 24 hours and further, 2 had dip in saturation at 3 hours and were found to have TTN and needed oxygen support for < 24 hours. 2 developed RDS and were on oxygen till 24 hours and further, 1 never maintained it and was referred to cardiac center.

Birth weight wise achievement of SpO_2 levels of ≥ 95% in NVD and LSCS group are given in table 6 & 7 respectively. Maximum number of newborn were in weight category 2500-2999 gm in both the groups and maximum number had achieved this by 30 minutes in both the groups. There was no statistically significant difference between the SpO_2 levels in two groups.

CONCLUSION

No statistically significant difference was observed between different modes of delivery in our study, as observed in some other studies. Normal vaginal or cesarean section mode of delivery does not affect the SpO_2 level in newborn.

Achievement of 95% SpO_2 levels within one hour can be considered as a negative screening tool for critical congenital heart disease. Non maintenance of SpO_2 > 90% as a posiitve indicator of serious structural cardiac defect.

Transition and adaptation time is more at higher altitudes and target SpO_2 levels are reached later at high altitudes. In absence of respiratory symptoms & signs, SpO_2 alone may not be considered as the only guiding factor for oxygen supplementation in first few hours after birth and a stationary or falling SpO_2 levels with other signs should be considered an indication for oxygen therapy, whereas a rising trend should be observed further.

REFERENCES

1. Pileggi CSC; Air versus oxygen for resuscitation of infants at birth: RHL commentary. The WHO Reproductive Health Library; Geneva: World Health Organisation. Available from: URL: https://extranet.who.int/rhl/topics/newborn-health/air-versus-oxygen-resuscitation-infants-birth Accessed November 09,2016.

2. Allison H, Patricia R, Apgar scores and oxygenation levels: a comparison of vaginal and cesarean section modes of delivery. URJHS Volume 9, 2010; Accessed June 20, 2018 www.kon.org/urc/v9/holt.html

3. Vento M, Anesi M, Sastre J et.al. Resuscitation with room air instead of 100% oxygen prevents oxidative stress in moderately asphyxiated term neonates. Pediatr. 2001;107(4):642-7.

4. Yacov R, Nalini S, Alberto NA. Room air Versus Oxygen Administration for Resuscitation of preterm infants: The ROAR study. Pediatr. 2011;128(2):374-381.

5. Gautam S, Agarwal A. Oxygen saturation trends in newborn after birth. JEMDS. 2015; 63(4):11037-11042.

6. Alet R, Knut Q, Jan T. Oxygen saturation in healthy newborns;

influence of birth weight and mode of delivery. J. Perinat. Med. 2009;37:403-406.
7. Bakr A, Babib HS. Normal values of pulse oximetry in newborns at high altitude. J Trop pediatr. 2005;51:170-173.
8. Saugstad OD. Oxygen for newborns: How much is too much?. J Perinatol.2005;25:845-9.
9. Jobe AH, Kallapur SG. Long term consequences of Oxygen therapy in the neonatal period. Semin Fetal Neonatal Med.2010;15(4):230-5.
10. Oster ME, Aucott SW, Glidewell J, et.al. Lessons learned from newborn screening for critical congenital heart defect. Pediatrics 2016;5:137.
11. Singh M. Disorders of weight and gestation In Care of the newborn 8th ed. New Delhi:.CBS Publishers;2015.p299-322.
12. Gary MW, Jeanette Z .Textbook of neonatal Resuscitation (NRP),7th ed.2016: AAP & AHA publications, USA.
13. Saugstad OD. Oxygen and retinopathy of prematurity. J perinatol 2006;5:563-4
14. Suwattanaphim S, Yodavuhd S, Puangsaart S. Time duration of Oxygen Adaptation immediately after birth ; monitoring by pulse oximeter in perinatal period of the infants at Charoenkrung Pracharak Hospital. J Med Assoc Thai. 2015;Jul;98(7):656-63.
15. Rosvik A, Oymar K, Kvaloy JT, Berget M. Oxygen saturation in healthy newborns; influence of birth weight and mode of delivery. Journal of Perinatal medicine. 2009;37:403-406.
16. Salas AA. Pulse Oximetry values in healthy term newborns at high altitude. Ann Trop Paediatr.2008;28(4):275-8.
17. Al Mazrouei SK, Moore J Ahmed F et.al. Regional implementation of newborn screening for critical congenital heart disease screening in Abu Dhabi. Pediatr Cardiol 2013; 34:1299.
18. MN Plana, J Zamora, G Suresh, LF Pineda, S Thangaratinam, AK Ewer. Pulse oximetry screening for critical congenital heart defects. Clinical Biostatics Unit, Ramón y Cajal Hospital (IRYCIS), CIBER Epidemiology and Public Health (CIBERESP), Carretera de Colmenar Km 9.100, Madrid, Spain, 28034. Accessed May 10, 2018, Cochrane library. wiley.com/ doi/10.1002/14651858.CD011912.pub2/full
19. Hay WW, Brockway JM, Eyzaguirre M. Neonatal pulse Oximetry: Accuracy and reliability. Pediatrics. 1989;83(5):717-22.
20. Levesque BM, Pollack P, Griffin BE, Nielsen HC. Pulse Oximetry: What is normal in the newborn nursery?. Pediatr Pulmonol.2000 Nov;30(5):406-12.
21. O brian LM, Stebbens VM, Poets CF et.al, oxygen saturation during the first 24 hours of life. Arch Dis Child Fetal Neonatal Ed. 2000;16:168-78.

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