Retrospective Clinical Research Report

Journal of INTERNATIONAL MEDICAL RESEARCH

Journal of International Medical Research
50(6) 1–10
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DOI: 10.1177/03000605221100753
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Length of stay and influencing factors of NICU in the Western Hunan, an underdeveloped area of China: A 9-year retrospective study

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Abstract

Objective: To investigate the factors that influence the length of stay (LOS) in a neonatal intensive care unit (NICU).

Methods: This retrospective study analysed clinical data from all newborns hospitalized in the NICU of a tertiary hospital in the Western Hunan area of China over a 9-year period (2012–2020). Factors associated with the LOS were analysed using univariate analysis and Cox regression analysis.

Results: A total of 16 094 newborns were included in the study: of which 9615 were inborn and 6479 were outborn newborns. There were 9482 males and 6612 females. Over the 9-year period, the mean LOS was 11.08 days (median LOS, 9.00 days; range, 1–141 days); and the LOS first increased, then decreased and stabilized. A LOS of 8–28 days was the most common duration (8849 of 16 094; 54.98%). Cox regression analysis demonstrated that sex, patient source, delivery method, gestational age, birth weight and comorbidities were significantly associated with LOS.

Conclusion: Being male, low gestational age and low birth weight increased the LOS. Reducing preterm and post-term infants, as well as eliminating comorbidities, could effectively shorten the LOS of newborns.

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Keywords
Newborn, neonatal intensive care unit, length of stay, influencing factor

Date received: 22 November 2021; accepted: 27 April 2022

Introduction

A long length of stay (LOS) in hospital exposes newborns to unfavourable environments,[1] increases the cost of hospitalization and hinders the interaction between parents and newborns.[2,3] How to shorten the LOS during the effective treatment of newborns is an important issue.

Investigating the influencing factors associated with a long LOS aims to shorten the LOS of newborns. A previous study reported that there were differences in LOS of newborns with the same disease in different regions of Finland.[4] Another study of European newborns found that different characteristics of newborns had a significant impact on LOS.[5] LOS increased significantly with the decrease of gestational age and birth weight.[5,6] LOS decreased significantly with the increase of gestational age and application of early nasal continuous positive airway pressure.[7,8] Other characteristics of newborns such as sex and delivery method also have an impact on LOS.[9–11] A study of very low birth weight infants reported that the LOS of males was higher than that of females.[9] Some reports have demonstrated that the LOS of caesarean delivery (CD) was higher than that of vaginal delivery (VD).[10,11] In addition, compared with VD, CD increased the rate of readmission of the infants.[12]

Western Hunan (Xiangxi) is an underdeveloped area in China that is one of the critical areas supported by the 'Healthy China 2030 Plan'. The aim of this retrospective study was to identify the influencing factors of LOS in a neonatal intensive care unit (NICU) of a tertiary hospital in the Western Hunan over a 9-year period in order to provide a theoretical basis for similar areas in China.

Patients and methods

Hospital status

The Western Hunan area has 17.88 million people, which accounts for 27.2% of the total population of Hunan Province of China. Western Hunan is the only underdeveloped area in Hunan and a large gap exists in the medical treatment level in this area compared with relatively developed areas. The NICU selected for this study is part of the largest hospital in the Western Hunan area with the highest standard of medical treatment in that region. The hospital uses electronic databases to record neonatal status, ensuring data are accurate and credible. The data collected in this hospital were considered to represent the disease spectrum and development of newborn diseases in the Western Hunan area.

Study population

This retrospective study collected clinical data from the electronic medical record database of inpatients at The First People's Hospital of Huaihua, Huaihua, Hunan Province, China. Samples were identified using census sampling. A retrospective analysis was undertaken on all hospitalized newborns discharged from the NICU between January2012 and December2020. All data were reviewed by two researchers (F.X. & Q.X.S.).

The study was conducted according to the Declaration of Helsinki and approved by the Biomedical Ethics Committee of Jishou University, Jishou, China (no. JSDX-2021-0028). Informed consent was not required as this was a retrospective study.

Study methods

The clinical data of all newborns were retrospectively analysed to investigate the effects of different newborn characteristics on the LOS. The analysis was based on each patient's first admission data (sex, patient sources, delivery method, gestational age, birth weight and comorbidities) and any readmission data were not considered. The reporting of this study conforms with the STROBE guidelines.[13]

Statistical analyses

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics of the demographic and clinical characteristics were analysed for all newborns. Categorical data are presented as *n* of patients. Student's *t*-test and F-test were used to compare data. The LOS in different periods is presented as mean and median. Univariate analysis and Cox regression were used to analyse the factors influencing LOS. A *P*-value <0.05 was considered statistically significant.

Results

A total of 17 206 newborns were included in this study. Of these, 1112 newborns were excluded for the following reasons: 406 had incomplete information, 604 had been readmitted to the hospital and 102 remained in hospital for <1 day (Figure 1). The data from 16 094 newborns were included: of which 9615 were inborn (born in the current hospital) newborns and 6479 were outborn (transferred from outside hospitals) newborns. There were 9482 males and 6612 females. Over the 9-year period, the mean LOS was 11.08 days (median LOS, 9.00 days; range, 1–141 days). Over the 9-year period, the mean LOS first increased and then decreased and stabilized (Figure 2). A LOS of 8–28 days was the most common duration (8849 of 16 094; 54.98%), while a LOS of 1–3, 4–7 and >28 days was observed in 9.24% (1487 of 16 094), 30.94% (4979 of 16 094) and 4.84% (779 of 16 094) of newborns, respectively.

Analysis of the characteristics of newborns demonstrated that LOS was significantly associated with sex, patient source, delivery method, gestational age, birth weight and comorbidities ($P < 0.05$ for all comparisons) (Table 1). The mean LOS of male newborns (11.27 days) was significantly longer than that of females (10.80 days) ($P < 0.002$). The mean LOS varied significantly according to the delivery method: the LOS of CD (11.37 days) and induced labour (11.19 days) were significantly higher than that of VD (10.70 days) ($P < 0.001$). Analysis of the LOS of newborns with different gestational ages demonstrated that the LOS increased with the decrease of gestational age. In particular, the mean LOS of <28 week-old infants (35.32 days) was the longest. The LOS was also associated with birth weight, with the newborns with lower or overweight birth weights having a prolonged LOS. Having ≥2 comorbidities was associated with a significantly longer LOS ($P < 0.001$).

Based on the univariate analysis, the sex, patient source, delivery method, gestational age, birth weight and comorbidities were used as independent variables and the LOS was used as the dependent variable for a Cox regression analysis. The results showed that sex, patient source, delivery

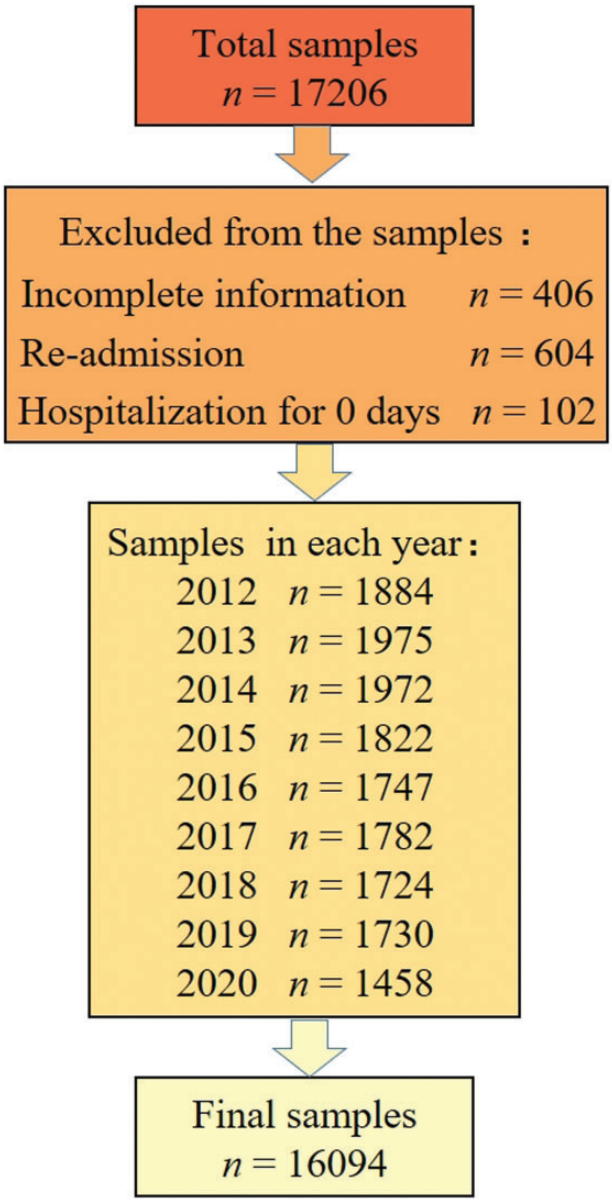

Figure 1. Flow chart showing enrolment, exclusion and analysis of newborns admitted to a neonatal intensive care unit of a tertiary hospital in Western Hunan, China over a 9-year period that were enrolled in a study to investigate the factors influencing the length of stay.

method, gestational age, birth weight and comorbidities were significantly associated with LOS ($P < 0.05$ for all comparisons) (Table 2).

The mean LOS of males and females were 11.27 and 10.80 days, respectively, with the mean LOS of males being 0.47 days (4.35%) longer than that of female

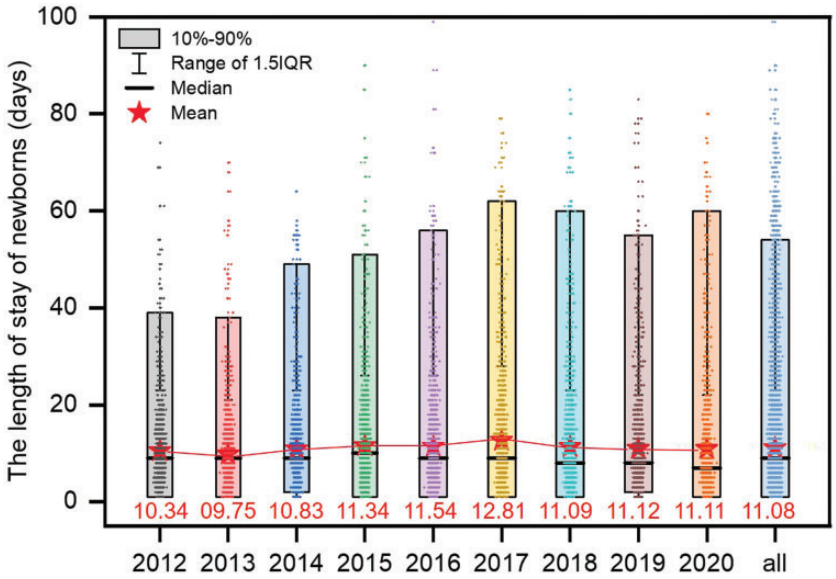

Figure 2. Box-whisker plots of the length of stay of newborns ($n = 16\,094$) admitted to a neonatal intensive care unit of a tertiary hospital in Western Hunan, China between 2012 and 2020. The colour version of this figure is available at: http://imr.sagepub.com.

newborns (Table 1). As shown in Figure 3a, the mean LOS of males and females first increased and then decreased, finally becoming the same, over the 9-year period. The mean LOS of male and female newborns increased from 10.47 and 10.12 days respectively to a maximum mean LOS of 13.08 and 12.44 days respectively in 2017; and then decreased to 11.08 and 11.16 days respectively in 2020. It is worth noting that in 2012–2019, the mean LOS of male newborns was higher than female infants, while it was very similar in 2020 (a difference of 0.08 days).

With regard to the impact of patient source, the mean LOS of inborn newborns was 1.05 days (10.05%) longer than that of outborn newborns (Table 1). Figure 3b shows the distribution of the mean LOS of the newborns based on their patient source between 2012 and 2020. The mean LOS of inborn newborns increased first and then decreased over the 9-year period, which was similar to the changes shown in Figure 3a for the male and female groups. The mean LOS of outborn newborns fluctuated from year to year, eventually showing a downward trend. It is worth noting that between 2012 and 2015, the distribution of the mean LOS of the two patient sources was similar. From 2016 to 2020, the mean LOS of inborn newborns was higher than that of outborn newborns. The difference between the two patient sources gradually increased from 1.5 days in 2016 to 2.24 days in 2020.

With regard to the impact of VD and CD, the mean LOS of newborns born via CD was 0.67 days (6.26%) longer than that of newborns born via VD (Table 1). Over the 9-year period, the mean LOS of VD and CD newborns increased first and then decreased (Figure 3c). It is worth noting that over the 9-year period, the mean LOS of the VD group decreased by 1.5 days, while the mean LOS of the CD group increased by 2.12 days. In addition, the mean LOS of the CD group was 2.8 days

Table 1. Univariate analysis of the relationship between patient characteristics and length of stay (LOS) in newborns ($n = 16\,094$) admitted to a neonatal intensive care unit of a tertiary hospital in Western Hunan, China over a 9-year period.

Characteristic	*n*	LOS, days	X^2	Statistical analysis
Sex				
Male	9482	11.27	3.113[a]	$P < 0.002$
Female	6612	10.80		
Patient source				
Inborn	9615	11.50	7.310[a]	$P < 0.001$
Outborn	6479	10.45		
Delivery method				
Vaginal	6965	10.70	10.198[b]	$P < 0.001$
Caesarean	9096	11.37		
Induced labour	33	11.19		
Gestational age, weeks				
<28	79	35.32	1012.938[b]	$P < 0.001$
28–31 + 6	923	26.19		
32–34 + 6	2345	14.51		
35–36 + 6	3255	10.64		
37–41 + 6	9445	8.70		
≥42	47	10.64		
Birth weight, g				
<1000	60	32.53	1113.867[b]	$P < 0.001$
1000–1499	707	28.01		
1500–2499	4542	13.39		
2500–3999	10 155	8.86		
≥4000	630	9.10		
Comorbidities[c]				
Only one disease	2266	8.68	55.387[a]	$P < 0.001$
≥2 diseases	13 723	11.49		

Data presented as *n* of patients and LOS presented as mean.
[a]Groups were compared using Student's *t*-test; [b]groups were compared using F-test.
[c]One disease was defined as there being only one disease between admission and discharge; ≥2 diseases was defined as two or more diseases or clinical conditions that coexisted with the primary disease and were independent of each other.

Table 2. The Cox regression analysis of the relationship between patient characteristics and length of stay in newborns ($n = 16\,094$) admitted to a neonatal intensive care unit of a tertiary hospital in Western Hunan, China over a 9-year period.

Characteristic	β	SE	Wald	*P*-value	HR	95% CI
Sex	0.086	0.016	28.877	$P < 0.001$	1.090	1.056, 1.125
Patient source	–0.200	0.017	136.860	$P < 0.001$	0.819	0.792, 0.847
Delivery method	–0.037	0.016	5.544	$P = 0.019$	0.963	0.934, 0.994
Gestational age, weeks	0.318	0.011	791.341	$P < 0.001$	1.375	1.345, 1.406
Birth weight, g	0.264	0.016	277.328	$P < 0.001$	1.262	1.262, 1.343
Comorbidities	–0.245	0.021	137.027	$P < 0.001$	0.751	0.751, 0.815

SE, standard error; HR, hazard ratio; CI, confidence interval.

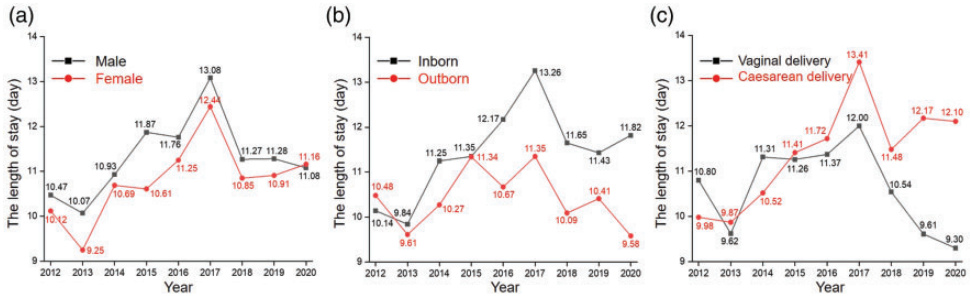

Figure 3. The relationship between sex (a), patient source (b) and delivery method (c) with length of stay in newborns ($n = 16\,094$) admitted to a neonatal intensive care unit of a tertiary hospital in Western Hunan, China over a 9-year period. The colour version of this figure is available at: http://imr.sagepub.com.

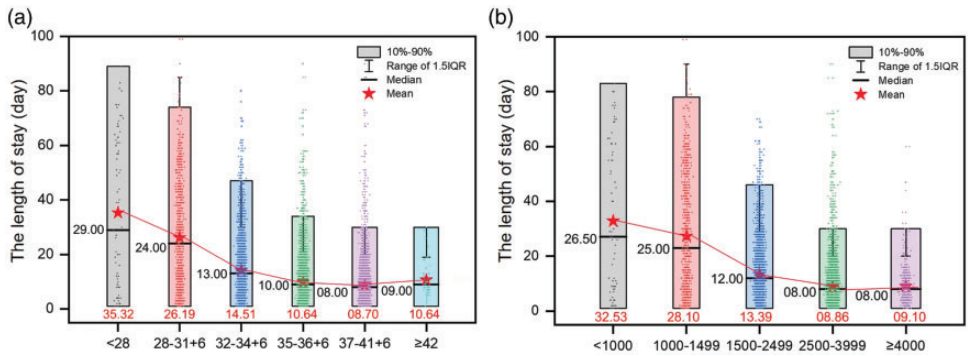

Figure 4. Box-whisker plots showing the relationship between different gestational ages (a) and birth weights (b) with length of stay in newborns ($n = 16\,094$) admitted to a neonatal intensive care unit of a tertiary hospital in Western Hunan, China over a 9-year period. The colour version of this figure is available at: http://imr.sagepub.com.

(30.11%) longer than that of the VD group in 2020.

Figure 4a shows the distribution of LOS with different gestational ages, which was similar to a 'U' curve. The mean LOS of preterm, full-term and post-term infants were 14.48, 8.70 and 10.64 days, respectively; and the median LOS was 12.00, 8.00 and 9.00 days, respectively. These results demonstrated that the shorter the gestational age, the longer the LOS. Compared with full-term infants, the preterm infants (<37 weeks) and post-term infants had a mean LOS that was increased by 5.78 days (66.44%) and 1.94 days (22.30%), respectively.

Figure 4b shows the distribution of LOS with different birth weights. These results demonstrated that the lower the birth weight, the longer the LOS. Over the 9-year period, the mean LOS in the low birth weight infants, normal weight infants and fetal macrosomic infants was 15.55, 8.86 and 9.10 days, respectively; and the median LOS was 12.00, 8.00 and 8.00 days, respectively. Compared with normal weight infants, having too low or excessive birth weight prolonged the LOS. Compared with normal weight infants, the low birth weight infants and fetal macrosomic infants had a mean LOS that was increased by 6.69 days (75.51%) and 0.24 days (2.71%), respectively.

Over the 9-year period, the mean LOS in newborns with only one disease and ≥2 disease comorbidities was 8.68 days and 11.49 days, respectively. A total of 105 newborns had no disease comorbidities. Compared with newborns with only one disease, ≥2 disease comorbidities had a mean LOS that was increased by 2.81 days (32.37%). When the newborns were stratified according to a mean LOS of 1–3, 4–7, 8–28 and >28 days, the proportion of newborns with one disease was 15.80% (358 of 2266), 41.22% (934 of 2266), 40.29% (913 of 2266) and 2.69% (61 of 2266), respectively; and the proportion of newborns with ≥2 disease comorbidities was 8.13% (1115 of 13 723), 29.28% (4018 of 13 723), 57.37% (7873 of 13 723) and 5.22% (717 of 13 723), respectively.

Discussion

In this current retrospective study, the mean LOS was 11.08 days (range, 1–141 days) over a 9-year period for the NICU of a tertiary hospital in Western Hunan, China. The LOS ranged from 8 to 28 days for the majority of newborns (54.98%). This current study found that the LOS was significantly associated with sex, patient source, delivery method, gestational age, birth weight and comorbidities ($P < 0.05$ for all comparisons). The mean LOS of male newborns was significantly longer than that of females ($P < 0.002$), which was consistent with a previous report.[9] In addition, the death rate of males was higher than females.[9]

A previous study reported that the global CD rates have continuously increased from 1990 to 2018.[14] China has one of the highest CD rates in the world.[15] Over the 9-year period of 2012–2020, the current study demonstrated that the mean LOS in the NICU first increased and then decreased, followed by stabilization. It was interesting to note that 2017 had the longest mean LOS and the mean LOS of CD newborns increased from 2016 (see Figure 3c). This was due to China's 'universal two-child policy' that was introduced in 2016, which significantly increased the proportion of mothers with advanced maternal age, maternal complications and multiple pregnancies in 2017.[16,17] The tertiary hospital selected in this current study had a rescue centre for high-risk pregnant women and lying-in women for the Western Hunan region. The CD rate was 56.52% in this current study, which was higher than the 2018 Chinese mean of 36.7%.[18] This resulted in a longer LOS for inborn newborns compared with the outborn newborns. The current results demonstrated that the LOS of the CD group was longer than the VD group, which was consistent with previous reports.[10,11] In addition, CD increases the rate of readmission of infants.[12]

An analysis of the LOS by gestational age demonstrated that the LOS decreased with increasing gestational age but then increased when gestational age went beyond the full-term age in this current study. It is worth noting that being large for gestational age also increased the LOS of newborns in this current study, as did a lower birth weight. In addition, the presence of comorbidities also increased the LOS, which was consistent with previous reports.[2,5,6,10,19,20] A previous study used parametric and semiparametric models to explore the LOS of NICU newborns and found that it was significantly associated with breastfeeding, phototherapy, acute renal failure, presence of mechanical ventilation and availability of central venous catheter.[21] Phototherapy, acute renal failure and mechanical ventilation increased LOS.[21]

A strength of this current work is that it provides an insight into newborn health in an underdeveloped area of China. The LOS was comprehensively investigated via the

census sampling method. The findings of this current study provide the basis for predicting and shortening the LOS of newborns in NICU. A limitation of this current study was that it was a simple study of the influencing factors of LOS. Future research will use machine learning to build a LOS prediction model for clinical practice.

In conclusion, the results of this 9-year retrospective analysis of LOS in NICU newborns in Western Hunan, China suggest that outborn, vaginal delivery and having only one comorbid disease provided protective effects against LOS, whereas being male, low gestational age and low birth weight increased the LOS. Therefore, reducing preterm and post-term infants, as well as eliminating comorbidities, could effectively shorten the LOS of newborns.

Author contributions

F.X. was involved in the writing and design of the manuscript and drafted the initial version of this paper; Q.X.S. and Z.Y.C. were involved in the conceptual framing of the manuscript, review of the background literature and editing of the manuscript; F.X. and J.X.L. participated in the data collection and analysis. All authors have read and agreed to the published version of the manuscript.

Acknowledgements

Thanks to those that participated in the data collection and data entry and the valuable support of the participants.

Declaration of conflicting interest

The authors declare that there are no conflicts of interest.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by Hunan Provincial Innovation Foundation for Postgraduate (no. CX20211063), The National Social Science Fund of China (no. 21XMZ090) and Jishou University school-level scientific research project (no. Jdlc2015).

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