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Impact of Specialized Nursery Care for Late Preterm Infants on NICU Admission Rate and Length of Stay

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Abstract

Objective To compare neonatal intensive care unit (NICU) admission rates and length of stay (LOS) of late preterm infants (LPIs) born before and after opening a specialized care nursery (SCN) at our academic, pediatric tertiary care center with ~4,500 total deliveries annually.

Study Design Retrospective chart review of inborn LPIs ($35^{0/7}$–$36^{6/7}$ weeks) who were asymptomatic or minimally symptomatic at birth and delivered 7 months before the opening of the SCN (pre-SCN) or 7 months subsequently (post-SCN). Infants were excluded for major congenital anomalies or other conditions requiring immediate NICU admission. The pre-SCN options for care were standard couplet care or NICU. The post-SCN options for care were standard couplet care, SCN, or NICU.

Results Pre-SCN ($n = 109$), 73 (67%) infants received standard couplet care, while 36 (33%) infants were ever admitted/transferred to the NICU. Post-SCN ($n = 112$), 59 (53%) infants received standard couplet care, while 20 (18%) were ever admitted/transferred to the NICU. A total of 33 (29%) infants were admitted/transferred to the SCN and avoided a NICU stay. Median LOS for all infants was 3 days.

Conclusion The frequency of LPIs admitted/transferred to the NICU decreased by ~50% after the opening of the SCN. LOS did not differ by birth cohort, but did differ significantly by location of care (standard couplet care < SCN < NICU).

Keywords
- late preterm
- NICU admission
- Length of Stay

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Objective

Late preterm births, which are defined as birth from $34^{0/7}$ weeks through $36^{6/7}$ weeks gestation, account for slightly more than 8% of all children born in the United States and 70% of all children born before 37 weeks gestational age.[1] Numerous investigators have shown that late preterm infants (LPIs) are more likely to be admitted to the neonatal intensive care unit (NICU) and have higher rates of depression at birth (low Apgar scores), respiratory distress, hypoglycemia, feeding problems, temperature instability, and apnea than do term infants.[2–9] In addition, neonatal mortality is 4.6 times higher in LPIs compared with term infants.[10] The level of hospital resources required for LPIs is also greater. LPIs make up the largest proportion of neonates in the NICU, incur the greatest NICU costs, and use most of the neonatal respiratory support provided in the United States.[11]

Most U.S. hospitals with NICU facilities routinely admit all infants less than 34 completed weeks of gestation and/or those with a birth weight less than 1,800 to 2,000 g to a NICU or special care nursery. Those falling into the late preterm range, especially those greater than 2,000 g, however, are not always assigned to these higher care/higher cost units.[6,12,13] Most often, if asymptomatic at birth, these infants are given the same level of care as full-term infants. Similar admission practices have been noted in a recent national survey from England,[14] though there are limited data to support these practices. There are, however, some data to suggest that a lower level of care for LPIs can result in increased readmission rates in the short term.[15] Conversely, a higher level of care may be associated with increased behavioral problems at age three.[16] The American Academy of Pediatrics (AAP) declared in a recent policy statement that more studies are needed to determine the outcome risks of LPIs by level of care.[17]

The University of Oklahoma Children's Hospital is a pediatric tertiary care center with ~4,500 deliveries annually, with 500 of these births identified as late preterm. As part of an ongoing effort to improve the quality of care, the University of Oklahoma Children's Hospital established a specialized care nursery (SCN) for infants $\geq 35^{0/7}$ weeks gestation and $\geq$2,000 g needing a higher level of care than is typically available in our standard mother–baby couplet care unit, but not requiring all the resources and attention available in the NICU. This was done both as a measure to more appropriately allocate resources based on the individual patient's needs, and to provide the greatest level of access and convenience for the newborn's family. Specifically, the SCN is staffed by NICU nurses and provides cardiorespiratory monitoring with continuous pulse oximetry as well as treatments such as short-term intravenous fluids or antibiotics, feedings by orogastric tube, short-term supplemental oxygen by nasal cannula or oxyhood, phototherapy, and temperature monitoring under a radiant warmer. The physical unit contains four monitored beds. Two additional infants can be cared for from the unit while remaining in their mother's room, off continuous monitors, but receiving the same NICU nursing care as those physically in the unit. The nursing to patient ratio in this unit is, at most, 1:3 based on patient census, while the ratio for the couplet care nursery is 1:4. Both the SCN and routine couplet care follow the same recommended monitoring guidelines from the National Perinatal Association.[18] The only difference in the nursing care pathways between the two units is that vital signs are recorded every 3 hours for infants in the SCN as compared with every 4 hours for those in routine couplet care. Feeding protocols and hypoglycemia protocols are the same for both units. Along those lines, access to lactation services throughout the day remains the same for both units.

The current study retrospectively compared the progress and placement of asymptomatic and minimally symptomatic LPIs born prior to the opening of the SCN, who were treated in either our standard couplet care unit or the NICU, with those born after the opening of this unit, who were assigned to either the standard couplet care unit, the SCN, or the NICU. Specifically, we examined NICU admission rates and length of stay (LOS) of LPIs born before and after the opening of the SCN. Also, we analyzed maternal and infant demographic and health characteristics to identify those factors most important in determining the optimal location of care for LPIs born at our facility.

Study Design

We retrospectively evaluated all late preterm births between April 1, 2010, and May 31, 2011 (7 months prior to the opening of the SCN on November 1, 2010 and 7 months subsequent to the opening) at the University of Oklahoma Children's Hospital. Preterm births were divided into two cohorts, those delivered before the opening of the SCN (pre-SCN) and those born after its opening (post-SCN). Infants born at a gestational age of $35^{0/7}$ to $36^{6/7}$ weeks (by best obstetrical estimate or Ballard exam) who were inborn and asymptomatic or minimally symptomatic at birth were included, as these infants met eligibility criteria for admission to the SCN or standard couplet care. Minimally symptomatic infants included those with respiratory distress and/or oxygen requirement but not requiring more than 1 L per minute, as well as those with jitteriness, drug exposure, temperature instability, abnormal tone, low Apgar scores, minor congenital anomalies, or other concerns that did not meet criteria for automatic NICU admission. Charts were reviewed as potentially eligible for inclusion based on gestational age and date of birth. Infants were excluded if they had a major congenital anomaly or other condition and/or other disease process requiring immediate NICU admission, including a birth weight of $<$ 2,000 g, gestational age less than $35^{0/7}$ weeks, or need for a higher level of respiratory support than low-flow nasal cannula. The study design and data collection procedures for this project were approved by the institutional review board at the University of Oklahoma Health Sciences Center prior to project initiation.

In the pre-SCN cohort, infants requiring short-term oxygen, intravenous fluids, continuous cardiorespiratory monitoring, or anything other than standard couplet care were admitted to the NICU. In the post-SCN cohort, these infants were generally admitted to the SCN. In this cohort, the

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disposition of these minimally symptomatic or asymptomatic infants from the delivery room to the NICU, SCN, or couplet care was ultimately at the discretion of the provider, but all providers were encouraged to utilize the SCN as much as possible.

Study investigators collected primary and secondary outcomes data from the medical records of all included infants. Outcomes were analyzed and compared by cohort (pre-SCN vs post-SCN) and location of care (NICU or couplet care in the pre-SCN cohort; NICU, couplet care, or SCN for the post-SCN cohort). In the post-SCN cohort, several infants received care in multiple locations. For purposes of study analysis, infants were analyzed based on the highest level of care they received, regardless of the level to which they were initially assigned. For instance, if the infant was initially admitted to routine couplet care and then transferred to the SCN and subsequently to the NICU, the infant was assigned to the NICU group. Likewise, if the infant was first admitted to the NICU and subsequently transferred to the SCN, the infant was still considered as being in the NICU group.

Preliminary data analysis suggested that the opening of the SCN would reduce the proportion of infants admitted to the NICU by ~16%. Consequently, a target sample size of 222 (111 for each subgroup) was needed to achieve 80% power with a Type I error of 5%. Categorical variables were compared between cohorts using Pearson chi-squared test or Fisher exact test, as appropriate. Continuous variables were compared between cohorts using Wilcoxon rank-sum tests. Because the LOS data was not normally distributed, a Kruskal–Wallis test was used to compare the median LOS for LPIs, by location and birth cohort. The statistical significance of all tests was determined using an α of 0.05.

Logistic regression was used to estimate the log odds of a LPI being admitted to the NICU, before and after the opening of the SCN, while controlling for various predefined maternal and neonatal complications thought to be potentially associated with NICU admission. Maternal complications included pregnancy complications, such as gestational diabetes or hypertension, as well as complications occurring in the intrapartum period, such as prolonged rupture of membranes. Neonatal complications included low Apgar scores, feeding problems, jaundice, hypothermia, hypoglycemia, and respiratory distress. If Breslow–Day testing of these covariates was significant, indicating interaction, a cross-product term between opening of the SCN and the covariate was included in the logistic regression model. The identified subset of covariates and cross-product terms were used to create a maximal logistic regression model. Multivariable logistic regression using variable inflation factors and backward variable selection was used to identify which, if any, covariates could predict the log odds of a LPI being admitted to the NICU. Model parameters were exponentiated to obtain odds ratios.

Results

Of the 393 charts reviewed, 221 met criteria for inclusion (109 in the pre-SCN cohort and 112 in the post-SCN cohort) (►**Fig. 1**). Most of the 170 exclusions were for outborn delivery and/or neonatal condition at delivery necessitating immediate NICU admission, i.e., need for respiratory support beyond low-flow nasal cannula. Maternal and neonatal characteristics were no different between these temporally defined groups, apart from an increased incidence of prior history of preterm labor ($p = 0.03$) and a slight, but nonsignificant increased proportion of male infants ($p = 0.05$) in the pre-SCN cohort (►**Table 1**).

Pre-SCN, 73 (67%) of the included infants received standard couplet care exclusively, while 36 (33%) were ever admitted/transferred to the NICU. Among those that were ever admitted to the NICU, 20/36 (56%) were admitted directly from the delivery room, generally for mild respiratory symptoms (not requiring support beyond low-flow nasal

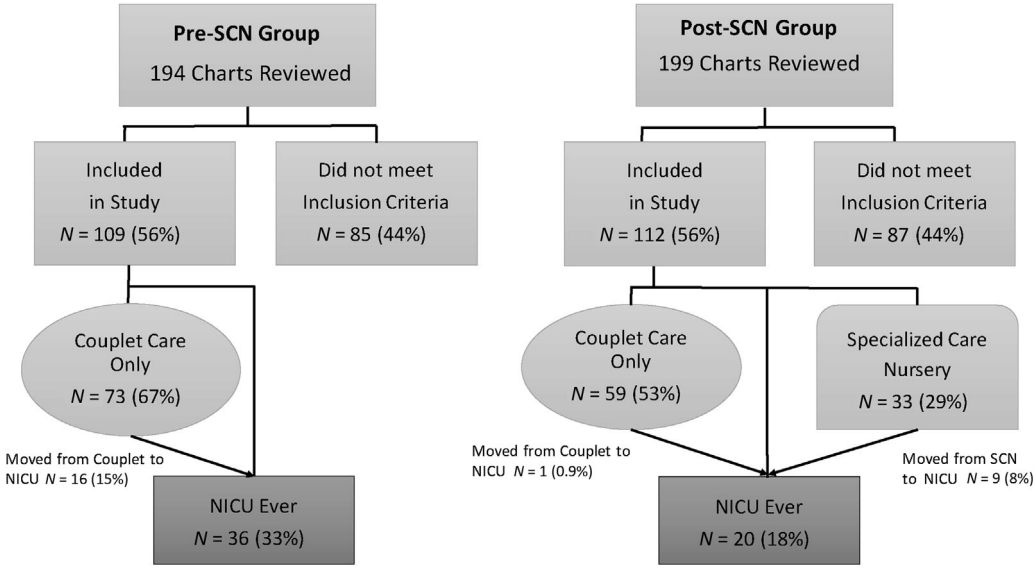

Fig. 1 Location of care of included patients.

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Table 1 Maternal and neonatal characteristics by SCN availability

	Pre-SCN ($n = 109$)	Post-SCN ($n = 112$)	*p*-value
Maternal characteristics			
Maternal age (median years)	27.0	25.5	0.24
Gravida (median)	2.0	2.0	0.68
Pregnancy complications			
Pregnancy-induced hypertension/preeclampsia, *n* (%)	22 (20%)	29 (26%)	0.31
Diabetes mellitus/GDM, *n* (%)	20 (18%)	18 (16%)	0.65
History of preterm labor, *n* (%)	27 (25%)	15 (13%)	**0.03**
Intrapartum complications			
Premature membrane rupture, *n* (%)	69 (63%)	74 (66%)	0.67
Labor induction, *n* (%)	16 (15%)	22 (20%)	0.42
Cesarean delivery, *n* (%)	57 (52%)	45 (40%)	0.07
Intrapartum antibiotics given, *n* (%)	49 (45%)	50 (45%)	0.91
GBS positive status, *n* (%)	19 (17%)	18 (16%)	0.87
Infant characteristics			
Birth weight (median grams)	2,520	2,557	0.71
Gestational age (median weeks)	36.3	36.4	0.89
Length of hospital stay (median days)	3.0	3.0	0.34
Male gender, *n* (%)	64 (59%)	51 (46%)	0.05
Twin gestation, *n* (%)	20 (18%)	25 (22%)	0.46
5-minute Apgar <7/need for resuscitation, *n* (%)	13 (12%)	15 (13%)	0.74
Feeding problems, *n* (%)	30 (28%)	26 (23%)	0.46
Hypoglycemia, *n* (%)	23 (21%)	33 (29%)	0.15
Hypothermia, *n* (%)	21(19%)	27 (24%)	0.36
Jaundice, *n* (%)	22 (20%)	17 (15%)	0.33
Respiratory distress, *n* (%)	16 (15%)	20 (18%)	0.52

Abbreviation SCN, specialized care nursery; GDM, gestational diabetes mellitus; GBS, Group B Streptococcus.
Note: Bold values indicate the statistical significance.

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cannula) that could have been managed in the SCN (had it been available). The remaining 16 infants (44% of all NICU admissions) were transferred to the NICU from standard couplet care for symptomatology such as apnea, temperature instability, or poor feeding (►**Fig. 1**).

In the post-SCN cohort, many infants were admitted to multiple locations at various times in their stay (►**Fig. 1**). From the delivery room, only 10 patients (9%) were admitted to the NICU as compared with 33 (29%) admitted to the SCN and 59 (53%) admitted to standard couplet care. Subsequently, only one patient (0.9%) was transferred to the NICU from standard couplet care, while nine (8%) were transferred to the NICU from the SCN. Of note, seven of the infants admitted or transferred to the NICU were subsequently transferred back to standard couplet care and one was transferred from the NICU to the SCN. In summary, for the post-SCN cohort of 112 patients, 59 (53%) received standard couplet care, while 20 (18%) were ever admitted/transferred to the NICU and 33 (29%) were admitted/transferred to the SCN without ever going to the NICU.

The frequency of LPIs admitted/transferred to the NICU decreased from 33 to 18% ($p = 0.01$) after the opening of the SCN (►**Fig. 1**). Median LOS for all infants was 3 days, both before and after the opening of the SCN. Differences were seen, however, with secondary analysis comparing LOS by location of care (►**Fig. 2**). Median LOS was longer for all patients admitted to the NICU ($n = 56$) at 6 days (range 2–34 days), as compared with all patients admitted to standard couplet care ($n = 132$) with median LOS of 3 days (range 2–9 days, $p < 0.01$). Median LOS was also 3 days in the SCN (range 2–12 days), which was significantly shorter than for all patients admitted to the NICU ($p < 0.01$), but significantly longer when comparing infants in the SCN to those receiving standard couplet care ($p = 0.01$ in post-SCN cohort or $p < 0.01$ when comparing both cohorts of standard couplet care), due to differences in the range of LOS. Among infants ever in the NICU, median LOS trended down from 6 days in the pre-SCN cohort to 4 days in the post-SCN cohort ($p = 0.21$).

No maternal demographic, pregnancy, or intrapartum complications were significantly related to NICU admissions.

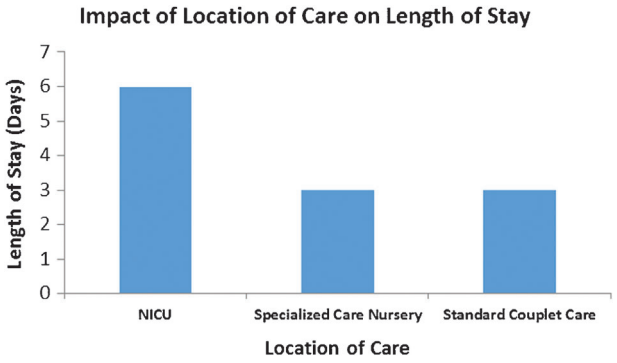

Fig. 2 Impact of location of care on length of stay. $p < 0.01$ for NICU versus standard couplet care and $p < 0.01$ for NICU versus specialized care nursery.

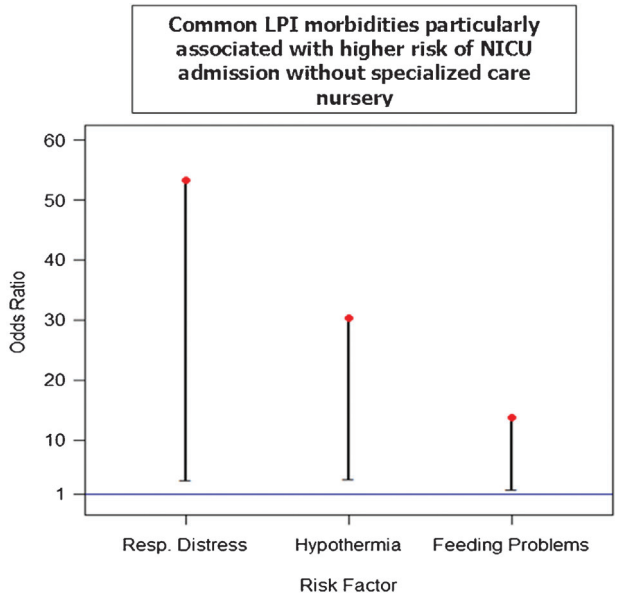

Fig. 3 Common late preterm infants' morbidities particularly associated with higher risk of NICU admission without specialized care nursery.

However, certain neonatal characteristics were significantly associated with NICU admission. These included 5-minute Apgar score < 7 ($p < 0.01$), feeding problems ($p < 0.01$), hypoglycemia ($p = 0.01$), hypothermia ($p = 0.01$), jaundice ($p < 0.01$), respiratory distress ($p < 0.01$), and lower median birth weight ($p = 0.04$) (see ►**Supplemental Table 1**). Length of hospital stay (days) was also included in the model because it remained a significant predictor of NICU admission/transfer status. Logistic regression analysis was performed to analyze the effect of the opening of the SCN on infants with these characteristics. Respiratory distress, hypothermia, LOS, and feeding problems showed significant interaction by Breslow–Day testing and were thus included as cross-product terms. Correcting for significant neonatal covariates and cross-product terms, the odds of NICU admission/transfer for an infant with respiratory distress was 53 times higher (OR = 53, 95% CI: 3, 854) pre-SCN as compared with post-SCN. Similarly, the odds were 30 times higher for those with hypothermia (OR = 30, 95% CI: 4, 252) and 14 times higher for those with feeding problems (OR = 14, 95% CI: 2, 101) (►**Fig. 3**).

Discussion

Our retrospective study showed that NICU admission rates among LPIs were nearly halved after the introduction of the SCN. Nearly all of this decrease was attributable to a dramatic decrease in the number of infants transferred from standard couplet care to the NICU. These infants appeared perfectly well in the delivery room, but subsequently became symptomatic. After the availability of the SCN, these infants seem to have been more promptly recognized and the level of care was escalated appropriately, so that only 1 infant out of 112 (0.9%) was in an unmonitored setting at the time of becoming symptomatic. Perhaps this was because they were more closely monitored than they would have been if only standard couplet care had been available. Interestingly, the proportion of infants identified in the closely monitored setting of either the delivery room or SCN who required NICU admission was constant in both cohorts at 18%. This suggests that there is a fixed but small proportion of LPIs who will need a higher level of care regardless of the availability of specialized nursery care.

Contrary to our expectations, we did not find that infants admitted after the opening of the SCN had shorter lengths of stay. Our hypothesis was based on the prediction that more prompt recognition of common late preterm morbidities such as feeding difficulties would allow for earlier intervention and thus promote earlier discharge. Our data showed that admission to the SCN was actually associated with a significantly *longer* LOS as compared with admission to standard couplet care. While this may appear less optimal in the short term, a large study by Escobar et al showed that among LPIs, a LOS of less than 4 days was associated with a significantly higher rate of readmission as compared with stays of 4 or more days.[19] It is also important to note that the SCN provides more family-centered care, which may result in improved outcomes and family satisfaction. As all of the infants in our study had similar baseline characteristics documented, it seems there may be unmeasured characteristics that contributed to physician decisions regarding the admission location and timing of discharge. More research is needed to better elucidate these factors, so that location of care and LOS can be optimized for LPIs.

Our logistic regression analysis shed some light as to the infant morbidities most readily associated with NICU admission in the absence of the SCN. Respiratory distress, feeding problems, and hypothermia were associated with markedly greater odds of NICU admission prior to the opening of the SCN as compared with afterward. This is in spite of the fact that there were no differences in the baseline rates of these morbidities across the two cohorts. This suggests that an intermediate unit such as ours is particularly beneficial for infants with these morbidities. Moreover, these risk factors may help predict which infants really need transfer to the NICU as compared with those that have a very transient change in status, not requiring escalation of level of care.

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Our NICU admission rate in the pre-SCN cohort was similar to published rates in the literature, which range from 33 to 42% for large populations of 34 to 36 week infants, where the only options are NICU or standard well baby care.[6,13] Few studies have compared intrafacility or interfacility NICU admission rates among facilities with intermediate level of care options for LPIs, such as our SCN. These studies have shown variable NICU admission rates of 9 to 55%, with 25 to 49% being cared for in the intermediate care locations.[5,20] Only one retrospective study by Roblin et al compared care options between multiple facilities and showed a significantly higher risk-adjusted likelihood ratio of admission to the NICU in the one facility without an intermediate care option as compared with those with intermediate care nurseries. The differences could not be explained by variations in neonatal morbidities, payment structure, or bed space availability, but seemed to potentially be related to a higher propensity to start supplemental oxygen at the facility with the highest NICU admission rate.[21] This would be consistent with our finding that respiratory distress was associated with markedly higher odds of NICU admission.

Published data on average LOS suggest consistently higher lengths of stay among LPIs as compared with term infants, with significant variation between centers. Average LOS for 35 weekers ranges from 3 to 7 days, as compared with 2 to 6 days for 36 weekers and 1 to 3 days for term infants.[5,7,13,19,20,22,23] Similar to our data, several studies have shown significantly longer lengths of stay among LPIs admitted to the NICU as compared with those receiving routine nursery care,[19,20,23] but little is known about the impact of intermediate care locations on LOS. Additional work is needed to better elucidate the complex, variable factors that contribute to physician triaging and discharge decisions for LPIs.

The primary limitation of our study was its retrospective design. Because the study was not randomized or controlled, careful effort was made to examine potential covariates affecting NICU admission rates and to control for these effects in our statistical analysis. Strengths of our study include the innovative set-up of our unit with the potential for both rooming-in care and continuous monitoring. To date, there have been no published reports of such a unit and there is limited published data regarding the structure and impact of more traditional intermediate or special care nurseries. Clearly, more studies are needed to examine the impact of location of care of LPIs on patient outcomes, cost, and family satisfaction. Perhaps with additional research, more optimal systems of care can be developed for this population.

Conclusion

This study of asymptomatic or minimally symptomatic LPIs shows that the frequency of LPIs admitted/transferred to the NICU decreased by ~50% after the opening of the SCN, while overall LOS was not affected. Our SCN, which is primarily a designated nursing care plan for infants that may or may not reside in the physical space of the unit, offers a new alternative to traditional special care nurseries by combining the expertise of NICU nurses with the ability to provide family-centered care in the mother's room.

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