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Intrauterine Growth Curves for Singleton Live Babies in Paropakar Maternity and Women's Hospital in Nepal

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ABSTRACT

Background: To construct birth weight, crown heel length and head circumference centile chart referenced to gestational age for Nepalese infants.

Methods: The study was conducted over a period of six months. It included consecutive live births from 28 to 42 weeks of gestation. Their birth weight, crown-heel length and head circumference were recorded. Smoothed percentile values along with curves were created using the Lambda Mu Sigma (LMS) method. The curves were compared with one of the Indian study.

Results: A total of 9710 newborns were measured. The mean birth weight, crown-heel length, head circumference at 40 weeks were 3023g, 49.22cm and 33.61cm respectively. Smoothed percentile values calculated gave the cutoffs for defining small and large gestational age for Nepalese newborns. Comparison with Indian study showed significant difference ($p<0.01$) in weight. The Indian babies weighed less than Nepalese babies.

Conclusions: The referenced growth standards help in clinical assessment, defining and identifying high risk newborns, thus, leading to improved care and management of neonates. It should help public health policy makers to track population difference due to several factors, intervene and find response over time.

Keywords: centile, crown-heel length, gestation, growth curves, head circumference, newborn and weight.

INTRODUCTION

Intrauterine growth is viewed in three main components: birth weight, crown-heel length and head circumference. Intrauterine growth curves are used for clinical assessment of neonates to determine perinatal growth, risk factors and the need of postnatal monitoring in high risk newborns along with their outcomes.

Birth weight is determined by the gestation and reflects intrauterine development of the newborn. Neonatal outcome of babies with similar weight but different gestation varies. Length at birth is a reflection on the intrauterine accretion of lean-mass.[1]

Lubchenco and her co-workers[2] in 1963 were first to present intrauterine growth in the form of centile curves using weight, HC and crown-heel length. Many growth curves have been published by different authors reflecting growth patterns of diverse population in various parts of the world.

The disadvantage of cross-sectional growth curve is that they are developed from anthropometric data at different gestational ages to represent longitudinal growth of fetus in utero. The growth curves based on ultrasound estimated fetal weight have the question of accuracy. A comprehensive auxological evaluation of the neonate should consider not only weight, length and head circumference at birth but also fetal ultrasound biometry and Doppler velocimetry.[3]

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The present study attempts to have intrauterine growth pattern of Nepalese population and project the growth in percentiles and curves.

METHODS

The study was a prospective cross-sectional study. It was conducted over six months (March to August 2010) at Paropakar Maternity and Women's Hospital including. All the live birth delivered during the study period was included in the study and ethical approval was taken by the Institutional Review Board. Gestational age was estimated by first day of the last menstrual period. In cases where LMP was unknown or in clinically discrepant cases, it was confirmed by clinical assessment using New Ballard's scoring system. If the difference between LMP and scoring was more than two weeks then gestational age estimated by scoring was included. Birth weight was measured within 24 hours of birth on the electronic weighing machine to the nearest ±5 grams. Crown heel length was recorded to the nearest 0.1cm using infantometer. HC was measured with the locally available measuring tape.

Following details were recorded for enrolled newborns: name and age of the mother, address, ethnic group, maternal and paternal occupations, maternal and paternal educational levels, significant present and past illness, obstetric history, last menstrual period (LMP), expected date of delivery (EDD), Apgar score, weight, sex and anthropometry.

The mean, standard deviation, and 3^{rd}, 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, 97^{th} centiles of each variable at each gestation were computed for all live born infants. Thereafter, centile charts and growth curves were constructed with statistical analysis.

Still birth, multiple pregnancy, gross congenital malformation and hydrops were excluded.

Microsoft 2007 Excel, Growth Analyzer 3.5, SPSS 17 was used for data analysis. Cole's[4] Lambda Mu Sigma(LMS) method estimates three age specific parameters: (L) a Box-cox power transformation of skewness, (M) median, and (S) coefficient of variation that correspond to the relationships in the following formulas: $Z=\{(x/M^{L} -1)/LS$, where X is the measured value of weight (in kg), length, or HC; and $Centile=M(1+LSZ)^{1/L}$, where Z is the z-score that corresponds to a given percentile (http://ad314_statistical.ht). A smoothed percentile curve or an individualized score can be obtained from the smoothed values of L, M and S. Inspection of the calculated Z-score distributions by GA was used to know whether the curves fit these data well at all gestational ages. Chi-square test of goodness of fit was used to compare the Nepalese and Indian data. $p>0.01$ indicated that both data were compatible while $p<0.01$ was taken as significant difference.

RESULTS

There were 9,710 live newborns which were analyzed over a period of six months. Total number of babies along with number in each sex (Table 1). The mean and standard deviation of each variable at each gestation was computed (Table 2). Smoothed percentile values (3^{rd},10^{th},25^{th},50^{th},75^{th},90^{th},97^{th}) of weight, HC and CHL were calculated for each gestation (Table 3,4,5). Smoothed curve values of the 3^{rd},10^{th},25^{th},50^{th},75^{th},90^{th}, 97^{th} percentiles for weight, HC and CHL were plotted against gestation (Figure 1-3).The mean weight at 40 weeks gestation was 3023gms, HC 33.61cm and CHL 49.22cm. These measurements were normally distributed. We compared our growth curve with Indian curves[5] for 10^{th}, 50^{th} and 90^{th} centile. The p value for each gestation in comparing HC, weight and CHL was calculated. Chi-square test of goodness of fit was used (df=14). The comparison is shown in the form of curves (Figure 5-12).

Table 1. Number of newborns at each gestation.

Gestation (weeks)	Females (n)	Males (n)	Total (n)
28	5	7	12
29	8	8	16
30	12	11	23
31	14	20	34
32	24	35	59
33	37	37	74
34	38	44	82
35	68	64	132
36	129	138	267
37	250	292	542
38	528	587	1115
39	936	1122	2058
40	1805	1940	3745
41	473	481	954
42	289	308	597
Total	4616	5094	9710
%	47.5	52.5	100

The HC from 37 to 42 weeks in 50^{th} centile ranged from 32.20cm to 34.39cm. The CHL in the same gestation period ranged from 47.65cm to 49.81cm. The 50^{th} centile value of weight between 37 to 42 weeks was from 2669.79gms to 3124.34gms. The rate of increase in weight had a slow pace from 39 weeks onwards similar to other studies.[2,6-8] Similar pattern was seen for CHL from the centile chart similar to other studies[6,7] while values of HC did not show the same trend as reflected from the curve, rather it showed almost constant

increment in values. This pattern of HC differed from one of the Hispanic study,[7] where 50th centile reflected near flattening 40 weeks onwards, while increment in our study was similar to Chinese study.[6] The 50th centile value of weight at 40 weeks in the Lubchenco[2] study was 3230 gms which was 205gms more than our present study.

Table 2. Mean weight(g), mean CHL(cm), mean HC(cm) and their standard deviation at each gestation.

Gest-ation (weeks)	Mean weight (g)	Mean CHL (cm)	Mean HC (cm)	Standard Deviation		
				Weight	CHL	HC
28	1040.5	36.4	26.6	72.9	1.86	0.67
29	1144.3	37.84	27.78	82.9	1.48	0.66
30	1294.7	39.13	28.51	95.1	1.73	0.68
31	1433.1	40.63	29.2	107.5	1.42	0.73
32	1642.8	42.2	29.66	147.8	1.23	0.75
33	1771.1	42.89	30.63	198.1	1.25	3.88
34	1981.6	44.34	30.86	250	1.35	0.9
35	2272.8	45.88	31.19	359.7	1.83	0.99
36	2449.8	46.81	31.55	391.5	1.76	0.9
37	2695.8	48.12	32.12	386.9	1.93	0.91
38	2829	48.49	32.67	393.7	1.8	0.9
39	3000.97	49.18	33.23	359.7	1.66	0.93
40	3023	49.22	33.61	367	1.52	1.04
41	3087.48	49.38	34	392.53	1.68	1.13
42	3089.18	49.67	34.26	369.26	1.5	1.14

Table 3. Smoothed percentile values of birth weight (g) for each gestation from 28 to 42 weeks.

Gestation	Smoothed percentiles						
(weeks)	c3	c10	c25	c50	c75	c90	c97
28	691.743	771.244	854.948	950.112	1048.54	1142.43	1235.79
29	819.235	911.602	1008.79	1119.23	1233.39	1342.25	1450.45
30	945.979	1050.66	1160.74	1285.76	1414.93	1538.04	1660.38
31	1083.8	1201.4	1325	1465.28	1610.16	1748.18	1885.28
32	1225.57	1356.03	1493.07	1648.52	1808.98	1961.79	2113.52
33	1382.67	1526.94	1678.37	1850.07	2027.2	2195.82	2363.18
34	1543.79	1701.73	1867.43	2055.2	2248.82	2433.05	2615.85
35	1715.87	1887.84	2068.16	2272.37	2482.84	2683.02	2881.57
36	1879.36	2063.96	2257.41	2476.38	2701.95	2916.4	3129.02
37	2036.7	2232.57	2437.71	2669.79	2908.75	3135.82	3360.87
38	2167.21	2371.37	2585.07	2826.7	3075.37	3311.57	3545.59
39	2272.62	2482.11	2701.27	2948.93	3203.67	3445.54	3685.08
40	2343.34	2554.8	2775.89	3025.62	3282.36	3526.02	3767.24
41	2398.58	2610.25	2831.43	3081.12	3337.68	3581.07	3821.93
42	2444.26	2655.29	2875.68	3124.34	3379.73	3621.89	3861.46

Table 4. Smoothed percentile values of CHL (cm) for each gestation from28 to 42 weeks.

Gestation (weeks)	Smoothed percentiles						
	c3	c10	c25	c50	c75	c90	c97
28	32.823	34.1	35.45	36.994	38.605	40.158	41.721
29	34.0124	35.336	36.734	38.334	40.004	41.613	43.233
30	35.157	36.525	37.971	39.624	41.35	43.014	44.688
31	36.333	37.747	39.241	40.95	42.734	44.453	46.183
32	37.451	38.908	40.448	42.209	44.048	45.82	47.603
33	38.577	40.078	41.664	43.479	45.372	47.198	49.035
34	39.619	41.161	42.79	44.654	46.599	48.474	50.36
35	40.629	42.21	43.881	45.792	47.786	49.709	51.644
36	41.5074	43.122	44.829	46.781	48.819	50.783	52.76
37	42.286	43.931	45.67	47.659	49.735	51.736	53.75
38	42.891	44.56	46.324	48.341	50.447	52.477	54.519
39	43.37	45.058	46.841	48.881	51.01	53.063	55.128
40	43.697	45.39	47.195	49.25	51.395	53.463	55.544
41	43.963	45.674	47.482	49.55	51.708	53.788	55.882
42	44.197	45.917	47.735	49.814	51.983	54.075	56.179

Table 5. Smoothed percentile values of HC (cm) for each gestation from 28 to 42 weeks.

Gestation (weeks)	Smoothed percentiles						
	c3	c10	c25	c50	c75	c90	c97
28	25.622	26.215	26.832	27.526	28.239	28.914	29.583
29	26.163	26.759	27.378	28.075	28.789	29.467	30.138
30	26.685	27.283	27.904	28.603	29.319	29.998	30.67
31	27.224	27.823	28.446	29.147	29.864	30.544	31.217
32	27.74	28.341	28.965	29.666	30.385	31.065	31.737
33	28.269	28.871	29.496	30.197	30.916	31.596	32.268
34	28.773	29.375	30	30.701	31.419	32.098	32.769
35	29.288	29.889	30.514	31.214	31.931	32.609	33.278
36	29.779	30.38	31.003	31.703	32.417	33.093	33.761
37	30.283	30.883	31.504	32.202	32.914	33.588	34.253
38	30.762	31.359	31.979	32.674	33.383	34.054	34.716
39	31.241	31.836	32.453	33.144	33.8509	34.517	35.175
40	31.682	32.274	32.887	33.575	34.276	34.938	35.591
41	32.119	32.708	33.317	33.999	34.695	35.352	35.999
42	32.533	33.117	33.721	34.398	35.0887	35.739	36.3814

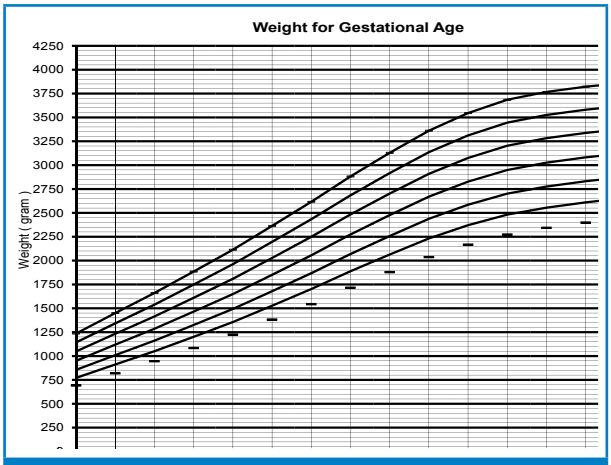

Figure 1. Smoothed curve for birth weight

Figure 2. Smoothed curve for crown-heel length.

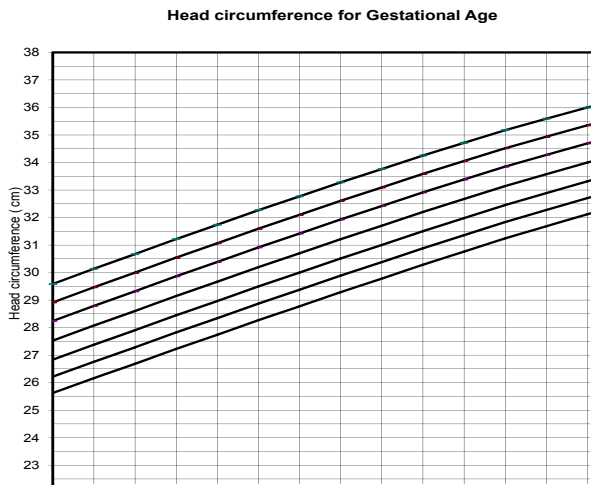

Figure 3. Smoothed curve for head circumference.

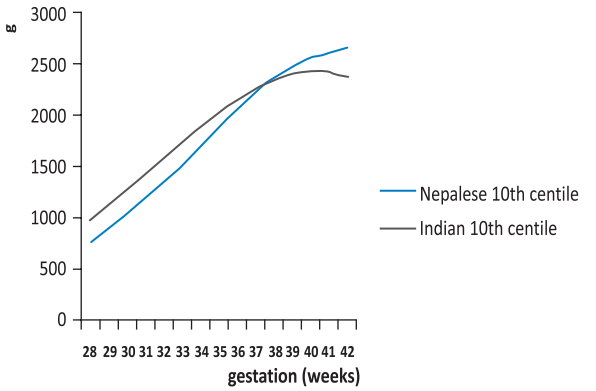

Figure 4. Curve comparing Nepalese and Indian weight for 10th centile.

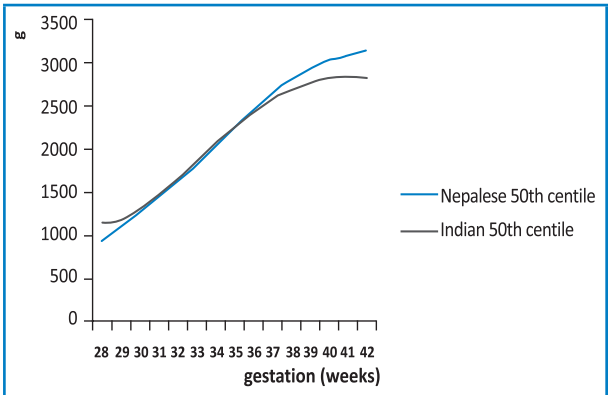

Figure 5. Curve comparing Nepalese and Indian weight for 50th centile.

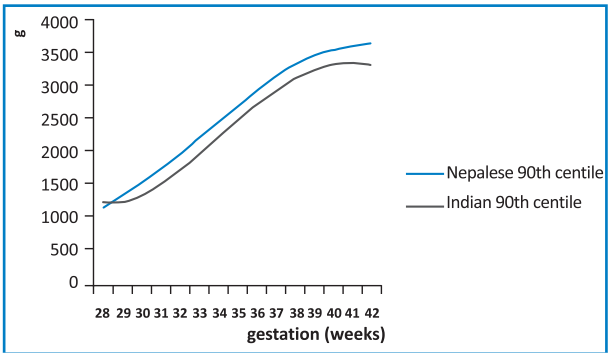

Figure 6. Curve comparing Nepalese and Indian weight for 90th centile.

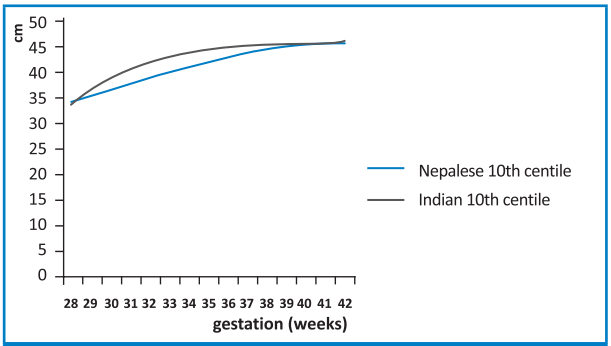

Figure 7. Curve comparing Nepalese and Indian crown-heel length for 10th centile.

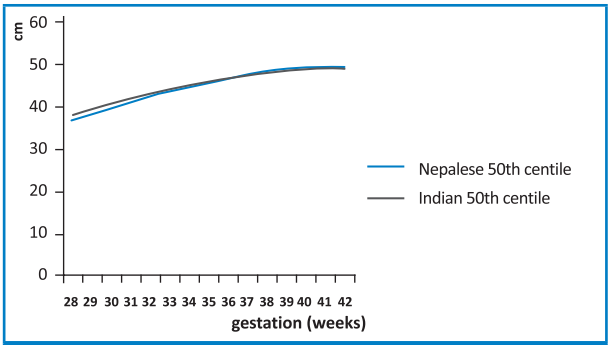

Figure 8. Curve comparing Nepalese and Indian crown-heel length for 50th centile.

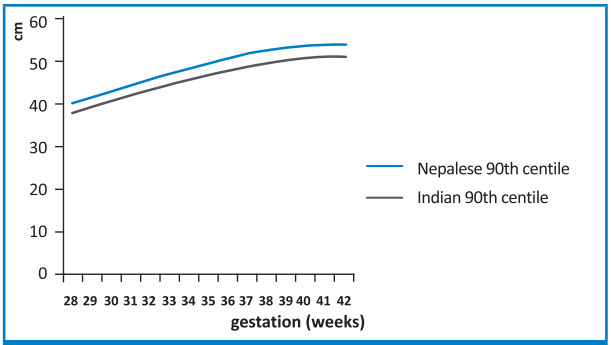

Figure 9. Curve comparing Nepalese and Indian crown-heel length for 90th centile.

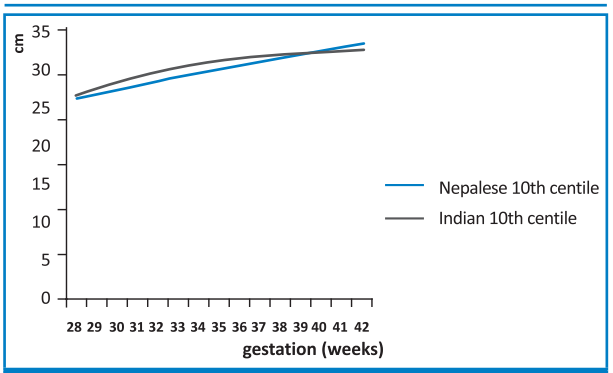

Figure 10. Curve comparing Nepalese and Indian head circumference for 10th centile.

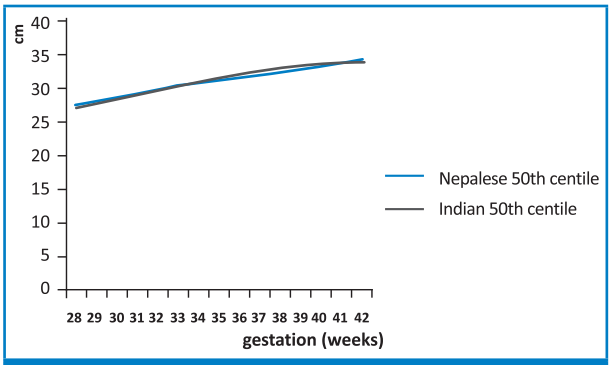

Figure 11. Curve comparing Nepalese and Indian head circumference for 50th centile.

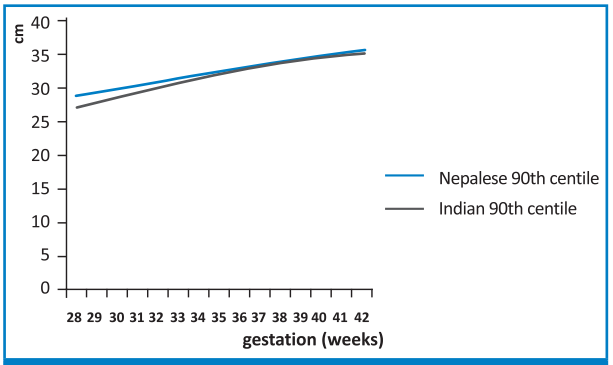

Figure 12. Curve comparing Nepalese and Indian head circumference for 90th centile.

DISCUSSION

We calculated and developed the centile charts and growth curves of the neonates at our hospital. Similar to other studies, the number of the preterm infants between 28 to 30 weeks of gestation was less in comparison to the number of infants above that gestation, especially near or full term babies. Paropakar Maternity and Women's Hospital is one of the hospital with maximum number of deliveries comprising mixed group of population representing different ethnicity, races, castes not only from Kathmandu valley but from other surrounding mountain and hilly areas as well. The plain i.e. Tarai area of the country is not well represented thus, growth study if done in this area could be compared and find if there are significant differences with the present study could be found if any. As we lack such previous data of our country, we could not compare and see how the trend has changed over a period of time.

There are many issues in the construction of gestation specific growth curves. They include, whether the data should be generated from a non-selected sample of the population or a selected sample of "healthy subjects" with no known factors affecting growth.[6] There are many unidentified factors affecting fetal growth too, so developing an ideal reference growth curve is questionable. Secondly, the validity of gestational in such studies whether we use ultrasound estimation, LMP method, maturity assessment using different scoring methods, none is without flaws. Early US assessment has improved the accuracy of estimation of gestational age and the best combination is based on reported LMP and early US assessment.[3]

We compared our study with one of the Indian study[5] in all the three parameters weight, HC and CHL. The p value was also calculated for 10th, 50thand 90thcentile (Figure 4-12). There was no significant difference in values of HC and CHL but p value (<0.01) was significant for weight in all the three centiles. Nepalese children were found to have more weight with significant difference as compared to Indian babies although this Indian data is almost twenty years old. Therefore, the cut-off values for small and large for gestational age would differ from one country to another country, thus emphasizing on the use of local standard growth charts for one's own country or region.

The Lubchenco curves are still used in NICUs in many parts of the world because it had good sample size (>3000 infants), the same sample of infants for all three curves; grid increments (i.e. weekly for GA; every 200g of weight; every 1cm of length/HC); percentiles (versus SDs from mean) for ease of interpretation

CONCLUSIONS

As there is an important relation between body size at birth and the future health of newborns, these charts would be useful in many ways. Neonatal charts clinically detect neonates at high risk of neonatal and postneonatal morbidity and growth impairment, and compare neonatal anthropometric conditions with those observed during postnatal growth.[3] Hence, it would improve the clinical assessment, care and management of our newborns. Also, it would help in finding out the

population difference by geographical areas, ethnicity, socioeconomic states, and other important local factors by public health personnel.[10] In future they can see the trend of growth curves over time and result of the interventions done by them.

Percentile curves should be periodically reviewed because of changes in and of socioeconomic factors that have a temporal influence on a determined population.[8] Intrauterine chart should be updated every 5 to 10 or 15 to 20 years in conformity with the intensity of the "secular trend of growth" in the population.[3]

The cross-sectional anthropometric data of this study like all other similar studies cannot be used for the estimation of the fetal growth velocity as it does not reflect the intrauterine growth of the fetuses. For this longitudinal in utero study of individual fetuses is required.

The drawbacks of our study included lack of data regarding maternal smoking, maternal nutrition and iron status, weight gain during pregnancy and the impact of all this on growth of the fetus.

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