

# Common challenges managing bed and staff availability on labor and delivery units in the United States: A qualitative analysis

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## Abstract

**Background:** Managers of labor and delivery units need to ensure that their limited supply of beds and nursing staff are adequately available, despite uncertainty with respect to patient needs. The ability to address this challenge has been associated with patient outcomes; however, best practices have not been defined.

**Methods:** We conducted a secondary analysis of 96 interviews with nurse and physician managers from 48 labor and delivery units across the United States. Included units represented a diverse range of characteristics, but skewed toward higher volume teaching hospitals. The prior study scored management practice based on their proactiveness (ability to mitigate challenges before they occur). Based on emerging themes, we identified common challenges in managing bed and staff availability and performed an analysis of positive deviants to identify an additional criterion for effective management performance.

**Results:** We identified four key challenges common to all labor and delivery units, (1) scheduling planned cases, (2) tracking patient flow, (3) monitoring bed and staff availability in the moment, and (4) adjusting bed and staff availability in the moment. We also identified “systematicness” (ability to address challenges in a consistent and reliable manner) as an emerging criterion for effective management. We observed that being proactive and systematic represented distinct characteristics, and units with both proactive and systematic practices appeared best positioned to effectively manage limited beds and staffing.

**Discussion:** Labor and delivery unit managers should distinctly assess both the proactiveness and systematicness of their existing management practices and consider how their practices could be modified to improve care.

## KEYWORDS

labor and delivery, management, quality

## 1 | INTRODUCTION

The way hospital service units are managed has been associated with patient outcomes in a wide variety of health care

settings from cardiac intensive care units to substance abuse treatment programs.<sup>1-4</sup> Unit management includes directing operations and human resources; tracking, reporting, and improving quality and performance; and setting the culture

and norms for the unit. In childbirth, management of labor and delivery units has been associated with risk of cesarean delivery, hemorrhage, and prolonged length of stay.<sup>5</sup> In spite of these associations with patient outcomes, best practices for managing labor and delivery units have not been defined.

Prior efforts to measure and explain management practices have emphasized the need to proactively anticipate and mitigate operational challenges before they occur.<sup>6</sup> Labor and delivery units are particularly challenged by this need. Low financial margins often mean that beds and nursing staff are in limited supply.<sup>7</sup> Managers also face considerable uncertainty with respect to how patient census and acuity may vary over the course of a shift. Throughout health care, insufficient availability of beds and nursing staffing have been associated with higher rates of morbidity and mortality.<sup>8-12</sup> In obstetrics, prior research has suggested that an inability to manage surges in patient volume may be a reason why weekend delivery is a significant risk factor for adverse outcomes, including neonatal seizure and hemorrhage.<sup>13</sup> Bed availability also has been shown to affect clinician decision making, including the likelihood of recommending cesarean deliveries.<sup>14,15</sup>

The ability to effectively manage bed and staff availability appears to have substantial influence on patient care and is a priority for unit managers who aim to use limited resources efficiently and effectively. We conducted a secondary analysis of interviews with nurse and physician managers of labor and delivery units across the country to describe the variation in management practices in labor and delivery units and identify criteria that distinguish effective management of patient throughput and nurse staffing.

## 2 | METHODS

We performed a qualitative analysis to describe the variation in labor and delivery management practices and an analysis of positive deviants (with negative deviants as a comparator) to identify an additional criterion for effective management practices.

### 2.1 | Prior study of labor and delivery management

These secondary analyses were performed on interviews conducted for a prior study that aimed to assess the independent effect of differences in labor and delivery unit management on maternal outcomes.<sup>5</sup> The study included 118 interviews with nurse and physician managers who worked at 53 labor and delivery units across the contiguous United States. These labor and delivery units represented a diverse range of characteristics, but overall skewed toward units in higher volume academic medical centers on the east coast. All enrolled labor

and delivery units were members of the National Perinatal Information Center/Quality Analytics Service (NPIC/QAS) and were recruited through emails and telephone calls with their NPIC/QAS contacts. Each NPIC/QAS contact identified the primary nurse and physician managers of their labor and delivery unit to participate in 50-minute telephone interviews between February and December 2015.

The semi-structured interviews discussed three dimensions of management: the management of (1) unit culture, including practices that facilitate communication, collaboration, and quality improvement, (2) patient flow, including practices that adjust resources to accommodate surges in patient arrival, and (3) nursing, including practices that ensure appropriate nurse staffing levels. After each interview, the interviewer quantitatively scored descriptions of management practices based on their "proactiveness," defined as their ability to mitigate management challenges before they occur. The interview guides and scoring scales included in the management assessment instrument were developed with input from nurses, midwives, physicians, and patient advocates and validated through expert consultation, site visits, and analyses of construct validity.<sup>5</sup>

### 2.2 | Transcription and coding

All interviews from the prior study were transcribed from audio recordings. The interviewer from the prior study and a qualitative methodology expert provided the transcriptionists with a glossary of key obstetrics and management terms used in the interviews and reviewed 10-minute segments of the preliminary set of transcribed interviews to ensure the quality of the transcripts.

The interviewer, the qualitative expert, and a clinical expert developed a deductive coding scheme, which included construct-related themes derived directly from the interview guide from the prior study and cross-cutting themes based on higher-level concepts captured throughout the interviews. Throughout the coding process, we inductively added emerging subthemes based on the specific practices managers reported in the interviews.<sup>16</sup> Each subtheme was defined and discussed with all researchers and coders to ensure consistent use across interviews.

We applied these codes and conducted the subsequent analysis using NVivo (Version 11). The interviewer and the qualitative expert trained two coders familiar with labor and delivery unit operations in the coding scheme. We reviewed all coding until each coder achieved >80% agreement with the reviewer. In cases of disagreements, we discussed the coding until the group reached consensus and, if necessary, clarified the code definition.<sup>17</sup> After each coder reached the 80% agreement threshold, we continued to review a 10% subsample of interviews to ensure maintained quality throughout the coding.

**TABLE 1** Characteristics of labor and delivery units studied and managers interviewed across the United States, 2015

Unit and manager characteristics	Median [IQR] or n (%) (N = 48)
Annual delivery volume	
≤1500	6 (13)
1501-3000	15 (31)
3001-4500	11 (23)
4501-6000	7 (15)
>6000	9 (19)
Teaching service	32 (67)
Midwifery service	33 (69)
System membership	39 (81)
NICU level	
I	4 (8)
II	4 (8)
III	35 (73)
IV	5 (10)
Geography	
Northeast	14 (29)
South	22 (46)
Midwest	6 (13)
West	6 (13)
Physician manager	
Tenure in role (y)	2 [1-5]
Tenure in unit (y)	16 [10-26]
Nurse manager	
Tenure in role (y)	3 [2-6]
Tenure in unit (y)	12 [8-20]

### 2.3 | Qualitative analyses

To understand what specific types of management practices are associated with better maternal outcomes, we performed an analysis of positive deviants with negative deviants as a comparator. Our analysis included the first 2 stages of a positive deviance approach: identify positive deviants (stage 1) and qualitatively study positive deviants to generate hypotheses about their strategies for success (stage 2).<sup>18,19</sup>

The quantitative analyses from the prior study indicated that more proactive management of patient flow and nursing was associated with a lower risk of prolonged length of stay in low-risk women (defined based on the AHRQ IQI #33 measure of uncomplicated primary cesarean rates). Therefore, we selected a sample of interviews from units with the highest and lowest scores for proactiveness in patient flow and nursing dimensions for secondary analysis to identify specific practices and themes that distinguish

hospitals with more proactive patient flow and nursing management. We included interviews with nurse and physician managers from 33 units in the highest and lowest tertiles of scores for managing patient flow and 39 units in the highest and lowest tertiles of scores for managing nursing. The number of units included in the patient flow and nursing management samples differed because multiple units at the border of the tertiles had the same scores. We decided to either include or exclude all units with the same borderline score based on which approach would create tertiles as close to a third of the full sample as possible. Given the overlap between the patient flow and nursing management samples, we included a total of 48 units (96 interviews) in the secondary analysis.

In our qualitative analyses, first, we analyzed patient flow and nursing management practices included in the samples to capture the range of variation in practices (see Appendix for details). Based on a synthesis of all these practices, we identified overarching challenges managers face related to the management of patient flow and nursing. Second, we summarized practices and themes across hospitals in the high and low scoring groups and compared these summaries to identify similarities and differences between units with more vs less proactive management practices.<sup>20</sup> Given the substantial variation within and across groups, there were few specific practices that showed clear associations with the higher or low scoring groups; however, an assessment of themes across practices identified a second key criterion that distinguished high scoring units, which we labeled “systematicness” (see Results for description). We developed a framework for identifying effective patient flow and nursing management practices based on both the emerging criterion of systematicness and the prior criterion of proactiveness, which formed the basis of management assessment instrument from prior studies.

The summaries of these findings were interpreted with three obstetrician/gynecologists involved in the study and an interdisciplinary advisory group, including an operations management expert, a quality and safety manager, and two nurse managers with experience managing labor and delivery units in academic medical centers, community hospitals, and critical access hospitals. Because the aim of this study is to highlight variation in practice, we report all practices that occur at least once in our sample.

## 3 | RESULTS

We present our results in the order of our analytic approach. After describing our study population, we present common management challenges among all the units we analyzed. Then we present the emerging management characteristic we observed among proactively managed hospitals. Finally,

we describe specific effective management practices for addressing each of the challenges we identified based on a framework of proactiveness and systematicness.

### 3.1 | Study population

The 48 units included in the analysis of patient flow and nursing had larger annual delivery volumes (only 13% with  $\leq 1500$  deliveries per year), were more likely to be higher acuity (83% NICU Level III or IV), and were more likely to be in teaching hospitals (67%) compared with labor and delivery units across the United States (Table 1).<sup>21</sup> The units were located across the contiguous United States, but the sample was skewed toward the Northeast or South (75%). The nurse and physician managers who were interviewed generally had over 10 years of work experience in their unit and 2 years of experience in their managerial role.

### 3.2 | Emerging management challenges

Based on our analyses, we identified four patient flow and nursing management challenges common to all labor and delivery units studied:

1. Scheduling planned cases (managing the volume and clinical appropriateness of planned cases),
2. Tracking patient flow (tracking patient census, acuity, and throughput throughout the unit and creating plans to address bottlenecks in patient flow),
3. Monitoring bed and staff availability in the moment (monitoring beds and staffing levels and ensuring appropriate patient assignments moment-by-moment), and
4. Adjusting bed and staff availability in the moment (accessing additional beds and staff to accommodate changes in patient census or acuity).

The advisory group validated that these four challenges represent key operational management challenges faced on labor and delivery units, but also highlighted that they are challenges that can be potentially mitigated through effective management.

### 3.3 | Emerging criterion for effective management

In addition to the criterion of proactiveness prioritized in the management assessment from the prior study, a second criterion of systematicness emerged through the analysis of positive deviants. We defined the emerging criterion of systematicness as the degree to which management practices were intentionally structured and consistently implemented. Systematic practices generally involved both designated roles and structured processes to allow effective unit management practices to be structurally incorporated into unit operations.

Systematic practices often facilitated more proactive practices, those which fulfill the criterion for effective practices identified in prior work, by creating the time and space for forward thinking and planning. For example, the systematic practice of having a designated charge nurse protected from patient care responsibilities was reported to be:

*A really good process...because they really have the 30 000 view and they're able to see what's going on, and to keep constant communication with the staff during the shift to make sure that we know what's going on with the patients, and that we had fair assignments.*

Although systematicness could facilitate proactiveness, these two criteria represented distinct features of management practices. While the most effective management practices embodied both criteria, we also observed some practices that proactively addressed challenges in unsystematic ways and others that reactively addressed challenges in systematic ways.

Management practices that were less proactive and systematic were reported to decrease satisfaction, efficiency, and safety on labor and delivery units. For example, one manager whose unit struggled with adjusting bed availability and delayed cases instead of using any type of flexible capacity reported:

*There is a significant frustration with the delay of cases, so I wouldn't say that that is particularly efficient...it's certainly not very efficient from that patient's perspective or that provider's perspective.*

Another manager with similar issues with delayed cases reported:

*This whole c-section schedule is another huge safety issue, 'cause one of the things that happens, again, with our scheduled c-sections on a busy day when we're doing sections off the labor floor, we absolutely hold up scheduled c-sections for hours and hours and hours...it's just, that's always a safety issue.*

### 3.4 | Examples of effective management practices

#### 3.4.1 | Strategies for scheduling planned cases

Units with more systematic case scheduling practices had a dedicated staff role with responsibility for scheduling all

**TABLE 2** Examples of strategies for managing labor and delivery unit patient flow and nursing from units across the United States, 2015

Management challenge	More proactive and more systematic	More proactive and less systematic	Less proactive and more systematic	Less proactive and less systematic
1) Scheduling planned cases	<ul style="list-style-type: none"> <li>• Scheduler trained in appropriateness guidelines and empowered to review cases while scheduling</li> <li>• Enforced limits on the quantity of cases per day by procedure type</li> <li>• Schedule maintained in broadly accessible and automatically updating computer system</li> </ul>	<ul style="list-style-type: none"> <li>• Any nurse who answers the phone reviews cases for appropriateness and schedules</li> <li>• Schedule maintained in a paper logbook</li> </ul>	<ul style="list-style-type: none"> <li>• Secretary schedules all cases and nurse manager subsequently reviews all cases on the schedule for appropriateness</li> </ul>	<ul style="list-style-type: none"> <li>• No designated scheduling role</li> <li>• No review of cases for appropriateness</li> <li>• No enforced limits on the quantity of cases scheduled per day</li> </ul>
2) Tracking patient flow	<ul style="list-style-type: none"> <li>• Regular daily meetings to discuss census, cases, and plans for anticipated issues</li> <li>• Teletracking system for tracking bed placements, transfers, and delays</li> <li>• Computer program to predict census based on planned cases and spontaneous admission trends</li> </ul>	<ul style="list-style-type: none"> <li>• Ad hoc meetings with leadership to discuss census, cases, and plans for anticipated issues</li> </ul>	<ul style="list-style-type: none"> <li>• End of day reports for leadership on numbers of deliveries, visits, and laboring patients</li> <li>• Retrospective review of delivery log to identify bottlenecks</li> </ul>	<ul style="list-style-type: none"> <li>• No tracking system</li> <li>• Frontline staff report bottlenecks and issues as they occur</li> </ul>
3) Monitoring bed and staff availability in the moment	<ul style="list-style-type: none"> <li>• Protected charge nurse with designated backup well-positioned to take over the monitoring role (eg, manager)</li> <li>• Charge nurse regularly checks in with patient-assigned nurses (eg, after major changes on the unit or at regular time intervals)</li> </ul>	<ul style="list-style-type: none"> <li>• Protected charge nurse but no designated back-up for emergencies</li> <li>• Charge nurse checks in with patient-assigned nurses ad hoc</li> </ul>	<ul style="list-style-type: none"> <li>• Charge nurse with patient care responsibilities, but designated backup well-positioned to take over the monitoring role (eg, manager)</li> </ul>	<ul style="list-style-type: none"> <li>• Charge nurse with patient care responsibilities and no designated backup</li> <li>• Nurses responsible for reporting excessive workload to the charge nurse</li> </ul>
4) Adjusting bed and staff availability in the moment	<ul style="list-style-type: none"> <li>• Appropriate and easily usable flexible spaces (eg, dedicated overflow rooms or antepartum rooms with central monitoring)</li> <li>• Floating or resource pool nurses with labor and delivery competencies</li> <li>• Preset plans for accommodating surges enacted before reaching maximum capacity</li> </ul>	<ul style="list-style-type: none"> <li>• Poorly equipped or challenging to use flexible spaces (eg, antenatal testing beds, separate area requiring additional security measures)</li> <li>• Floating or resource pool nurses without labor and delivery competencies (eg, NICU nurse to be a baby nurse)</li> </ul>	<ul style="list-style-type: none"> <li>• On-call system for recruiting additional nurses during surges</li> <li>• Preset plans for accommodating surges enacted after reaching maximum capacity</li> </ul>	<ul style="list-style-type: none"> <li>• Divert, delay, or cancel cases</li> <li>• Contact all nurses (call, text, email, social media) to recruit additional nurses during surges</li> <li>• No preset plan for accommodating surges</li> </ul>

planned cases, and units with more proactive case scheduling processes empowered these scheduler(s) to limit the number of cases scheduled per day with separate quotas for each type of procedure scheduled (Table 2, Row 1). Managers of less proactive units, which did not limit case scheduling or only had quotas for some types of cases (eg, limits for the number of cesareans but not inductions), often reported either a complex and burdensome process for aligning scheduled

case volume with resource availability or challenges with in-the-moment adjustments to the case schedule or beds and staffing levels on overscheduled days. More proactive units also trained scheduler(s) to review cases based on gestational age and clinical indications during the scheduling process to restrict cases that did not meet standards for early elective deliveries at the time of scheduling. While almost all units had processes for physicians to appeal for exceptions to case

appropriateness guidelines, training the scheduler(s) to review and restrict cases at the point of scheduling could prevent the need to reschedule cases later identified as inappropriate and reduce the workload of the reviewers, who are often frontline clinicians or members of the leadership team with numerous other clinical and/or administrative responsibilities.

### 3.4.2 | Strategies for tracking patient flow

Units with more systematic tracking of patient flow had structured processes to ensure that tracking was “baked into the way that we do business” (Table 2, Row 2). For example, more systematic units had regular meetings to discuss current patient census and acuity, anticipated changes in census or acuity with upcoming scheduled cases or discharges, and plans for any possible issues during the next shift or day with leadership or the full care team. Units with more proactive tracking of patient flow had systems to preemptively address any potential issues with census, acuity, or resources that may affect the flow of patients in and out of the labor and delivery unit. For example, some more proactive units reported teletracking systems that tracked bed placements and patient flow to identify and facilitate planning for issues. Another unit reported anticipating overcrowding issues and closing their case schedule at potentially overbooked times using a computer program that analyzed planned cases and historical trends in spontaneous admissions.

### 3.4.3 | Strategies for monitoring bed and staff availability in the moment

Units with more proactive methods for monitoring bed and staff availability had charge nurses (also referred to as resource nurse, lead nurse, or care coordinator) protected from patient care responsibilities who regularly checked in with frontline nurses about the status of their patients (Table 2, Row 3). Units with more systematic methods for monitoring bed and staff availability also had designated a backup to support the charge nurse and structured processes for assigning patients to nurses. Designated backup support during emergencies or breaks included individuals who could provide skilled, accessible, and accountable support for the unit, such as the manager, nurse educator or specialist, or frontline nurse with charge nurse experience. For patient assignments, more proactive units incorporated considerations such as patient acuity and preferences, continuity of care, nurse skills, and experiences into their patient assignments.

### 3.4.4 | Strategies for adjusting bed and staff availability in the moment

Units with more proactive approaches for adjusting bed and staff availability primarily accommodated changes in patient

census or acuity through the use of flexible spaces or staff within the unit, service line, or hospital (Table 2, Row 4). The flexibility and availability of these resources allowed for immediate adjustments to accommodate patient care without delays or disruptions for incoming or existing patients. Several more proactive units further improved the seamlessness of their adjustments through surge plans that started enacting adjustments before the unit reached maximum capacity. Units with more systematic approaches for adjusting bed and staff availability had flexible spaces and staff that were appropriate for supporting the full range of labor and delivery care, such as dedicated overflow rooms or antepartum rooms with central monitoring and labor beds, and floating nurses or resource pool nurses with labor and delivery competencies who could support the full range of labor and delivery care needs.

## 4 | DISCUSSION

All labor and delivery unit managers face some uncertainty regarding when and how the needs of their unit may change, but we have found that managers address these challenges in many different ways. Prior studies of management have primarily focused on elements of safety culture related to communication and teamwork.<sup>22-26</sup> Our analyses add to this body of work by describing how managers of labor and delivery units across the United States address issues of patient flow and nurse staffing. These structural dimensions can set the foundation for successful and safe processes and outcomes of care.<sup>27,28</sup>

We found that labor and delivery units face a number of specific and common management challenges related to patient flow and nursing. Ahead of a given shift, managers can mitigate management challenges by scheduling their planned cases to align with their available beds and staff and by tracking patient flow to plan for issues based on their anticipated census and acuity.<sup>29-32</sup> These strategies offer managers more degrees of freedom to control their patient volume, beds, and nurse staffing levels, but less precision in their adjustments because even optimal scheduling and planning cannot account for all the uncertainties of labor and delivery care. Therefore, managers also need to actively monitor and adjust bed and/or staff availability to accommodate sudden changes in patient needs in the moment. While managers have more limited methods for adjustment in the moment, these strategies are necessary to precisely align beds and nurse staffing with actual patient needs.

Prior studies of management have prioritized management practices that proactively address unit challenges.<sup>1-6</sup> Across the 48 units studied in this analysis, units with the most efficient management of these challenges had practices that were not only proactive, as characterized in prior literature, but

were also systematic, an additional criterion identified in our study through an analysis of positive deviants with negative comparators. Combined, these two criteria mirror the characteristics of effective management performance in other safety critical industries, such as aviation and energy.<sup>33</sup> Proactive practices can improve management through mitigating challenges before they occur and reducing the complexities involved with resolving problems in the midst of crises, such as implementing a surge plan to adjust beds and staffing levels before a unit reaches maximum capacity. Systematic practices can also reduce the complexities and burdens of management processes by reducing unnecessary redundancies, such as requiring an additional level of review for all scheduled cases instead of checking indications at the time of scheduling, and automating management best practices to occur consistently. Labor and delivery unit managers considering how to optimize their management practices should ensure that their practices embody both of these dimensions of effective management. Future work should aim to validate the usefulness of this framework in benchmarking and improving management practices.

Our results were limited by our study design involving a secondary analysis of interviews that were intended to capture detailed data on management practices in varied units. These interviews were useful for descriptive analyses, but provided limited insight into the facilitators and barriers underlying management, such as financial or technical support. The interviews also captured existing practices from a sample of units recruited from the National Perinatal Information Center/Quality Analytics Service membership that skewed toward higher volume and acuity academic centers.<sup>21</sup> Therefore, the management practices described in our results represent the most proactive and systematic practices among the range of existing practices in these types of units, but the specific practices may not be optimal for all units. Lower volume and lower resource units may not reasonably be able to achieve some management practices that are optimal in larger units, such as protecting dedicated roles for planned case scheduling and unit monitoring. However, while lower volume units have fewer beds, nurses, and patients, they also have some advantages over higher volume units such as often having more flexible space capabilities and staff competencies that can be leveraged for proactive adjustments.

Our study provides an opportunity for managers to understand the range of existing practices for managing patient flow and nursing and to evaluate opportunities to intentionally incorporate practices that are both more proactive and more systematic into the management of their units. Our analyses also provide a basis for further inquiry into best practices for labor and delivery unit management. Similar to evidence-based best practices in clinical care, there may be opportunities for individual hospitals,

systems, or quality collaboratives to create evidence-based standards for appropriate labor and delivery unit management to improve operational efficiency and quality of care.

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## REFERENCES

1. McConnell KJ, Lindrooth RC, Wholey DR, et al. Management practices and the quality of care in cardiac units. *JAMA Intern Med.* 2013;173:684.
2. McConnell KJ, Lindrooth RC, Wholey DR, Maddox TM, Bloom N. Modern management practices and hospital admissions. *Health Econ.* 2016;25:470-485.
3. McConnell KJ, Hoffman KA, Quanbeck A, McCarty D. Management practices in substance abuse treatment programs. *J Subst Abuse Treat.* 2009;37:79-89.
4. Dorgan S, Layton D, Bloom N, Homkes R, Sadun R, Van Reenen J. *Management in Healthcare: Why Good Practice Really Matters.* London, UK: McKinsey & Company and London School of Economics; 2010.
5. Plough AC, Galvin G, Li Z, et al. Relationship between labor and delivery unit management practices and maternal outcomes. *Obstet Gynecol.* 2017;130:358-365.
6. Bloom N, Van Reenen J. Measuring and explaining management practices across firms and countries. *Q J Econ.* 2007;122:1351-1408.
7. Hung P, Kozhimannil KB, Casey MM, Moscovic IS. Why are obstetric units in rural hospitals closing their doors? *Health Serv Res.* 2016;(Simpson 2011):1-15.
8. Hoot NR, Aronsky D. Systematic review of emergency department crowding: causes, effects, and solutions. *Ann Emerg Med.* 2008;52:126-136.
9. Needleman J, Buerhaus P, Mattke S, Stewart M., Zelevinsky K. Nurse-staffing levels and the quality of care in hospitals. *New Engl J Med.* 2002;346:1715-1722.

10. Needleman J, Buerhaus P, Pankratz VS, Leibson CL, Stevens SR, Harris M. Nurse staffing and inpatient hospital mortality. *N Engl J Med*. 2011;364:1037-1045.
11. Aiken LH, Sloane DM, Bruyneel L, et al. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. *Lancet*. 2014;383:1824-1830.
12. Neuraz A, Guérin C, Payet C, et al. Patient mortality is associated with staff resources and workload in the ICU. *Crit Care Med*. 2015;43:1587-1594.
13. Snowden JM, Kozhimannil KB, Muoto I, Caughey AB, McConnell KJ. A “busy day” effect on perinatal complications of delivery on weekends: a retrospective cohort study. *BMJ Qual Saf*. 2017;26:e1.
14. Snowden JM, Darney BG, Cheng YW, McConnell KJ, Caughey AB. Systems factors in obstetric care: the role of daily obstetric volume. *Obstet Gynecol*. 2013;122:851-857.
15. Cheng YW, Snowden JM, Handler S, Tager IB, Hubbard A, Caughey AB. Clinicians’ practice environment is associated with a higher likelihood of recommending cesarean deliveries. *J Matern Fetal Neonatal Med*. 2014;27:1220-1227.
16. Fereday J, Muir-Cochrane E. Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and theme development. *Int J Qual Methods*. 2006;5:80-92.
17. Garrison DR, Cleveland-Innes M, Koole M, Kappelman J. Revisiting methodological issues in transcript analysis: negotiated coding and reliability. *Internet High Educ*. 2006;9:1-8.
18. Baxter R, Taylor N, Kellar I, Lawton R. What methods are used to apply positive deviance within healthcare organisations? A systematic review. *BMJ Qual Saf*. 2016;25:190-201.
19. Bradley EH, Curry LA, Ramanadhan S, Rowe L, Nembhard IM, Krumholz HM. Research in action: using positive deviance to improve quality of health care. *Implement Sci*. 2009;4:25.
20. Sandelowski M. Focus on research methods whatever happened to qualitative description? *Res Nurs Health*. 2000;23:334-340.
21. Simpson KR. An overview of distribution of births in United States hospitals in 2008 with implications for small volume perinatal units in rural hospitals. *J Obstet Gynecol Neonatal Nurs*. 2011;40:432-439.
22. Lyndon A, Johnson MC, Bingham D, et al. Transforming communication and safety culture in intrapartum care: a multi-organization blueprint. *J Obstet Gynecol Neonatal Nurs*. 2015;44:341-349.
23. Halligan M, Zecevic A. Safety culture in healthcare: a review of concepts, dimensions, measures and progress. *BMJ Qual Saf*. 2011;20:338-343.
24. Singer S, Lin S, Falwell A, Gaba D, Baker L. Relationship of safety climate and safety performance in hospitals. *Health Serv Res*. 2009;44(2P1):399-421.
25. Singer SJ, Vogus TJ. Reducing hospital errors: interventions that build safety culture. *Annu Rev Public Health*. 2013;34:373-396.
26. Kringos DS, Sunol R, Wagner C, et al. The influence of context on the effectiveness of hospital quality improvement strategies: a review of systematic reviews. *BMC Health Serv Res*. 2015;15:277.
27. Donabedian A. Evaluating the quality of medical care. *Milbank Mem Fund Q*. 1966;44:166.
28. Donabedian A. The quality of care: how can it be assessed? *JAMA*. 1988;260:1743-1748.
29. Dexter F, Macario A. Optimal number of beds and occupancy to minimize staffing costs in an obstetrical unit? *Can J Anesth Can d’anesthésie*. 2001;48:295-301.
30. Cochran JK, Bharti A. Stochastic bed balancing of an obstetrics hospital. *Health Care Manag Sci*. 2006;9:31-45.
31. Pehlivan C, Augusto V, Xie X, Crenn-Hebert C. Multi-period capacity planning for maternity facilities in a perinatal network: a queuing and optimization approach. In: *Proceedings of the 2012 IEEE International Conference on Automation Science and Engineering (CASE)*; 2012:137-142. <http://ieeexplore.ieee.org/abstract/document/6386385/>. Accessed February 4, 2018
32. Gombolay M, Golen T, Shah N, Shah J. Queueing Theory Analysis of Labor & Delivery at a Tertiary Care Center. MIT Computer Science and Artificial Intelligence Laboratory Technical Report, 2014-029; 2014. <https://dspace.mit.edu/bitstream/handle/1721.1/92354/MIT-CSAIL-TR-2014-029.pdf;sequence=2>. Accessed February 7, 2018.
33. Hudson P. Applying the lessons of high risk industries to health care. *Qual Saf Health Care*. 2003;12 (Suppl 1):i7-i12.

## SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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