Original Article
Application of obstetric nursing-sensitive quality indicators in continuous quality improvement

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Abstract: Objective: To verify the effect of obstetric nursing-sensitive quality indicators for continuously improving nursing quality. Methods: We retrospectively analyzed the obstetric nurse quality in the First Affiliated Hospital of Chongqing Medical University and University-Town Hospital of Chongqing Medical University from October 2019 to September 2020. Nurses and patients in the Obstetrics Department of the First Affiliated Hospital of Chongqing Medical University and University-Town Hospital of Chongqing Medical University were respectively assigned into an experimental group and a control group. High-quality nursing services were provided to patients in both groups. In addition to the high-quality nursing services, the obstetric nurses in the experimental group received training on obstetric nursing-sensitive quality indicators based on the knowledge-attitude-practice model. An obstetric nursing quality evaluation was conducted between the two groups. Continuous quality improvement was achieved using the plan-do-check-act (PDCA) cycle. The nursing quality was reflected by 14 obstetric nursing-sensitive quality indicators and the nurses' job satisfaction was compared between the experimental group and the control group before and after intervention. Results: The information regarding the nurses and parturients, and the nurses' job satisfaction were not significantly different between the two groups before intervention (P>0.05). Except for information regarding the lateral perineotomy at vaginal delivery, there was no significant difference in other obstetric nursing-sensitive quality indicators between the two groups before the intervention. In the experimental group, the rates of early skin-to-skin contact between mothers and infants, early sucking with exclusive breastfeeding during hospitalization, parturient satisfaction with the nurses' work, and nurses' job satisfaction after intervention were better than before (P<0.05). In the experimental group, the rates of neonatal asphyxia/severe neonatal asphyxia and postpartum hemorrhage following vaginal delivery after intervention was significantly lower than before (P<0.05). The experimental group had better outcomes than the control group in the rates of early skin-to-skin contact between mothers and infants, early sucking with exclusive breastfeeding during hospitalization, parturient satisfaction with the nurses' work, and nurses' job satisfaction (P<0.05). Conclusion: Obstetric nursing-sensitive quality indicators can be used to improve the nursing quality in continuous quality improvement, which is worthy of promotion in clinics.

Keywords: Obstetrics, nursing quality, nursing-sensitive quality indicators, continuous quality improvement

Introduction

Nursing-sensitive quality indicators are quantitative metrics of nursing quality and are also essential tools of hospital nursing quality management [1]. Nursing-sensitive quality indicators are a good way to continuously improve nursing quality, and they are also an important part of nursing quality evaluation [2, 3].

Nursing-sensitive quality indicators are defined as nursing related structure, process and outcome indicators provided by nurses that are mainly affected by nursing work, but for which nurses are not completely responsible by the American Nurses Association (ANA) and the National Quality Forum (NQF) [4]. In 1998, based on Donabedian's structure-process-outcome framework, the ANA issued guidelines of 10 nursing-sensitive quality indicators and their application [2]. In 2016, the nursing center of China's Hospital Management Institute proposed 13 nursing-sensitive quality indicators, but there are no unified obstetric nursing-sensitive quality indicators [5].

With development of China's medical reform and implementation of the two-child policy,

obstetric nursing quality has become more important for hospital managers and families. Most pregnant women in the world do not have serious health problems, thus both the families and pregnant women have a high expectation for health and safety. At present, obstetric nursing-sensitive quality indicators have been widely used in Europe, America and other countries and regions to measure and improve nursing quality. For example, Boesveld et al. constructed 30 structural and process indicators for fertility centers [6]. It was then verified that 28 indicators can be used to evaluate the nursing quality of fertility centers [7]. Pileggi applied five perinatal health care indicators issued by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) in Italy [8]. As a result, the rate of exclusive breastfeeding reached its goal (81%). Based on the 15 indicators for maternal and newborn health service quality, proposed by WHO, Madaj et al. regularly collected the relevant data and analyzed the feasibility in 963 obstetric institutions in 10 middle and low-income countries in Africa and Asia [9]. It was found that some indicators were applicable to clinical practice, and some indicators may be used after improvement or usage of other data collection methods. Zhu of Zhejiang University constructed 16 obstetric nursing-sensitive quality indicators through the improved Delphi method, which has not been verified yet [10]. Therefore, it is necessary to apply these obstetric nursing-sensitive quality indicators to clinical practice and verify their feasibility.

The knowledge, attitude, practice model (KAP model) is a behavioral intervention theory, which divides the transformation processes of human behavior into three sections: knowledge acquisition, belief generation and behavior formation [11]. This model has been widely used in the field of nursing to change the health-related behavior of medical staff and patients. The clinical application of nursing-sensitive quality indicators in China is in the early stage [12]. In clinical practice, identifying, monitoring and tracking nursing-sensitive quality indicators can improve nursing quality [13]. The KAP model was used to train obstetric nursing staff on obstetric nursing-sensitive quality indicators, which helped obstetric nursing staff understand and use these indicators.

Materials and methods

This is a retrospective study. We retrospectively analyzed obstetric nursing quality in the First Affiliated Hospital of Chongqing Medical University and University-Town Hospital of Chongqing Medical University from October 2019 to September 2020. According to the application of obstetric nursing-sensitive quality indicators in nursing work, patients at the First Affiliated Hospital of Chongqing Medical University were classified into an experimental group and patients at the University-Town Hospital of Chongqing Medical University were placed into the control group. The obstetric nursing-sensitive quality indicators built by Zhu were applied to the experimental group for specialty nursing quality evaluation. The implementation results are reported in this study [10]. The evaluation of the 16 obstetric nursing-sensitive quality indicators is shown in **Table 1** (the indicators of continuous support for women in the delivery room were not included due to difficult implementation of this practice at public hospitals).

Subjects

From April to September 2020, the obstetric nurses and patients at the First Affiliated Hospital of Chongqing Medical University and University-Town Hospital of Chongqing Medical University were respectively divided into an experimental group and a control group. Inclusion criteria for obstetric nurses: (1) Nurses on duty from April to September 2020; (2) Nurses who signed the informed consent and were willing to participate in the present study. Exclusion criteria for obstetric nurses: (1) Nurses engaged in advanced training; (2) Intern nurses; (3) Nurses unwilling to participate in the present study. Inclusion criteria for patients: (1) Parturients who were admitted to the study hospitals from April to September 2020; (2) Parturients who signed the informed consent and were willing to participate in the present study. Exclusion criteria for patients: (1) Parturients with mental illness or other non-autonomous expression abilities; (2) Parturients who were unwilling to participate in the present study.

Finally, a total of 146 nurses were recruited in the experimental group, including 1 male and 145 females. There were 51 nurses in the control group, all of which were females. There

Table 1. Evaluation of 16 obstetric nursing-sensitive quality indicators

Indicators	Calculation formula	Remark
Bed-to-nurse ratio for midwives	Ratio of the number of midwives to beds =3:1	Excluding the midwives assigned to the predelivery room.
Continuous support for women in the delivery*	$\dfrac{\text{The number of vaginal delivery continuously supported by professionals}}{\text{The total number of parturients with vaginal delivery}}$	Midwives, music guides and obstetric nurses provide continuous one-to-one support for mothers throughout the whole delivery.
Early skin-to-skin contact between mothers and infants/ early Sucking	$\dfrac{\text{The number of newborns with early skin contact between mothers and infants and early sucking}}{\text{The total number of normal newborns}}$	1. The rate of early skin-to-skin contact between mothers and infants/early sucking refers to the number of newborns having skin-to-skin contact with their mothers for ≥ half an hour in the first hour after birth. 2. The denominator is the number of newborns separated from their mothers after excluding the medically indicated separations; the Apgar score should be ≥8. 3. Both the numerator and the denominator include the cases receiving cesarean section.
Lateral perineotomy at vaginal delivery*	$\dfrac{\text{The number of parturients with lateral perineotomy at vaginal delivery}}{\text{The total number of parturients with vaginal delivery}}$	
Trial of labor with conversion to cesarean section	$\dfrac{\text{The number of trial of labor with conversion to cesarean section}}{\text{The total number of parturients with trial of vaginal labor}}$	Trial of labor begins when the uterine orifice is opened by 2-3 cm after admission into the delivery room.
Exclusive breastfeeding during hospitalization	$\dfrac{\text{The number of newborns with exclusive breastfeeding at discharge}}{\text{The number of healthy newborns}}$	The numerator does not include the newborns receiving artificial breeding, mixed feeding, and with the use of a supplemental nursing system during hospitalization; denominator does not include newborns medically indicated for artificial feeding and mother-infant separation.
Neonatal asphyxia	$\dfrac{\text{The number of newborns with Apgar score of 47}}{\text{The total number of vaginally delivered newborns}}$	The Apgar score was 1 and 5.
Severe neonatal asphyxia	$\dfrac{\text{The number of newborns with Apgar score} \leq 3}{\text{The total number of vaginally delivered newborns}}$	The Apgar score was 1 and 5.
Birth injuries of naturally delivered newborns	$\dfrac{\text{The number of naturally delivered newborns with birth injuries}}{\text{The total number of naturally delivered newborns}}$	Birth injuries mainly include injuries of the bones, organs and nerves and intracranial hemorrhage, with the exclusion of congenital factors such as skeletal dysplasia.
Perineal wound infection following vaginal delivery	$\dfrac{\text{The number of parturients with perineal wound infection}}{\text{The total number of parturients with vaginal delivery}}$	Definition of perineal wound infection: local induration and suppuration of the wound, or even wound dehiscence, with low fever (deep abscess may be combined with high fever). All types of perineal laceration and incision during delivery, including the device-assisted vaginal delivery.
Unintended birth	$\dfrac{\text{The number of unintended birth}}{\text{The total number of birth}}$	Unintended birth refers to unprepared delivery resulting from untimely or inaccurate observation of the stage of labor.
Neonatal hypoglycemia in 24 h	$\dfrac{\text{The number of newborns with hypoglycemia in 24 h}}{\text{The total number of newborns}}$	The numerator is the number of newborns with blood glucose <2.2 mmol/L in 24 h.
Healthy babies born vaginally	$\dfrac{\text{The number of full-term healthy babies born vaginally}}{\text{The total number of full-term babies born vaginally}}$	The Apgar score should be ≥8; for both the numerator and denominator, congenital diseases and deformity in the newborns and poor intrauterine fetal growth are excluded.
III/IV-degree perineal laceration at vaginal delivery	$\dfrac{\text{The number of parturients with III/IV-degree perineal laceration at vaginal delivery}}{\text{The total number of parturients with vaginal delivery}}$	
Postpartum hemorrhage following vaginal delivery	$\dfrac{\text{The number of parturients with postpartum hemorrhage following vaginal delivery}}{\text{The total number of parturients with vaginal delivery}}$	The numerator is the number of parturients within blood loss ≥500 mL in 24 h after vaginal delivery.
Parturient satisfaction with the nurses' work	$\dfrac{\text{The number of parturients with satisfaction before discharge}}{\text{The total number of parturients surveyed}}$	Including both vaginal delivery and cesarean section, sampling or survey of all cases.

Note: Indicators marked by * were not included in the present study.

were 3621 parturients aged 18-52 years old in the experimental group, and 927 parturients aged 19-46 years old in the control group. Overall there were 14 obstetric nursing-sensitive quality indicators which were finally included in this study (excluding two indicators, namely, continuous support for women in the delivery and the incidence of lateral perineotomy at vaginal delivery).

The research protocol was approved by the hospital ethics committee (approval No.: 2019 Research Ethics Approval No. 2019-118).

Interventions

Experimental group: From April to September 2020, the obstetric nurses in the experimental group were trained on the obstetric nursing-sensitive quality indicators online and offline based on the KAP model. The indicators were applied in clinical practice, and obstetric nursing quality was continuously improved.

Building a quality control group: The quality control group consisted of 2 head nurses working in the delivery room and ward, 8 leaders in the delivery room and three ward areas, and 6 primary nurses. The two head nurses were leaders of the quality control group, who were responsible for organizing the quality control group to hold seminars on obstetric nursing-sensitive quality indicators. They were also dedicated to highlighting the importance of the obstetric nursing-sensitive quality indicators and motivating the nurses. Leaders of the ward areas and the primary nurses collected and reported data of the nursing-sensitive quality indicators. The quality control group held a quality control meeting once per month to develop strategies for continuous quality improvement.

Theoretical knowledge training: Multimedia technology was applied to the training for obstetric nursing-sensitive quality indicators in the experimental group. The content of training mainly included background, definitions, meaning, and computational methods for the indicators, which were required to be learned within 2 weeks. According to the opinions of two clinical nurse specialists in our department, it was necessary to enhance theoretical training on important nursing-sensitive quality indicators (e.g., early skin-to-skin contact between moth-

ers and infants/early sucking, neonatal asphyxia, and postpartum hemorrhage following vaginal delivery). For example, the nurses were trained on the definition, etiology, clinical manifestations, treatment principles, and prevention and treatment workflows of postpartum hemorrhage. Literature sharing was also a part of the training in addition to deepening the nurses' understanding about these indicators so as to inform the nurses on the frontiers of research in obstetric nursing. The training was provided on one important indicator per month.

Attitude and belief training: A quality control meeting was held once per month. All nurses in the department were mobilized to participate in the clinical use of obstetric nursing-sensitive quality indicators. Every nurse was encouraged to present recommendations or opinions concerning the quality control of obstetric nursing so as to raise their awareness, responsibility and capacity in nursing. Senior nursing experts were invited to share personal experiences regarding problems encountered in obstetric nursing and their feelings in the manner of narrative teaching. The nurses were inspired to focus on obstetric nursing quality. The nurses' belief in the use of obstetric nursing-sensitive quality indicators was enhanced. The training session was held once per month, three times in total.

Action capacity training: Members of the quality control group and two clinical nursing experts in our department developed the specialty measures to improve the nursing-sensitive quality indicators. For example, for the indicator of neonatal asphyxia, leaders of the ward areas organized the filming of a micro-video on resuscitation for neonatal asphyxia. This micro-video was used in combination with scenario simulation for off-line training of obstetric nurses. All nurses were tested and assessed for their skills in neonatal resuscitation. As to the training on the indicator of postpartum hemorrhage following vaginal delivery, the obstetric nurses were trained to observe and evaluate postpartum hemorrhage. The nurses were required to treat all parturients as if they were at a high risk of postpartum hemorrhage, and closely observe vaginal hemorrhage [14, 15]. As to the ability training, senior nurses played the role of teachers and trainers for less experienced nurses, they also guided clinical nursing and participated in assessment and feedback.

Continuous quality improvement: The leader of the quality control group collected data of obstetric nursing-sensitive quality indicators and reported the results to medical staff in the department. The leader of the quality control group collected data of obstetric nursing-sensitive quality indicators and created the course content. The data were reported to all medical staff involved. Continuous nursing quality improvement (taking early skin-to-skin contact between mothers and infants/early sucking as an example) was implemented using the PDCA cycle.

(1) Potential reasons: It was found that the early skin-to-skin contact between mothers and infants, and early sucking in the experimental group was not implemented in a standard way before intervention. In some patients, the duration of early skin-to-skin contact between mothers and infants did not reach the standard. According to WHO recommendations, China's Recommendations for Clinical Implementation of Early Essential Newborn Care Techniques and Expert Consensus on Early Essential Newborn Care, the early skin-to-skin contact between mothers and infants immediately after birth should last for 90 min [16-18]. Through literature review and brainstorming, we found that the influencing factors of early skin-to-skin contact included [19]: ① Medical and nursing factors (lack of medical and nursing personnel, insufficient attention of healthcare workers, or lack of facilities); ② Puerperal factors (lack of knowledge, conscious fatigue); ③ Mode of delivery (cesarean section).

(2) Improvement measures: ① Strengthen health education on early skin-to-skin contact between mothers and infants with early sucking: Strengthen and consolidate the training on early skin-to-skin contact between mothers and infants among the obstetric nurses using course material to help them master new techniques and ideas and get ready for instructing and assisting the parturients both in theory and practice. Before labor, the midwives carried out one-on-one health education on early skin-to-skin contact between mothers and infants in the outpatient clinic; they instructed the parturients with a gestational age above 28 weeks on mammary gland and nipple care, and assisted the low-risk parturients in nipple extension and traction exercises to correct and improve flatness or enhance the extensibility of inverted nipples. After admission, primary nurses carried out health education on mammary gland and nipple care and breastfeeding. The parturients and their relatives were educated on the importance of early skin-to-skin contact between mothers and infants for breastfeeding. ② Instructions on early skin-to-skin contact between mothers and infants, and early sucking: The primary nurses assisted the parturients, especially those after cesarean section, in early skin-to-skin contact between mothers and infants. Healthy full-term babies who were vaginally born were placed naked in the prone position on the mother's bare chest. The baby's back was wrapped in a towel for warmth. The early skin-to-skin contact between mothers and infants lasted for 90 min [17]. Due to position restrictions and wound pain, parturients receiving a cesarean section were more likely to have a delayed early skin-to-skin contact between mothers and infants [20]. In the present study, the parturients receiving a cesarean section did not begin skin-to-skin contact for 90 min with their babies until they had been returned to their wards.

Control group: From April to September 2020, high-quality nursing was implemented in the control group, without the KAP training on the obstetric nursing-sensitive quality indicators and continuous improvement of obstetric nursing quality.

Research tools

Data collection for obstetric nursing-sensitive quality indicators: The data collection and evaluation of the obstetric nursing-sensitive quality indicators are shown in **Table 1**. The parturient satisfaction with the nurses' work indicator was collected using the parturient-perceived nursing quality questionnaire survey designed by Zhang, which covered 33 items and involved a 5-point Likert scale. The options of each item were "very dissatisfied-very satisfied" scored 1 to 5 points. The total score was from 33 to 165 points [21]. The overall Cronbach's α was 0.918, and the construct validity was 0.814.

Obstetric nurses' job satisfaction questionnaire: Obstetric nurses' job satisfaction was surveyed using the questionnaire designed by Hua, which covered 24 items of five dimensions: Hospital management, work stress,

Table 2. Comparison of baseline information of obstetric nurses and nurses' job satisfaction between the two groups before intervention

Variable	Experimental group ($\bar{x} \pm$ sd)/(%)	Control group ($\bar{x} \pm$ sd)/(%)	t/χ^2	P
Age (years old)	34.53±6.5	32.82±6.5	1.607	0.110
Years of working (years)	10.73±7.2	8.22±6.5	1.318	0.189
Nurses' job satisfaction	68.84±7.4	66.75±6.2	1.756	0.081
Education background				
Specialist diploma	46 (31.51)	12 (23.53)	1.158	0.282
Bachelor's degree/master's degree	100 (68.49)	39 (76.47)		
Professional title				
Nurse	46 (31.51)	16 (31.37)	0.016	0.992
Senior nurse	79 (54.11)	28 (54.90)		
Nurse-in-charge/Professor of nursing	21 (14.38)	7 (13.73)		

Note: Senior nurse: conduct clinical nursing work and technical operations and teach nursing students. Nurse-in-charge: intermediate professional title, inspect and supervise the clinical work of nurses. Professor of nursing: senior professional title, manage clinical staff and promote professional development.

interpersonal relationship, salary/benefits, personal development/promotion, and a 5-point Likert scale was used [22]. The options for each item were "completely disagree-completely agree" scored 1-5 points. The total score was from 24 to 120 points. The overall Cronbach's α was 0.906, and KMO was 0.838. Obstetric nurses in the control group and the experimental group were surveyed before and after the study, respectively.

Data collection

The rates of early skin-to-skin contact between mothers and infants, and early sucking with exclusive breastfeeding during hospitalization, along with neonatal hypoglycemia within 24 h, parturient satisfaction with the nurses' work and nurses' job satisfaction were observed by the primary nurses and surveyed by sampling, 3-5 times each week (the parturient satisfaction with the nurses' work questionnaire consisted of 33 items). For the sake of convenience, the sampling survey was conducted for the items above. The data of other indicators were collected from the obstetrics electronic health record (EHR) system. The nurses' job satisfaction score was collected by a specially designed questionnaire survey from the obstetric nurses in the two groups.

Statistics

Statistical analyses were performed using SPSS 23.0. GraphPad Prism8 was used to make the figures. Measurement data were described by mean ± standard deviation. Intergroup comparisons were conducted by using independent samples t-test. Enumeration data were described by frequencies and percentages. Intergroup comparisons were conducted using χ^2 test and Fisher's exact test, with the significance level set to a=0.05. P<0.05 indicated a significant difference.

Results

Comparison of information of nurses and parturients, and the nurses' job satisfaction between the two groups before the intervention

The information of nurses and parturients, and the nurses' job satisfaction were not significantly different between the two groups before the intervention (P>0.05, **Tables 2**, **3**).

Comparison of obstetric nursing-sensitive quality between the two groups before the intervention

Before the intervention, there were no unintended births, birth injuries of naturally delivered newborns, perineal wound infection following vaginal delivery, neonatal hypoglycemia in 24 h, and III/IV-degree perineal laceration at vaginal delivery. Except for lateral perineotomy at vaginal delivery, there was no significant difference in other indicators between the two groups before the intervention (P>0.05, **Table 4**).

Table 3. Comparison of baseline information of parturients between the two groups before intervention

Variable	Experimental group ($\bar{x} \pm$ sd)/(%)	Control group ($\bar{x} \pm$ sd)/(%)	t/χ^2	P
Age (years old)	29.96±4.2	30.13±5.5	-0.911	0.362
Gestational age (days)	271.260±14.1	271.90±11.9	-1.402	0.161
Complication				
Gestational diabetes mellitus	522 (14.42)	112 (12.08)	3.351	0.067
Hypertension in pregnancy	77 (2.13)	23 (2.48)	0.432	0.511
Premature rupture of membrane	166 (4.58)	31 (3.34)	2.740	0.098
Placental abruption	51 (1.41)	19 (2.05)	2.002	0.157
Preeclampsia	96 (2.65)	18 (1.94)	1.520	0.218

Table 4. Comparison of obstetric nursing-sensitive quality between the two groups before intervention

Obstetric nursing-sensitive quality	Experimental group (n, %)/($\bar{x} \pm$ sd)	Control group (n, %)/($\bar{x} \pm$ sd)	χ^2/t	P
Bed-to-nurse ratio for midwives	5 (20, 25.00)	5 (16, 31.25)		0.722
Early skin-to-skin contact between mothers and infants/early sucking	119 (330, 36.06)	110 (330, 33.33)	0.542	0.462
Lateral perineotomy at vaginal delivery	213 (1407, 15.13)	108 (498, 21.69)	11.256	0.001
Trial of labor with conversion to cesarean section	52 (1414, 3.68)	21 (522, 4.02)	0.125	0.723
Exclusive breastfeeding during hospitalization	128 (330, 38.79)	123 (330, 37.27)	0.161	0.688
Neonatal asphyxia/Severe neonatal asphyxia	12 (1422, 0.84)	3 (503, 0.60)	0.294	0.587
Birth injuries of naturally delivered newborns	0 (1350, 0.00)	0 (496, 0.00)	--	--
Perineal wound infection following vaginal delivery	0 (1407, 0.00)	0 (498, 0.00)	--	--
Unintended birth	0 (3587, 0.00)	0 (908, 0.00)	--	--
Neonatal hypoglycemia in 24 h	0 (330, 0.00)	0 (330, 0.00)	--	--
Healthy babies born vaginally	1334 (1336, 99.85)	478 (482, 99.17)	3.129	0.077
III/IV-degree perineal laceration at vaginal delivery	0 (1407, 0.00)	0 (498, 0.00)	--	--
Postpartum hemorrhage following vaginal delivery	35 (1407, 2.49)	8 (498, 1.61)	1.294	0.255
Parturient satisfaction with the nurses' work	153.01±10.2	152.67±11.3	0.398	0.691

Note: The bed-to-nurse ratio for midwives was analyzed using Fisher's exact method. The number of healthy babies born vaginally was a value after continuity correction. The incidence of lateral perineotomy at vaginal delivery was statistically different between the two groups, so this indicator was not included in our study.

Comparison of obstetric nursing-sensitive quality in the experimental group before and after the intervention

There were no birth injuries of naturally delivered newborns, perineal wound infection following vaginal delivery, unintended births, neonatal hypoglycemia in 24 h, and III/IV-degree perineal laceration at vaginal delivery. Since the rates of neonatal asphyxia and severe neonatal asphyxia were very small in the two groups, the two indicators were combined during the statistical process. The bed-to-nurse ratio for midwives was not changed before and after intervention (P=1.000). The rates of early skin-to-skin contact between mothers and infants, early sucking and exclusive breastfeeding during hospitalization, as well as parturient satisfaction with the nurses' work after intervention were better than before (P<0.05). The rates of neonatal asphyxia/severe neonatal asphyxia and postpartum hemorrhage following vaginal delivery after intervention was significantly lower than before (P<0.05). There were no significant differences in the rates of transferring cesarean section and healthy babies born vaginally in the experimental group before and after the intervention (P>0.05) (**Table 5**).

Comparison of obstetric nursing-sensitive quality between the two groups after the intervention

There were no birth injuries of naturally delivered newborns, perineal wound infection following vaginal delivery, neonatal hypoglycemia in 24 h, or III/IV-degree perineal laceration at vaginal delivery. The experimental group was better than the control group after the intervention in the rates of early skin-to-skin contact between mothers and infants, early suck-

Table 5. Comparison of obstetric nursing-sensitive quality in the experimental group before and after the intervention

Obstetric nursing-sensitive quality	Before intervention (n, %)/($\bar{x} \pm$ sd)	After intervention (n, %)/($\bar{x} \pm$ sd)	χ^2/t	P
Bed-to-nurse ratio for midwives	5 (20, 25.00)	5 (20, 25.00)	0.000	1.000
Early skin-to-skin contact between mothers and infants/early sucking	119 (330, 36.06)	159 (330, 48.18)	9.944	0.002
Trial of labor with conversion to cesarean section	52 (1414, 3.68)	50 (1481, 3.38)	0.193	0.660
Exclusive breastfeeding during hospitalization	128 (330, 38.79)	155 (330, 46.97)	4.510	0.034
Neonatal asphyxia/Severe neonatal asphyxia	12 (1422, 0.84)	4 (1444, 0.28)	4.147	0.042
Birth injuries of naturally delivered newborns	0 (1350, 0.00)	0 (1402, 0.00)	--	--
Perineal wound infection following vaginal delivery	0 (1407, 0.00)	0 (1441, 0.00)	--	--
Unintended birth	0 (3587, 0.00)	0 (3621, 0.00)	--	--
Neonatal hypoglycemia in 24 h	0 (330, 0.00)	0 (330, 0.00)	--	--
Healthy babies born vaginally	1334 (1336, 99.85)	1404 (1408, 99.72)	0.119	0.730
Postpartum hemorrhage following vaginal delivery	35 (1407, 2.49)	20 (1441, 1.39)	4.545	0.033
III/IV-degree perineal laceration at vaginal delivery	0 (1407, 0.00)	0 (1441, 0.00)	--	--
Parturient satisfaction with the nurses' work	153.01±10.2	155.68±12.7	-2.974	0.003

Note: The number of healthy babies born vaginally was a value after continuity correction.

Table 6. Comparison of obstetric nursing-sensitive quality between the two groups after the intervention

Obstetric nursing-sensitive quality	Control group (n, %)/($\bar{x} \pm$ sd)	Experimental group (n, %)/($\bar{x} \pm$ sd)	χ^2/t	P
Bed-to-nurse ratio for midwives	5 (16, 31.25)	5 (20, 25.00)		0.722
Early skin-to-skin contact between mothers and infants/early sucking	126 (330, 38.18)	159 (330, 48.18)	6.725	0.010
Trial of labor with conversion to cesarean section	19 (512, 3.71)	50 (1481, 3.38)	0.128	0.721
Exclusive breastfeeding during hospitalization	130 (330, 39.39)	155 (330, 46.97)	3.860	0.049
Neonatal asphyxia/Severe neonatal asphyxia	1 (492, 0.20)	4 (1444, 0.28)	0.000	1.000
Birth injuries of naturally delivered newborns	0 (479, 0.00)	0 (1402, 0.00)	--	--
Perineal wound infection following vaginal delivery	0 (487, 0.00)	0 (1441, 0.00)	--	--
Neonatal hypoglycemia in 24 h	0 (330, 0.00)	0 (330, 0.00)	--	--
Unintended birth	1 (927, 0.11)	0 (3621, 0.00)	--	0.204
III/IV-degree perineal laceration at vaginal delivery	0 (487, 0.00)	0 (1441, 0.00)	--	--
Healthy babies born vaginally	463 (464, 99.78)	1404 (1408, 99.72)	0.000	1.000
Postpartum hemorrhage following vaginal delivery	3 (487, 0.62)	20 (1441, 1.39)	1.840	0.175
Parturient satisfaction with the nurses' work	153.09±11.3	155.68±12.7	-2.760	0.006

Note: The rate of neonatal asphyxia and the number of healthy babies born vaginally were values after continuity correction. The bed-to-nurse ratio for midwives and unintended birth were analyzed using Fisher's exact test, P=0.204.

ing and exclusive breastfeeding during hospitalization, as well as in parturient satisfaction with the nurses' work (all P<0.05). There were no significant differences in bed-to-nurse ratio for midwives, the rates of transferring to cesarean section and neonatal asphyxia/severe neonatal asphyxia, unintended birth and healthy babies born vaginally, and postpartum hemorrhage following vaginal delivery between the two groups after the intervention (**Table 6**).

Comparison of nurses' job satisfaction between the two groups before and after intervention

The nurses' job satisfaction was significantly improved in the experimental group after inter-

vention as compared with that before intervention, and significant different was found in nurses' job satisfaction between the two groups after the intervention (both P<0.001, **Figure 1**).

Discussion

Our results showed that the rate of early skin-to-skin contact between mothers and infants, early sucking and exclusive breastfeeding during hospitalization, the incidence of neonatal asphyxia/severe neonatal asphyxia and postpartum hemorrhage following vaginal delivery, as well as parturient satisfaction with the nurses' work and nurses' job satisfaction in the experimental group were all significantly better compared to before intervention. The experi-
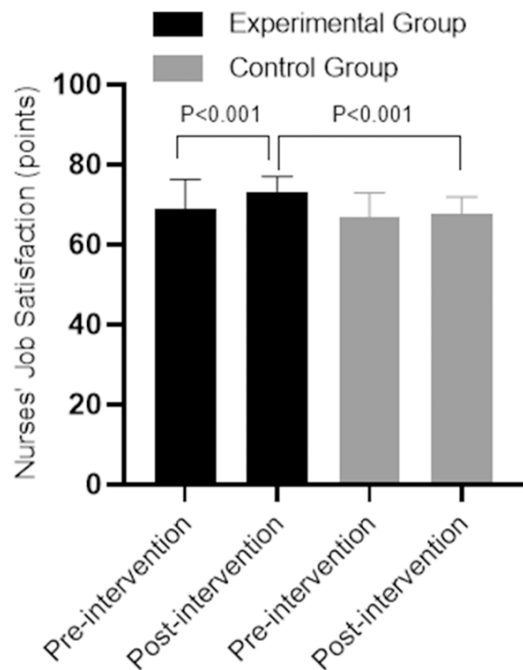
Figure 1. Comparison of nurses' job satisfaction between the two groups before and after intervention.

mental group outperformed the control group in the rates of early skin-to-skin contact between mothers and infants, early sucking and exclusive breastfeeding during hospitalization, plus parturient satisfaction with the nurses' work and nurses' job satisfaction. The above results indicated that the use of nursing-sensitive quality indicators could help find problems in the nursing work and promote timely correction and solution of these problems, thereby improving the nursing quality.

A total of 14 obstetric nursing-sensitive quality indicators were used to evaluate the nursing services and improve the nursing management measures, continuously. This method not only enhanced the clinical nursing quality of various nurses but also guaranteed patient safety and satisfaction. For example, early skin-to-skin contact between mothers and infants with early sucking can help enhance parturients' self-efficacy concerning breastfeeding and hence promote breastfeeding [23]. It is also conducive to maintaining body temperature in newborns, raising the blood glucose level, and facilitating affective exchanges between mothers and infants [24]. In a word, early skin-to-skin contact between mothers and infants and early sucking is of high clinical importance for

the health and safety of mothers and infants. Nursing-sensitive quality indicators are being constantly revised and updated, along with social changes. Following the recent guidelines and criteria, the duration of early skin-to-skin contact between mothers and infants was prolonged to 90 min in this study. The rate of early skin-to-skin contact between mothers and infants and early sucking in the experimental group before intervention was 36.06% (**Table 5**), which was similar to the results of Zhou' study (35.30%) [25]. The rate was improved to 48.18% after training and clinical use of the indicators (**Table 5**). However, it was still lower than the result of a cross-sectional study in Singapore (51.70%) [20]. The reason may be due to non-standard, insufficient early skin-to-skin contact between mothers and infants after cesarean section. Thus, it is necessary to continuously improve the nursing quality by early skin-to-skin contact between mothers and infants after cesarean section. Immediate skin-to-skin contact between mothers and infants may be practiced during cesarean section as long as safety is ensured.

Early skin-to-skin contact and early sucking increases the chance of breastfeeding success on the first attempt and promotes exclusive breastfeeding for the first 6 months of life. Breast milk is the ideal food for infants and plays a vital role in the healthy growth and development of infants and young children [26]. Our study found that before the intervention, the rate of exclusive breastfeeding during hospitalization in both the experimental group and the control group was lower than 40%, which was significantly lower than the survey results of Guo et al. [27] (50.8% for primiparas and 55.9% for second-born parturients). The rate of exclusive breastfeeding in China is far lower than that in European and American countries, which may be related to the feeding stereotypes. We extended the time of mother-to-child skin contact to stimulate early suckling, encouraged mothers, especially working women, to exclusively breastfeed and intervened in the psychology of mothers with negative emotional to build their breastfeeding confidence. In the end, the rate of exclusive breastfeeding during hospitalization of the two groups was improved, indicating that the application of nursing sensitive quality indicators in the continuous improvement of nursing quality is con-

ducive to discovering the problematic links in nursing work and promoting timely correction and solution of nursing problems.

Neonatal asphyxia is a hypoxic state in which there is only a heartbeat within 1 minute after delivery of the fetus, and regular breathing or no breathing cannot be established. Hypoxia can cause damage to multiple organs such as the heart, brain, and lungs of the newborn, especially severe asphyxia, and it may also be combined with metabolic acidosis, and multiple organ damage will be more serious, which directly endangers the life safety of the newborn [28]. The high mortality and disability rate due to neonatal asphyxia has always been a key issue in clinical research. We took neonatal asphyxia as an important nursing-sensitive quality indicator and made micro-videos of neonatal asphyxia resuscitation to train obstetric nurses to master the method of neonatal asphyxia resuscitation. After this training, the rate of neonatal asphyxia and severe neonatal asphyxia in the experimental group was significantly lower than before the intervention (**Table 5**), but there was no statistical difference between the experimental group and the control group, which may be related to the small sample size of the control group.

Postpartum hemorrhage is a serious complication during delivery and one of the most important causes of maternal death. It is the leading cause of maternal death in China. The rate of postpartum hemorrhage is 2%-3% of the total number of deliveries, and more than 80% of them occur within 2 hours after delivery [29]. In 2015, the global number of maternal deaths was 275,000, of which 34% were caused by hemorrhage [30]. Most maternal deaths caused by postpartum hemorrhage can be avoided by creating good nursing conditions, and the key lies in early diagnosis and correct treatment [31]. We regarded postpartum hemorrhage following vaginal delivery as an important nursing-sensitive quality indicator. According to the guidelines for the prevention and management of postpartum hemorrhage (2014) [31], the obstetric nurses are trained to let the nurses understand the causes and high-risk factors, prevention and treatment of postpartum hemorrhage, so as to better identify high-risk women and help doctors cope with its incidences for prevention and treatment. Clinically, it is recommended to closely observe the vital signs

of the mothers who are at high risk and deal with the signs of postpartum hemorrhage promptly. The rate of postpartum hemorrhage after vaginal delivery in the experimental group was lower than before intervention (**Table 5**), indicating that the training aroused the attention of obstetric nurses to postpartum hemorrhage, but there was no difference between the experimental group and the control group, which may be related to the small sample size of the control group.

The level of patient' satisfaction indirectly reflects the nursing quality, which is an important manifestation of the connotation of high-quality nursing, and also an important way for nursing managers to evaluate nursing quality [32]. In early 2019, the State Council issued the Opinions of the State Council on Strengthening Performance Appraisal in Third-Level Public Hospitals, which clarified patient' satisfaction as an important assessment indicator [33]. Through investigations in this study, it was found that parturient satisfaction with the nurses' work of the experimental group was lower before the intervention. By improving the ward environment, raising the professional skills and service awareness of nurses, the parturient satisfaction with the nurses' work in the experimental group was finally improved, which was statistically significant compared with the pre-intervention and control group (**Tables 5, 6**).

Our results showed that after application of obstetric nursing-sensitive quality indicators, the score of nurses' job satisfaction in the experimental group was significantly higher than that before intervention and the control. The KAP training was a good opportunity for obstetric nurses to learn and promote attitude and behavior changes. The enthusiasm of the nurses was mobilized, and their responsibility awareness, self-efficacy concerning the nursing work, and their clinical practical abilities were enhanced. In early 2019, the State Council issued the Opinions of the State Council on Strengthening Performance Appraisal in Third-Level Public Hospitals. It was explicitly specified that job satisfaction of medical staff is an important evaluation indicator [33]. Studies have shown that improving nurses' job satisfaction can better mobilize their enthusiasm and positive attitudes in work [34, 35]. Therefore, nursing performance, nursing quality, and patient satisfaction can be promoted. In the

present study, an increase in nurses' job satisfaction might also promote obstetric nursing quality. Nursing administrators can develop measures to improve nurses' job satisfaction to raise their work performance and nursing quality level, such as enhancing humanistic care for nurses, satisfying their needs for learning and further education, and increasing their welfare benefits.

A total of 14 obstetric nursing-sensitive quality indicators were applied in the present study, and the indicator number was too large. The inclusion and exclusion criteria for the calculation of each indicator also varied. Moreover, it was still time-consuming to collect and analyze the data of obstetric nursing-sensitive quality indicators due to deficiency of professional nursing information system. Besides, the data of several obstetric nursing-sensitive indicators (early skin-to-skin contact between mothers and infants, early sucking, exclusive breastfeeding during hospitalization, neonatal hypoglycemia in 24 h, and parturient satisfaction with the nurses' work) could be only collected by observation and sampling, which was also time- and labor-consuming. Informatization construction of nursing is a complex, and a systematic project [36]. In some foreign countries, a full-fledged information system for nursing quality management has been built to cover the following aspects: nursing quality evaluation, nursing information collection, intellectualization, telenursing, and network nursing [37]. In contrast, the information system for nursing quality management in China is still far behind other developed countries, and only a certain amount of progress has been made in application of the informatization platform to nursing quality management. However, information management of nursing quality based on an informatization platform and sharing of nursing resources and information across hospitals are not feasible at present. Thus, it is necessary to build a professional information system for nursing-sensitive quality indicators to help nurses to collect and analyze nursing information and relieve working load of the nurses. Meanwhile, an evidence-based management system instead of empirical management becomes feasible for the nursing managers to continuously improve nursing quality.

In conclusion, our study showed that the application of obstetric nursing-sensitive quality indicators helped improve obstetric nursing quality, parturient satisfaction with the nurses' work, and nurses' job satisfaction. Despite the use of the electronic information system, data collection of the indicators was still both time and labor consuming in this study. Collection and analysis of nursing-sensitive quality indicators across hospitals were not shared. Moreover, only one control group was included, and the sample size was small in the present study. All of these limitations might have affected our findings. Thus, construction of a professional information system is strongly recommended for nursing-sensitive quality indicators. An evidence-based approach is recommended to replace empirical management to co-build and share information across the hospitals, which aims at long-term, multi-center use of nursing-sensitive quality indicators and continuous improvement of nursing quality.

Disclosure of conflict of interest

None.

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