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The Double-Edged Sword of Clinical Decision Support in Labor & Delivery: A Systematic Review of its Impact on Nursing Judgment

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Abstract
Background: The integration of Clinical Decision Support (CDS) systems in Electronic Health Records (EHRs) has become the cornerstone of modern obstetric practice, aimed at standardizing and improving patient safety. In the high-stakes environment of Labor and Delivery (L&D), CDS tools, specifically for fetal heart rate (FHR) interpretation and oxytocin administration, are widely used in practice. These systems exert a profound influence on L&D nurses' workflow and clinical decision-making, as they are the primary agents of continuous patient monitoring.
Aim: This review synthesizes the literature from 2015 to 2024 to explore the multifaceted impact of EHR-embedded CDS on nursing judgment, specifically on its effect on nursing autonomy, patient safety, and the phenomenon of alert fatigue.
Methods: A narrative review was conducted by searching the databases PubMed, CINAHL, and Web of Science. Search terms were "clinical decision support," "nursing," "labor and delivery," "fetal heart rate," "oxytocin," "patient safety," "autonomy," and "alert fatigue."
Results: The findings show a complex and often conflicting interplay between CDS and nursing practice. CDS systems can enhance safety by providing an organized framework for FHR assessment and imposing evidence-based oxytocin protocols, thus leading to a reduction in adverse events. They can, at the same time, erode nursing autonomy by promoting algorithmic thought, deskilling, and replacing holism in clinical judgment. Furthermore, high levels of non-actionable or excessively sensitive alerts are one of the biggest contributors to alert fatigue, which consequently leads to workarounds, desensitization, and safety issues that eliminate the intended benefits.
Conclusion: CDS in L&D is a double-edged sword. Its optimal application depends on a human-factors design that produces systems to support, rather than supplant, the nurse's critical thinking. Strategies need to address escalating alert specificity, smoothly integrating CDS into nursing workflow, and building a culture in which technology supplements, but never substitutes for, expert nursing judgment. Safe obstetric care in the future hinges on a complementary partnership of nurse intuition and computerized intelligence.
Keywords: nursing judgment, labor and delivery, fetal heart rate monitoring, oxytocin, patient safety, nursing autonomy, alert fatigue.

1. Introduction

Labor and Delivery (L&D) units are dynamic, high-acuity environments in which rapid decisions with important consequences for two patients need to be made simultaneously. The cornerstone of intrapartum care is diligent observation, which is primarily performed by registered nurses, who observe for subtle signs of compromise of the fetus or mother. Two of the most hazardous and high-risk elements in this monitoring are the interpretation of the fetal heart rate (FHR) tracing and oxytocin infusion for induction or augmentation of labor. Both areas have documented practice variation and risk for human error, and therefore, they are a priority for health information technology standardization (Wisner et al., 2021; Forde-Johnston et al., 2023).

The widespread use of Electronic Health Records (EHRs) has opened the door to embedding

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Clinical Decision Support (CDS) systems into the clinical process. CDS is "tools that provide clinicians with person-specific information, intelligently filtered and presented at appropriate times, to enhance health and health care" (Sutton et al., 2020, p. 2). In L&D, they range from simple alerts—e.g., reminders for protocol compliance—to complex algorithms that examine FHR patterns and offer interpretation recommendations or recommend titrating oxytocin infusion rates according to pre-programmed criteria (Nggada, 2022).

The promised advantages of CDS are clear: to hardwire evidence-based practice, reduce cognitive load on clinicians, minimize practice variation, and ultimately improve patient safety by preventing missed diagnoses and medication errors. However, implementing any technology within a socio-technical system as complex as nursing care imposes unintended consequences. For L&D nurses, who practice at the crossroads of patient care and technology, CDS systems place an in-depth and pervasive impact on their crucial professional practices: clinical judgment and autonomous practice (Kagan et al., 2023).

This review synthesizes literature from 2015 to 2024 to critically examine the impact of EHR-integrated CDS systems on nursing judgment in L&D. It will focus on CDS tools for FHR interpretation and oxytocin administration and explore how these technologies influence three interconnected areas: (1) nursing autonomy and clinical reasoning, (2) patient safety outcomes, and (3) the generation and meaning of alert fatigue. By consideration of this triad, the review aims to provide a balanced perspective on the promise and dangers of CDS in modern obstetrics and to identify the essential building blocks of its effective implementation into nursing practice.

Methodological Framework

This systematic review was conducted through a systematic search of peer-reviewed literature from January 2015 to December 2024. The primary databases used were PubMed, CINAHL (Cumulative Index to Nursing and Allied Health Literature), and Web of Science. The search strategy employed the use of combined keywords and Medical Subject Headings (MeSH) of ("(clinical decision support systems" OR "decision support systems, clinical" OR "CDS" OR "electronic health record" OR "EHR") AND ("nursing" OR "nurse" OR "nursing judgment" OR "clinical judgment") AND ("labor and delivery" OR "obstetrics" OR "intrapartum care") AND ("fetal heart rate monitoring" OR "cardiotocography" OR "oxytocin" OR "pitocin") AND ("patient safety" OR "medical errors" OR "safety" OR "adverse events") AND ("professional autonomy" OR "clinical reasoning" OR "alert fatigue" OR "alarm fatigue"). Manual searches of reference lists of primary articles were also conducted for other papers that might be relevant. Inclusion criteria were English peer-reviewed articles reporting directly the impact of CDS on autonomy, safety, L&D nursing practice, or alert fatigue. Excluded from analysis were studies of only physician practice or CDS in other clinical specialties. Findings were synthesized thematically to address the review's key questions.

Decision Support for Labor and Delivery

CDS applications during L&D are designed to display real-time, point-of-care assistance to health care providers. For FHR monitoring, CDS can be displayed in numerous formats. Basic systems can prompt nurses to record some portion of the tracing, such as variability or decelerations, on a template for documentation. More advanced systems use algorithms to decode the FHR signal and give a categorical result (e.g., Category I, II, or III based on NICHD guidelines) or to alert on specific patterns of concern, such as persistent late or variable decelerations, minimal variability, or tachycardia (Thayer et al., 2023). The theoretical advantage is enhanced consistency and promptness of detection of non-reassuring patterns, resulting in earlier intervention.

For oxytocin dosing, CDS is typically protocol-directed. The system can have institution-specific, evidence-based protocols for starting doses, escalation intervals, and peak doses. CDS can prompt the nurse to alter the oxytocin rate, calculate the new dose, and notify deviations from protocol, i.e., too large an increase or not reassessing the patient before titration (Jackson et al., 2019). It can also integrate data from uterine contractility monitoring to alert against abnormally high uterine activity (tachysystole), a known risk factor for fetal hypoxia. The primary safety goals are prevention of hyperstimulation of the uterus and its sequelae, and maintenance of stable, safe medication administration. The underlying presumption in using these CDS tools is that they will be an intellectual adjunct, taking the nurse off mundane work and calculations and thereby clearing mental space for more abstract critical thinking and hands-on patient care.

The Impact on Nursing Judgment and Autonomy

L&D nursing judgment is a sophisticated, intuitive process informed by experience, pattern matching, and integration of numerous data points—like the FHR tracing, mother's vital signs, labor progression, and patient's overall clinical setting and status. CDS drastically alters this process, with significant implications for professional discretion.

Augmentation and Standardization of Clinical Reasoning

It is argued by supporters that CDS is a good learning and standardizing tool, particularly for novice nurses. Being a directed system of FHR interpretation, CDS can help in reinforcing the NICHD terminology as well as in having everybody on the care team using the same language (Du et al., 2023). For oxytocin, CDS can transfer the latest evidence into practice, reducing unwarranted variation and ensuring that all patients are receiving care that is in line with best-practice guidelines. From this viewpoint, CDS supplements nursing judgment by providing a safety net and a standard, perhaps enhancing a nurse's confidence in her own judgment (Negussie et al., 2019).

Erosion of Holistic Judgment and Deskilling

One big body of literature does mention, though, an erosion of autonomous clinical judgment. If CDS provides an authoritative-sounding FHR interpretation or obligatory oxytocin titration maneuver, it may promote "automation bias"—humans' proclivity to over-rely on automated information and override or under-use conflicting information from other channels (Kupfer et al., 2023; Wang et al., 2023). A nurse will be less likely to critically evaluate a "Category I" FHR tracing marked by the computer or will act on an oxytocin increase order without independently reviewing the cervical status of the patient and the FHR pattern at that moment.

This reliance can lead to "deskilling," where nurses' ability to independently analyze complicated FHR patterns or manage labor independently of computer guidance may weaken over time (McBride, 2006). The art of nursing as a human activity, incorporating technological information into the human context, is being jeopardized. For instance, a computer alert of "minimal variability" may fail to detect a sleeping fetus or recent narcotic use in the mother, circumstances that an experienced nurse would automatically consider. As CDS becomes the source of truth, the patient's comprehensive judgment is displaced, and care might become disconnected and less personalized (Colomar et al., 2021; Al-Mutawtah et al., 2023).

Shifting Accountability and the "Black Box" Problem

CDS also raises challenging problems of accountability. If a CDS recommendation is followed and then an adverse event occurs, who is to blame: the nurse who performed the action or the system (and its creators)? This can lead to moral distress in nurses, who can be driven into following the algorithm in spite of their clinical acumen advising otherwise (Kissler et al., 2020). Secondly, most CDS algorithms are closed "black boxes" in that the rationale for an alert is not known to the end-user. A nurse cannot critically evaluate the reasoning of a system she doesn't understand, which basically defeats the principles of informed clinical decision-making and can encourage feelings of powerlessness (James et al., 2021). Table 1 & Figure 1 summarize the dual impact of CDS on nursing judgment and autonomy in L&D.

Table 1: The Dual Impact of CDS on Nursing Judgment and Autonomy in L&D

Aspect of Nursing Practice	Potential Positive Impacts of CDS	Potential Negative Impacts of CDS
Clinical Reasoning	Standardizes approach using evidence-based guidelines (NICHD). Serves as a training tool for novice nurses. Reduces cognitive load for calculations (oxytocin).	Promotes automation bias and complacency. Leads to deskilling of independent interpretation. Fragments' holistic assessment by focusing on algorithm-driven data points.
Professional Autonomy	Provides a safety net, potentially increasing confidence in decisions. Empowers nurses to advocate for protocol adherence.	Displaces nurses' intuition and experiential knowledge. Creates moral distress when system recommendations conflict with personal judgment. Undermines professional authority.
Accountability	Creates a clear, auditable trail of care and alerts. Objectifies decisions based on standardized criteria.	Creates a "black box" problem with unclear accountability for errors. Shifts responsibility from human to machine, causing ethical dilemmas.

Figure 1: The Dual Impact of Clinical Decision Support (CDS) on Nursing Judgment and Autonomy in Labor & Delivery

The Impact on Patient Safety

The principal motivation for implementing CDS is enhancing patient safety. Its scientific evidence of its effectiveness in this area in L&D is incomplete, with both significant benefits and unexpected risks.

Adverse Effects: Prevention of Errors and Adherence to Guidelines

Numerous studies have established that CDS is capable of improving adherence to clinical guidelines. For example, research conducted by Baker et al. (2023) proved that the utilization of an oxytocin CDS was associated with a significant reduction in the occurrence of uterine tachysystole and a decline in the peak oxytocin doses given. By automating safe titration methods, CDS can prevent medication errors, such as improper dosing or too steep ramping, which are known to be contributory factors in adverse fetal outcomes.

In FHR monitoring, CDS has been shown to improve documentation completeness and consistency, which are critical for both medical-legal purposes as well as care team communication (Clark et al., 2013). Moreover, with the potential for early notification of abnormal patterns, CDS can assist with earlier intervention, e.g., intrauterine resuscitation or warning the physician, potentially preventing a non-reassuring status from escalating to a hypoxic-ischemic event (Zhao et al., 2018; Brocklehurst et al., 2017).

Safety Hazards and Unintended Effects

Ironically, it is the safety devices themselves that introduce new paths to failure. Top of the list is alert fatigue, explained in detail below. As nurses are bombarded by non-actionable alarms, they become accustomed and miss a critical warning, a syndrome known as "alarm fatigue" that has been well-documented in clinical settings (Sinno et al., 2022).

Furthermore, inadequately workflow-embedded CDS systems can create new safety risks. For instance, if the nurse must navigate through a number of cumbersome screens to acknowledge an alarm or record a response, it takes attention away from the patient (Molina et al., 2023). Workarounds developed to address the inefficient CDS, such as documenting FHR patterns in a generic form to satisfy the system without reflective thought, have the potential to render the data within the EHR less meaningful and even misleading for other members of the team (Bayes & Ewens, 2017). Lastly, if the CDS promotes a stereotypic algorithmic mentality that doesn't consider clinical context, it can lead to inadmissible care, such as high rates of cesarean sections for FHR patterns that, in context, are not foreboding (Georgieva et al., 2022).

The Challenge of Alert Fatigue

The accelerated application of Clinical Decision Support (CDS) systems for Labor and Delivery, designed to ensure safety, has triggered the counterintuitive and risky phenomenon known as alert fatigue. Alert fatigue is a state of psychological fatigue and desensitization created when doctors are flooded with an enormous number of electronic alerts that are clinically irrelevant or non-urgent, and response delays or misses to critical notifications ensue (Ahmed Elbilgahy et al., 2023). Alert fatigue is one of the strongest unintended consequences of CDS adoption and is directly counter to the patient safety goals for which it was designed to foster. In the fast-paced, high-pressure world of L&D, where vigilance is a luxury to be exploited, too heavy a mental burden of alerts can drain the very same attention it is meant to facilitate.

Etiology and Prevalence in the L&D Setting

The cause of alert fatigue in L&D is rooted in the foundation and implementation of CDS tools themselves. To prevent one potential bad thing from happening without being noticed, these systems are usually hypersensitive to detecting it. This results in low positive predictive value, where most of the alerts generated are false positives or reflect clinically insignificant changes (Olakotan & Yusof et al., 2020). For instance, a CDS algorithm might warn of "minimal variability" in fetal heart rate tracing during fetal sleeping time, or an oxytocin protocol might remind strictly of a dose increase at a moment when the nurse is managing maternal hypertension or preparing for an emergent procedure. The outcome is a constant barrage of sound and visual interruptions during a shift. This persistent deluge of information, much of which is non-actionable, engenders extreme cognitive overload, disrupts clinical workflow, and is the primary source of mental fatigue and professional burnout for L&D nurses (Storm & Chen, 2021). The unit's inherent high-frequency, high-acuity environment is fertile ground for this issue, in that the nurses are all at once managing physiological monitors, infusion pumps, and EHR alerts, all competing for their limited attention.

Clinical Workflow and Patient Safety Implications

The consequences of uncontrolled alert fatigue are severe and undermine patient care seriously. As the nurses get more and more desensitized to the blizzard of audible alerts, they adopt compensatory behavior that undermines the safety function intended by the CDS. The most common of these is the development of "clicking behavior," an instinctive, routine response in which nurses rapidly accept or ignore alerts without using critical thinking, primarily to quiet the interruption and restore the screen (Roller et al., 2023). This automatic dismissal converts a safety device into a procedural nuisance. In the more extreme cases, frustration and desensitization can lead nurses to deliberately disable specific kinds of alerts they have found to be useless. This creates a dangerous situation where an actually critical warning—such as one for deep fetal bradycardia or uterine tachysystole—may go unheeded or never be seen. The link between alarm fatigue and adverse patient outcomes, including sentinel events and death, has been established in other high-risk environments such as intensive care units, and the particular risks of L&D render it also, if not more, vulnerable to these preventable failures (Sendelbach & Funk, 2013).

Mitigation Strategies and System Optimization

To combat the ubiquitous threat of alert fatigue, a concerted, multi-pronged approach must be undertaken involving system optimization, human factors design, and ongoing training. One of the key aims must be to enhance the specificity of alerts. This entails evolving beyond simplistic, rule-dependent algorithms to more sophisticated, context-sensitive systems. By integrating multiple points of information—such as maternal medications, labor phase, and time trends—CDS may be calibrated to create fewer, but more clinically significant alerts that need a nurse's prompt attention (Ancker et al., 2017). The implementation of a tiered warning system is another key step. By categorizing notifications into priority levels (i.e., critical, warning, informational) and employing varying modalities per level (i.e., an initial loud, continuous alarm for a prolonged deceleration compared to a muted, on-screen banner for a protocol reminder), these systems can help nurses prioritize their responses and reduce noise in general (Ding et al., 2023).

Of all of the requisite ingredients for the success of the CDS, the most crucial may be the direct involvement of frontline L&D nurses in every stage of the CDS lifecycle, from selection and setup through constant improvement. Nurses are the users who will ultimately be interacting with the system, and incorporating their real-world experience into the design process is essential to creating a tool that supports, not hinders, clinical workflow (Kennedy & Moen, 2017). Finally, special education and training are required to foster an effective symbiosis between the nurse and the technology. The more that nurses understand the clinical justification and evidence supporting some of the alerts, the less they will regard them as arbitrary computer intrusions and the more they will accept them as valuable clinical decision aids. This instills a culture of "alert literacy" where nurses feel empowered to make use of the CDS as an intelligent collaborator in care, and therefore counteract the adversarial dynamic that fuels alert fatigue (Evans et al., 2022). Table 2 & Figure 2 illustrate the sources, consequences, and mitigation strategies for alert fatigue due to CDS in L&D.

Table 2: Sources, Consequences, and Mitigation Strategies for Alert Fatigue due to CDS in L&D

Domain	Key Issues	Potential Solutions
Sources & Causes	Overly sensitive alert thresholds (high false-positive rate). Non-contextual alerts (e.g., oxytocin reminder during a crash C-section). Poor system integration leading to redundant alerts.	Implement intelligent, context-aware algorithms. Conduct regular audits to refine alert criteria. Integrate data streams to eliminate redundant warnings.
Consequences for Practice	Cognitive overload and nurse burnout. Desensitization and automatic dismissal of alerts ("clicking through"). Development of unsafe workarounds. Delayed or missed response to critical events.	Use tiered-alert systems (critical vs. informational). Design streamlined, intuitive alert interfaces. Foster a culture of safety around alert response.
System & Cultural Mitigation	Lack of nurse input in CDS design and configuration. Inadequate training on the purpose and limitations of alerts.	Involve frontline nurses in CDS design and customization teams. Provide ongoing education on "alert literacy." Establish feedback loops for nurses to report problematic alerts.

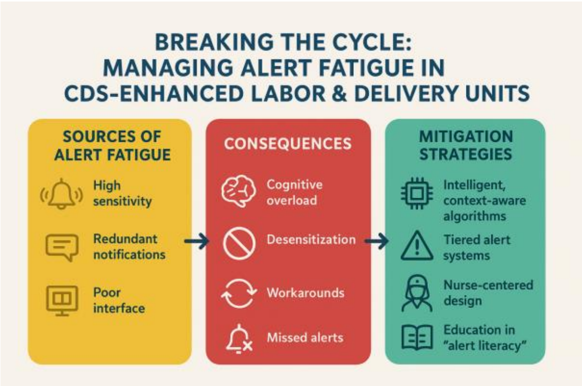

Figure 2: Pathways and Prevention of Alert Fatigue in Labor & Delivery Nursing

Towards a Synergistic Future

The results presented here indicate that CDS in L&D is neither a panacea nor a pariah. Its success in regard to nursing judgment, safety, and well-being will be highly contingent on the technology's design, implementation, and culture. The challenge is to break out of a paradigm that employs CDS as a tool of rule-based compliance and head towards a model of "cooperative partnership" between nurse and machine.

Directions in the future must be toward developing "intelligent" or "adaptive" CDS. Instead of static, rule-based alarms, systems in the future must employ machine learning to allow consideration of additional patient information, creating a wider clinical perspective and generating fewer, but more valuable, alarms (Chen et al., 2023). As a hypothetical example, an intelligent FHR CDS might synthesize evidence of maternal fever, hypertension, or medication administration to produce a more nuanced risk assessment than a simple pattern analysis alone.

In addition, the "human-centered design" principle has to come first. CDS has to be transparent only when it is working properly, unobtrusively assisting the workflow without disrupting it. This calls for long-term investment in usability testing with front-line nurses and a healthcare organization's commitment to continually iteratively design these systems around user experience feedback (Winter & Chico, 2023).

Lastly, nurse education will need to shift to generate the upcoming crop of nurses to practice in this technology-enabled care environment. Curriculum needs to include informatics instruction, careful assessment of CDS recommendations, and alert fatigue coping methods, so that nurses can remain in their role as well-informed, autonomous clinical decision-makers (Miller et al., 2015).

Conclusion

Clinical Decision Support systems embedded in EHRs have irrevocably transformed the face of Labor and Delivery nursing. In the high-risk domains of fetal heart rate monitoring and oxytocin titration, CDS has the dual possibility of significantly enhancing patient safety through standardization and minimization of errors, while simultaneously threatening nursing autonomy and judgment through fostering automation bias and deskilling. The pervasive problem of alert fatigue represents a central unintended consequence that is able to actively thwarts the safety goals of these systems.

The path forward is not to avoid technology, but to refine it. The goal must be to create CDS that is an intelligent instrument in the nurse's toolkit—one that supports, challenges, and reinforces their clinical judgment without replacing it. This synergistic vision can be achieved through a three-way partnership among technology developers, healthcare administrators, informaticists, and most importantly, the L&D nurses themselves. By designing systems well and implementing them with a close understanding of nursing practice, we may be able to use the power of technology to truly augment the expert judgment of those who safeguard the lives of mothers and newborns.

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