META-ANALYSIS

New labor management and obstetric outcomes: A systematic review and meta-analysis

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Abstract

Objective: This systematic review and meta-analysis is to compare the new labor management guideline with the traditional WHO guideline with regard to obstetric outcomes. Methods: The literature search was performed in the following databases: PubMed, Embase, Web of Science, the Cochrane Library and Chinese databases (including CNKI, WanFang Database and VIP). Randomized controlled trials (RCTs) or cohort studies comparing the new labor management and the old WHO guideline in terms of maternal and neonatal morbidity in low-risk pregnant women were included. Study quality was assessed using the Cochrane Risk Bias Evaluation Tool and Newcastle-Ottawa Scale (NOS). The I² statistic was used to evaluate heterogeneity. We used the random-effects model to pool the relative risk (RR) with corresponding 95% confidence intervals (CI). Prespecified subgroup and sensitivity analyses were conducted to explore the potential influencing factors. Publication bias analysis was also assessed based on funnel plots. Results: A total of 45 studies with a total sample size of 82,016 women were eventually included, with 15 RCTs and 30 cohort studies. 44 studies were included for data synthesis. Women with new labor management had less labor augmentation with oxytocin (RCTs: RR = 0.55 [0.36, 0.83], I² = 47%; cohort studies: RR = 0.62 [0.55, 0.70], I² = 58%), intrapartum cesarean section (RCTs: RR = 0.52 [0.47, 0.59], I² = 0; cohort studies: RR = 0.61 [0.55, 0.67], I² = 75%) and operative vaginal delivery (RCTs: RR = 0.60 [0.42, 0.87], I² = 0; cohort studies: RR = 0.69 [0.55, 0.86], I² = 82%) without increasing the incidence of 3rd- and 4th-degree perineal laceration, postpartum hemorrhage, infectious morbidity and postpartum urine retention, fetal distress, neonatal asphyxia or neonatal intensive care unit (NICU) admission. These results were robust to sensitivity analyses. Conclusion: Our study indicates that the new labor management guideline may be more beneficial than the traditional WHO guideline, with fewer intrapartum interventions and no increase in adverse obstetric outcomes. Key words: Friedman labor curve, Zhang’s labor curve, labor management, obstetric outcome

BACKGROUND

Labor management is a key component of obstetrics and gynecology practice. Prior to the mid-1950s, the evaluation of labor progress was based primarily on its duration. Vague admonitions based on prevailing observations about average labor duration and outcomes were commonly intoned.[1] In 1955, Dr. Emmanuel Friedman published a milestone article, illustrating a normal labor pattern that was based on cervical dilation against time and subdivided into 1st stage (including latent phase, acceleration phase, maximum slope of cervical dilation, deceleration phase), 2nd stage (from full dilation to delivery of the infant) and 3rd stage (from delivery of the infant to delivery of the placenta).[2] In the early 1970s, Philpott and colleagues developed guidelines to assess...
labor progression on the basis of Friedman’s findings.\textsuperscript{[3,4]} With this approach, all partograms were designed using
1 cm/hour or faster as an acceptable rate of dilatation in active phase, which was designated as the alert line on the
partograph. The action line was drawn parallel to but 4 hours to the right of the alert line. This partogram was
promoted worldwide by the WHO in 1994 following its landmark trial suggesting benefits.\textsuperscript{[5–7]} WHO’s research
and subsequent promotion played a key role in translating
Phillpott’s partogram into worldwide use. At the onset of
active labor, typically defined as 3–4 cm cervical dilatation,
a timeline is placed on the woman’s partograph. The
linear curve of expected labor progression is constant throughout labor and serves as a reference point for labor
dystocia.

Due to changes in clinical practices and obstetric populations during the past decades, the use of the WHO
partograph in contemporary obstetric populations has been questioned.\textsuperscript{[8–11]} In 2010, Zhang et al. presented a labor
curve based on a large cohort of women with normal outcomes in contemporary obstetric practice, which was
markedly different from the Friedman curve.\textsuperscript{[9]} In this study, it was noted that more than half of the patients
did not dilate at the rate proposed by Friedman et al. until 6 cm of cervical dilatation, proposing a new threshold for
diagnosing dystocia. And they also found that cervical dilatation accelerates as labor advances. This finding implies
that following Zhang’s guideline allows more time in early labor before labor dystocia is diagnosed. As a result, a new
guideline promulgated jointly by the American College of Obstetricians and Gynecologists (ACOG) and the Society
for Maternal-Fetal Medicine (SMFM) was released which was mainly based on Zhang et al.’s studies. The Consensus
Statement recommends that perinatal care providers should not perform cesarean births for lack of progress in active
labor until a person’s cervical examination has remained unchanged at a minimum of 6 cm dilatation for at least 4
hours with adequate contractions, or for at least 6 hours with oxytocin augmentation.\textsuperscript{[12]}

However, there is an ongoing debate concerning which guideline is more beneficial for managing labor. Many
authors raised concerns of patient safety in adopting the new recommendations while there is lack of robust
evidence on either direction. Some studies reported a reduction in cesarean delivery due to arrest disorders,
while others found no difference. It also remains unclear whether changes in the cesarean rate as a result of the
application of the new guidelines can also be translated into improved maternal and neonatal outcomes or portends an increase in morbidity. We therefore conducted a systematic review and meta-analysis to investigate whether the risk of adverse obstetric outcomes differed when adhering to the WHO guideline vs. the new guideline for labor management.

MATERIALS AND METHODS

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-
Analyses (PRISMA) guidelines, and prospective registration in the International Prospective Register of Systematic
Reviews (PROSPERO-CRD: CRD42022383775), without a prepared protocol.

Review questions

The review questions were based on the PICO protocol (population, intervention, comparison, outcomes). What
are the differences between the new labor management guideline (I) and the WHO guideline (C) in terms of
adverse obstetric outcomes, including maternal and neonatal morbidity (O) in low-risk pregnant women (P)?
Are there any differences in the indications for cesarean section between the two guidelines? Women in the control
group were monitored with the WHO guideline, with an alert line (drawn on the partograph) that showed the
expected cervical dilatation if labor was progressing by at least 1 cm per hour, and an action line drawn 4 hours later
than the alert line. The first stage of labor was divided into the latent phase (0–3 cm) and active phase (4–10 cm), labor
dystocia was diagnosed when the latent phase lasted longer than 16 hours or if the action line was crossed in the active
phase. Labor dystocia in the second stage of labor (from 10 cm of cervical dilatation until the baby is born) was
diagnosed if it lasted longer than 2 hours (or 3 hours for women with epidural analgesia [EDA]).

Women in the intervention group adopted the new labor management. With the reference point of the onset of
active phase starting from 6 cm, prolonged latent phase was no longer an indication for cesarean section. Dilation
stopping > 4 hours during the active period was considered as protracted active phase. When the uterine contraction
was not good, dilation stopping > 6 hours was defined as protracted active phase. Labor dystocia in the second stage
of labor was diagnosed if it lasted longer than 3 hours (or 4 hours for women with EDA) in nulliparas, and longer than
2 hours (or 3 hours for women with EDA) in multiparas.\textsuperscript{[13]}

Inclusion and exclusion criteria

Randomized controlled trials (RCTs), original prospective or retrospective cohort studies were included in this
analysis. We included the publications that met the following criteria: (1) the study population were nulliparous
or multiparous women or sub-groups with a singleton fetus at ≥ 37 weeks gestation, cephalic presentations and
spontaneous labor onset, or no evidence to the contrary; (2) “low-risk” at study entry based on their description in the
abstract (e.g., without medical condition, pregnancy complication, or diagnosed labor abnormality) or had
no evidence to the contrary; (3) the study presented identifiable method of labor management and pregnancy
outcomes. We excluded studies focusing on induction
of labor, or women with comorbidities or complications (e.g., gestational diabetes, hypertensive disorders, previous caesarean delivery), or with sample size lower than 40. Studies that applied the new labor management guideline only in the second stage were also excluded. Publications that were not scientific research, including reports, books, news articles, editorials, and letters were excluded due to limited detailed information.

**Database search and study selection**
A search of the relevant literature was conducted using the electronic databases of PubMed, Embase, Web of Sciences, the Cochrane Library, CNKI, VIP, Wanfang Database with publications up to December 07, 2022, using Medical Subject Headings (MeSH) or Emtree terms “labor, obstetric” and the term “management”, “Zhang’s”, “new” or “contemporary”. Literature searches of bibliographies of related systematic reviews and eligible studies complemented the search strategies. There were no date or language restrictions. Details of the search strategy are presented in Figure S1.

The Endnote software and manual checking have been used to remove duplicates. Two authors independently evaluated the retrieved titles and abstracts to determine their compliance with the full-text review criteria. For all documents that were not excluded at this stage, we read the full-text articles and determined if they met the inclusion criteria. Any different opinions between the evaluators were resolved by consensus or a third reviewer.

**Data extraction**
The following data were extracted: the study characteristics, such as sample size, study types, the year of publication; the basic characteristics of the included population, such as age, pre-pregnancy body mass index (BMI), gestational age; and adverse obstetric outcomes, including both maternal and neonatal morbidity. Adverse maternal outcomes included intrapartum cesarean section, operative vaginal delivery, 3rd- and 4th-degree perineal laceration, postpartum hemorrhage, postpartum urine retention and infectious morbidity (chorioamnionitis, endometritis and puerperal infection). Adverse neonatal outcomes included fetal distress, neonatal asphyxia and neonatal intensive care unit (NICU) admission. The indications for cesarean sections were also extracted, if available, which include failure in labor induction, prolonged latent phase, protracted active phase, prolonged second phase, relative cephalon-pelvic disproportion, fetal distress and the others.

**Study quality assessment**
The quality of RCTs was assessed using the Cochrane Risk Bias Evaluation Tool, which included random sequence generation, allocation concealment, binding of participants and personnel, binding of outcome assessment, incomplete outcome data, selective reporting, and other sources of bias. The quality of the cohort studies was assessed using the Newcastle-Ottawa Scale (NOS), which included the selection of the cohort, comparability between groups, and results.

**Data synthesis and statistical analysis**
Data synthesis and statistical analysis were performed using Review Manager (RevMan, Version 5.4.1, The Cochrane Collaboration, Copenhagen, Denmark) and R (Windows Version 4.2.1, R Foundation for Statistical Computing, Vienna, Austria). Continuous outcomes were presented as mean difference (MD) between experimental and control groups with 95% confidence intervals (CI); for dichotomous data, they were presented as risk ratio (RR) with 95% CI. For studies which only reported median and interquartile range (IQR), the estimation of sample mean ± standard deviation (SD) proposed by Wan et al.[14] was used to convert the data. The results are represented by forest plots. For the indications for cesarean section, a pooled proportion of indications was obtained based on binomial distribution with Freeman-Tukey double-arcsine transformation and expressed as proportions and 95% CI. Zero event was managed using continuity correction adding 0.5 in each cell. The random-effects model was used for all analyses to account for variation between studies. We performed the average age, pre-pregnancy BMI and gestational age at delivery among all studies, which may indicate the source of heterogeneity. The heterogeneity of the pooled data was estimated by calculating the Q and F statistics, and the difference was considered significant when $P < 0.05$ or $I^2 > 40\%$. For the results with high heterogeneity, a subgroup and sensitivity analysis were used to assess the probable source of heterogeneity and the result's strength. Subgroup analyses that pre-specified was according the type of cohort study (retrospective or prospective cohort study). A sensitivity analysis assesses the effect of overall results by eliminating specific low-quality studies. Finally, funnel charts were used to observe whether there was publication bias. Corrections for asymmetry were performed according to the trim and fill method.

**RESULTS**
A total of 413 citations were screened and 112 references were removed as duplicates. All 301 abstracts were screened to identify labor progression publications. 143 publications were selected for full review, and in 98 studies either the study population or the outcomes did not meet the inclusion criteria. Finally, 45 studies were included in this systematic review. The selection procedure and screened studies are presented in a PRISMA flowchart (Figure 1).

**Characteristics of included studies and patients**
Forty-five studies were eventually included. There were 15 RCTs[15–29] and 30 cohort studies.[30–59] The analysis included 44 single-center studies and 1 multi-center study.[23] The tabulated studies included a total of 82,016 women.
The intervention group consisted of 42,563 individuals (6265 women from RCTs, 36,298 women from cohort studies). The comparison group consisted of 39,453 individuals (5606 women from RCTs, 33,847 women from cohort studies). Region of origin for included studies were China (n = 41), Norway (n = 1),[25] America (n = 1)[58] and France (n = 1).[57] Of note, the Norwegian study was the only multicenter RCT. A full description of included studies is presented in Table 1. Risk of bias and quality assessment are presented in the supplementary materials. The quality of RCTs was assessed using the Cochrane Risk of Bias Evaluation Tool (Figure S2). The quality of the cohort studies was assessed using the NOS (Table S1). Since the study by Bernitz et al. employed different criteria of labor dystocia,[25] it was not included in the data synthesis. We first compared the women’s characteristics that may affect the outcomes and found no difference between the two groups in age, pre-pregnancy BMI, gestational age at delivery and the proportion of nulliparas (Table 2).

**Maternal morbidity**

Labor augmentation with oxytocin: 15 studies with 3 RCTs[20,23,27] and 12 cohort studies[30–34,40,45,48,51,52,53,55] examined this outcome. The results showed that the intervention group used less oxytocin for labor augmentation than the comparison group in both the RCTs and cohort studies (RCTs: RR = 0.55 [0.36, 0.83], I² = 47%; cohort studies: RR = 0.62 [0.55, 0.70], I² = 58%) (Figure 2A).

Intrapartum cesarean section: 13 RCTs[16–24,26–29] and 29 cohort studies[30–37,39–59] examined this outcome. The results showed that the intrapartum cesarean section rate in the intervention group was lower than the comparison group in both the RCTs and cohort studies (RCTs: RR = 0.52 [0.47, 0.59], I² = 0; cohort studies: RR = 0.61 [0.55, 0.67], I² = 75%) (Figure 2B). There were 1 RCT[22] and 12 cohort studies[32,33,37,39,41–44,49,52,57,58] examined the indications for intrapartum cesarean section. As shown in Table 3, there was no significant difference in failure in induction of labor, protracted active phase, prolonged second phase and fetal distress between two groups. The major indications for cesarean section were protracted active phase and fetal distress in the intervention group and protracted active phase and relative cephalo-pelvic disproportion in the comparison group respectively. Prolonged latent phase was no longer the indication for cesarean section in the intervention group, and the pooled proportion of prolonged latent phase in indications was 0.14 (0.11, 0.18) in the comparison group. The other indications including maternal request, maternal complications and placental abnormality etc. were more often in the intervention group compared with the comparison group (0.09 [0.05, 0.13] vs. 0.06 [0.03, 0.09], RR = 1.57 [1.04, 2.36]).

Operative vaginal delivery: 6 RCTs[15,17,19,23,28,29] and 19 cohort studies[31–34,36–38,40,44,46–50,53,55,57–59] examined this outcome. The results showed that operative vaginal delivery was less common in the intervention group than that in the
Table 1: Characteristics of included studies and patients

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Study types</th>
<th>Intervention/Comparison</th>
<th>Sample size</th>
<th>Nulliparas</th>
<th>Age</th>
<th>Pre-pregnancy BMI</th>
<th>Gestational age</th>
<th>Outcomes*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huang et al. 2017[26]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>242</td>
<td>238</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>[2][4][5]</td>
</tr>
<tr>
<td>Wang and Liu 2017[27]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>102</td>
<td>102</td>
<td>-</td>
<td>28.6 ± 1.3</td>
<td>28.5 ± 1.1</td>
<td>[2][3][9]</td>
</tr>
<tr>
<td>Ma 2018[28]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>44</td>
<td>44</td>
<td>44</td>
<td>29.7 ± 3.9</td>
<td>28.0 ± 3.1</td>
<td>[2][4][5][6]</td>
</tr>
<tr>
<td>Zhuang 2018[29]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>27.5 ± 3.5</td>
<td>27.8 ± 3.4</td>
<td>[2][3][5]</td>
</tr>
<tr>
<td>Li and Ren et al. 2019[30]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>100</td>
<td>112</td>
<td>112</td>
<td>29.1 ± 8.6</td>
<td>30.3 ± 8.2</td>
<td>[1][2][3][9]</td>
</tr>
<tr>
<td>Xiaomei Liao 2019[31]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>40</td>
<td>40</td>
<td>23</td>
<td>26.8 ± 2.3</td>
<td>26.1 ± 2.4</td>
<td>[2][5][7][9]</td>
</tr>
<tr>
<td>Zhang et al. 2019[32]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>44</td>
<td>44</td>
<td>28</td>
<td>28.7 ± 3.6</td>
<td>30.5 ± 3.4</td>
<td>[2][8]</td>
</tr>
<tr>
<td>Zhong and Su 2019[33]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>50</td>
<td>50</td>
<td>-</td>
<td>31.7 ± 1.3</td>
<td>31.3 ± 1.1</td>
<td>[1][2][3][9]</td>
</tr>
<tr>
<td>Zhou 2019[34]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>200</td>
<td>200</td>
<td>-</td>
<td>26.2 ± 0.1</td>
<td>25.1 ± 0.4</td>
<td>[2][8]</td>
</tr>
<tr>
<td>Bernini et al. 2019[35]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>3972</td>
<td>3305</td>
<td>3305</td>
<td>-</td>
<td>23.6 ± 4.3</td>
<td>[1][2][3][5][9]</td>
</tr>
<tr>
<td>Zeng 2020[36]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>1000</td>
<td>1000</td>
<td>-</td>
<td>28.3 ± 3.3</td>
<td>28.5 ± 3.4</td>
<td>[2][5][6][9]</td>
</tr>
<tr>
<td>Zhang 2020[37]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>105</td>
<td>105</td>
<td>-</td>
<td>26.7 ± 2.3</td>
<td>29.1 ± 2.5</td>
<td>[2][8]</td>
</tr>
<tr>
<td>Chen and Su 2021[38]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>66</td>
<td>66</td>
<td>-</td>
<td>28.1 ± 1.6</td>
<td>28.3 ± 1.5</td>
<td>[2][5][6][9]</td>
</tr>
<tr>
<td>Han et al. 2021[39]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>192</td>
<td>192</td>
<td>192</td>
<td>28.4 ± 3.3</td>
<td>28.5 ± 3.3</td>
<td>[2][5][6][9]</td>
</tr>
<tr>
<td>Lin et al. 2016[40]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>755</td>
<td>1050</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>[2][5][6][9]</td>
</tr>
<tr>
<td>Li et al. 2016[41]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>100</td>
<td>80</td>
<td>57</td>
<td>31.2 ± 3.6</td>
<td>30.6 ± 3.3</td>
<td>[2][5][6][7][9]</td>
</tr>
<tr>
<td>Zhang et al. 2016[42]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>187</td>
<td>255</td>
<td>-</td>
<td>29.6 ± 3.7</td>
<td>30.0 ± 3.9</td>
<td>[1][2][3][9]</td>
</tr>
<tr>
<td>Zhang 2016[43]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>659</td>
<td>763</td>
<td>763</td>
<td>27.6 ± 3.1</td>
<td>27.3 ± 3.6</td>
<td>[1][2][3][7][9]</td>
</tr>
<tr>
<td>Yan and Xiao 2016[44]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>3014</td>
<td>3254</td>
<td>-</td>
<td>29.1 ± 3.3</td>
<td>28.9 ± 4.0</td>
<td>[2][5][6][9]</td>
</tr>
<tr>
<td>Jin 2017[46]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>42</td>
<td>42</td>
<td>-</td>
<td>26.0 ± 2.2</td>
<td>26.5 ± 1.5</td>
<td>[1][2][3][9]</td>
</tr>
<tr>
<td>Li et al. 2017[47]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>88</td>
<td>101</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>[2][5][7][9]</td>
</tr>
<tr>
<td>Wang et al. 2017[48]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>7012</td>
<td>4892</td>
<td>-</td>
<td>27.0 ± 3.8</td>
<td>26.8 ± 3.2</td>
<td>[1][2][3][9]</td>
</tr>
<tr>
<td>Wang et al. 2017[49]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>6836</td>
<td>5385</td>
<td>6836</td>
<td>31.2 ± 3.7</td>
<td>30.9 ± 3.5</td>
<td>[2][3][4][9]</td>
</tr>
<tr>
<td>Wei et al. 2017[50]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>4146</td>
<td>3879</td>
<td>3879</td>
<td>29.9 ± 3.1</td>
<td>29.6 ± 3.0</td>
<td>[2][3][4][9]</td>
</tr>
<tr>
<td>Yang 2017[51]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>892</td>
<td>806</td>
<td>614</td>
<td>28.1 ± 4.3</td>
<td>26.5 ± 3.6</td>
<td>[2][5][7][9]</td>
</tr>
<tr>
<td>Zhao et al. 2017[52]</td>
<td>RCT</td>
<td>New labor / WHO labor</td>
<td>85</td>
<td>101</td>
<td>85</td>
<td>28.2 ± 3.2</td>
<td>28.5 ± 3.4</td>
<td>[1][2][5][9]</td>
</tr>
</tbody>
</table>

### Table 2: Comparison of patient baseline characteristics between the new labor management and the WHO guideline

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Effect</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>MD = -0.16 [-0.55, 0.23]</td>
<td>0.42</td>
</tr>
<tr>
<td>Nulliparas</td>
<td>RR = 1.00 [0.99, 1.00]</td>
<td>0.88</td>
</tr>
<tr>
<td>Pre-pregnancy BMI</td>
<td>MD = 0.08 [-0.15, 0.31]</td>
<td>0.52</td>
</tr>
<tr>
<td>Gestational age at delivery</td>
<td>MD = 0.07 [-0.03, 0.17]</td>
<td>0.18</td>
</tr>
<tr>
<td>Epidural anesthesia</td>
<td>RR = 1.05 [0.84, 1.31]</td>
<td>0.66</td>
</tr>
</tbody>
</table>

MD: mean deviation; RR: risk ratio; BMI: body mass index.

comparison group in both the RCTs and cohort studies (RCTs: RR = 0.60 [0.42, 0.87], $I^2 = 0$; cohort studies: RR = 0.69 [0.55, 0.86], $I^2 = 82\%$) (Figure 2C).

The 3rd- or 4th perineal laceration: 3 RCTs[^16,18,29] and 6 cohort studies[^37,50,54,56–58] examined this outcome, and all the 6 cohort studies were retrospective cohort studies. In the RCTs, the 3rd- or 4th perineal laceration was less likely to occur in the intervention group compared with the comparison group, while no significant difference was...
Table 3: Indications for cesarean section

<table>
<thead>
<tr>
<th>Indications</th>
<th>New RCTs</th>
<th>WHO</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure in induction of labor</td>
<td>72%</td>
<td>75%</td>
<td>1.18</td>
</tr>
<tr>
<td>Prolonged latent phase</td>
<td>-</td>
<td>75%</td>
<td>1.18</td>
</tr>
<tr>
<td>Protracted active phase</td>
<td>98%</td>
<td>98%</td>
<td>0.83</td>
</tr>
<tr>
<td>Prolonged second phase</td>
<td>95%</td>
<td>94%</td>
<td>0.73</td>
</tr>
<tr>
<td>Relative cephalo-pelvic</td>
<td>97%</td>
<td>98%</td>
<td>0.93</td>
</tr>
<tr>
<td>Fetal distress</td>
<td>98%</td>
<td>98%</td>
<td>1.31</td>
</tr>
<tr>
<td>Other indications</td>
<td>84%</td>
<td>85%</td>
<td>1.57</td>
</tr>
</tbody>
</table>

RR: risk ratio; Others including: maternal request, maternal complications and placental abnormality etc.

observed in cohort studies (RCTs: RR = 0.38 [0.21, 0.70], F = 30%; cohort studies: RR = 1.10 [0.60, 2.03], F = 86%) (Figure 2D).

Postpartum hemorrhage: 10 RCTs and 26 cohort studies examined this outcome. Women in the intervention group showed comparable postpartum hemorrhage to that of women in the comparison group in both the RCTs and the cohort studies (RCTs: RR = 0.76 [0.44, 1.31], F = 51%; cohort studies: RR = 0.97 [0.82, 1.14], F = 70%) (Figure 2E).

Maternal infectious morbidity: 7 RCTs and 11 cohort studies examined this outcome. The infectious morbidity showed no significant difference between the intervention group and the comparison group among all studies (RCTs: RR = 0.97 [0.52, 1.79], F = 8%; cohort studies: RR = 1.00 [0.73, 1.37], F = 19%) (Figure 2F).

Postpartum urine retention: 3 RCTs and 10 cohort studies examined this outcome, and no great difference was observed between two groups in both the RCTs and cohort studies (RCTs: RR = 0.82 [0.45, 1.50], F = 0; cohort studies: RR = 1.25 [0.81, 1.93], F = 35%) (Figure 2G).

For the results of maternal morbidity with high heterogeneity, a subgroup analysis was performed, and the results are shown in Figure 3. Sensitivity analysis for maternal morbidity did not change the summary OR (Figure S3). Funnel plots modified by trim-and-fill method were used to evaluate the presence of publication bias for maternal morbidity (Figure S4).

**Neonatal morbidity**

Fetal distress: 5 RCTs and 12 cohort studies examined this outcome. Fetal distress seemed less common in the intervention group than that in the comparison group in the RCTs, while no significant difference was observed in cohort studies (RCTs: RR = 0.60 [0.38, 0.95], F = 30%; cohort studies: RR = 0.98 [0.88, 1.09], F = 0) (Figure 4A).

Neonatal asphyxia: 11 RCTs and 26 cohort studies examined this outcome, no significant difference was observed between two groups in both the RCTs and cohort studies (RCTs: RR = 0.76 [0.50, 1.15], F = 20%; cohort studies: RR = 0.84 [0.68, 1.03], F = 38%) (Figure 4B).

NICU admission: 3 RCTs and 8 cohort studies examined this outcome, which showed no significant difference between the intervention group and the comparison group in both the RCTs and cohort studies. (RCTs: RR = 0.61 [0.26, 1.44], F = 0; cohort studies: RR = 1.10 [0.86, 1.40], F = 81%) (Figure 4C).

For the results of neonatal morbidity with high heterogeneity, a subgroup analysis was performed, and the results are shown in Figure 5. A sensitivity analysis for neonatal morbidity did not change the summary OR. (Figure S5) Funnel plots modified by trim-and-fill method were used to evaluate the presence of publication bias for neonatal morbidity (Figure S6).

**DISCUSSION**

This systematic review and meta-analysis demonstrates a lower maternal morbidity and no increase in neonatal morbidity for women under the new labor management compared to women under the WHO guideline. The results were supported by the overall estimate from RCTs and cohort studies. The subgroup and sensitivity analyses showed that the combined results were quite stable.

We found that women managed by the new guideline had less labor augmentation with oxytocin, fewer intrapartum caesarean section and operative vaginal delivery. Hypocontractile activity is the most common reason for labor
He et al.: Clinical evidence of practical benefits of the new labor management. In 2018, WHO advised that the expectation of 1 cm cervical dilation per hour and the use of alert or action lines to guide intrapartum intervention decisions were no longer recommended. A systematic review involving a total of

He et al.: Clinical evidence of practical benefits of the new labor management.


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Figure 4. Risk ratio for neonatal morbidity. (A): fetal distress. (B): neonatal asphyxia. (C): neonatal intensive care unit admission.

Figure 5. Subgroup analysis for neonatal morbidity. (A): fetal distress. (B): neonatal asphyxia. (C): neonatal intensive care unit admission.
1338 low-risk women in the first stage of spontaneous labor at term concluded that for low-risk women making slow progress in spontaneous labor, treatment with oxytocin as compared to no treatment or delayed oxytocin treatment did not result in any discernable difference in the number of caesarean deliveries performed, and there were no detectable adverse effects for mother or baby. The use of oxytocin was associated with a reduction of approximately two hours of the time to delivery which might be important to some women.\textsuperscript{[61]} There is also evidence, however, that oxytocin administration during labor for low-risk women may lead to worse birth outcomes with an increased risk of intrapartum cesarean section, episiotomy and the use of epidural analgesia for pain relief, as well as fetal asphyxia.\textsuperscript{[62–64]} In 2020, the use of oxytocin for prevention of delay in labor in women receiving epidural analgesia is not recommended by WHO.\textsuperscript{[65]}

Under the new labor management guideline, the probability of intrapartum caesarean section and operative vaginal delivery were significantly reduced, without increasing the incidence of 3rd- and 4th-degree perineal laceration, postpartum hemorrhage, infectious morbidity and postpartum urine retention, fetal distress, neonatal asphyxia or NICU admission. We further explored the indications for intrapartum caesarean section and found that the major decrease in intrapartum cesarean section may be attributable to the fact that the prolonged latent phase along was no longer an indication for cesarean section under the new labor guideline. However, the pooled result of 44 studies differed from the only multi-center study conducted by Bernitz et al.\textsuperscript{[25]} This cluster-randomized controlled trial of the new guideline was done in 14 hospitals in Norway, with low baseline cesarean rates and labor care provided primarily by midwives. The study resulted in no significant difference in the rate of intrapartum cesarean delivery for primigravid people in spontaneous active labor. Intrapartum cesareans were performed for 5.9% of participants in the comparison group (the WHO guideline based on Friedman's partograph)\textsuperscript{[66]} and 6.8% of the intervention group (partograph based on Zhang et al.). As Bernitz et al. acknowledged,\textsuperscript{[25]} the intrapartum cesarean rate decreased from 9.3% before the trial to 6.8% during the trial in the hospitals randomized to the comparison group, suggesting that the trial may have had a Hawthorne effect on the comparison group.

Another single center retrospective cohort study based on 525 women who underwent primary cesarean delivery for arrest disorder\textsuperscript{[67]} indicated that the primary cesarean delivery rate was not reduced after the publication of the 2014 guidelines (WHO guideline vs. the new guideline: 13.4% vs. 13.3%, \(P = 0.81\)); the rate of composite maternal morbidities significantly increased from 50% to 75% (\(P = 0.02\)) in patients who had cesarean delivery for arrest of descent, with no significant change in the composite neonatal morbidities. Nunes et al. conducted a single center retrospective cohort study based on 3665 women who had achieved 4 cm of cervical dilation.\textsuperscript{[68]} Women were classified into 3 groups: normal progress group, a group met Zhang’s criteria for labor arrest (\(n = 400\)) and a group that did not meet criteria for Zhang’s but met for Friedman’s (\(n = 426\)). No statistical differences were found when comparing Zhang’s and Friedman’s groups for maternal and neonatal morbidities, which including: postpartum hemorrhage, infectious morbidity, perineal trauma and thrombotic events and a composite neonatal morbidity. This may also strengthen our results regarding the safety of the new labor management.

It should be pointed out that labor management is very complex, highly individualized, and often physician/midwife-influenced process. Labor management styles vary wildly from physician to physician, hospital to hospital even within the same country. The definition of dystocia is just one important aspect of labor management. Thus, it is plausible that different trials and observational studies may produce diverse results.

In our study, we aimed to present results based on clinical practice and therefore included both RCT and cohort studies to overall estimate the evidence of the safety of the new labor management. This study also has several limitations that must be taken into account. First, the evidence was limited to some of the evaluated outcomes. For instance, only 3 RCTs and 6 cohort studies examined the 3rd- and 4th-degree perineal laceration. Second, there was high heterogeneity among the studies included for some of the evaluated outcomes. Subgroup analyses showed higher heterogeneity in retrospective cohort studies. However, no significant difference of pooled results was observed across subgroup analyses. Besides, the region of origin for included studies are only 3 studies from Norway, America and France respectively, the rest of studies were all from China, and the level of evidence was weak. More high-quality studies are needed to confirm these findings.

CONCLUSION

Our results indicate that the new labor management guideline may lead to less intrapartum intervention with no increase in adverse obstetric outcomes. More high-quality studies are needed to confirm these findings.

DECLARATIONS

Author contributions
Source of funding
This work was supported by a grant from the National Key Research and Development Program of China (No. 2018YFC1004602).

Conflict of interest
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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