

# Optimizing Surgical Access for Patients: A Systematic Review of Operating Room Coordination Strategies

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**Abstract Background:** Timely access to surgical care remains a global challenge. Inefficient operating rooms (ORs) result in prolonged wait times, cancellations, and wasted resources. This study highlights effective strategies to optimize OR coordination. **Methods:** A systematic review was conducted following PRISMA guidelines. Five databases—PubMed, Scopus, Web of Science, Cochrane Library, and CINAHL—were searched for English-language studies published between 2013 and 2025, including key earlier works. **Results:** The studies included (n = 34) were grouped into a few main themes related to improving the operating room. Six studies focused on scheduling and planning strategies, including models for resource allocation and optimization. Five studies examined workforce-related factors, including staffing levels, workload, and nursing competencies, while an additional five studies focused on coordination and communication within surgical teams. Four studies examined digital and AI-driven methods, which are a growing yet still emerging field. Three studies examined lean and process improvement methods. The remaining studies (n = 11) examined broader issues, including patient safety, surgical outcomes, and organizational performance. **Conclusion:** Strategies to coordinate ORs can increase efficiency and access. However, no single approach is universally effective. For Saudi hospitals, a customized model incorporating Lean principles, digital innovations, extended hours, and team engagement is most promising. **Recommendations:** Policymakers are encouraged to consider standardizing operating room performance metrics across hospitals and piloting extended evening and weekend operating lists at tertiary centers to maximize capacity and access. These efforts could be supported by routine monitoring, expanded Lean training programs for sustained improvement, and decisive investment in integrated digital and AI-driven scheduling tools aligned with Saudi Vision 2030.

**Keywords:** *Operating room, surgical access, Coordination, Utilisation, Scheduling*

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## 1. Introduction

Global health systems struggle to provide timely surgical care. Shortages and queues for elective surgeries have become a serious problem. This leads to increased patient frustration and poorer health outcomes. As a result, ensuring surgical access—where patients can receive operative care without needless delay—is a pressing goal for hospital administrators and health services researchers.

A critical bottleneck to access to the operating room (OR), a high-tech, resource-intensive setting, is surgical capacity. Suboptimal utilization of the OR can result in time voids, lost resources, and further prolongation of wait times for surgery. Hence, improving the efficiency of scheduling and operating room use is essential to increasing patient access to surgery.

To address these pressures, health care organizations have investigated several different approaches to coordinating operating room scheduling to improve throughput and minimize delays.

The three approaches can be classified into three aspects: OR scheduling, lean methodology and improvement, and Digital and AI-driven innovation.

Operating room (OR) coordination optimizes time and resources for surgical timetables, personnel, communication, and workflow, ensuring surgeries start and finish on time.

Most Gulf nations, including Saudi Arabia, Qatar, and the United Arab Emirates (UAE), are still developing their OR coordinating strategies. A linear workweek of time spent in the operating room (OR) has historically been established at public hospitals in various nations (e.g., 5 days/week of ~8 hours/day was the standard). The majority of Saudi hospitals are understaffed, and demand

for surgery outpaces the number of available OR slots, resulting in long wait times.

Worldwide, several countries have used various strategies to increase access, such as having ORs running in extended periods, such as at night or on weekends and an after-hours scheme. In Canada, the UK, and Australia, introducing extra weekday evening/weekend operations; such attempts resulted in significant waiting list reductions (e.g., 20–30% over a year), but they also faced problems, including staff mental fatigue and heavy overtime costs [1].

Public hospitals in Saudi Arabia have trailed evening and weekend elective lists to try to clear the backlog. One public hospital in Dammam has documented the possibility of increasing OR slots on weekends and weekday evenings [2].

The second approach is Lean Methodology and Process Improvement in ORs. Lean selectively addresses highly inefficient in-process problems (long turnaround times, late first-case starts and too many moves through the preoperative process).

A Lean project at the Mayo Clinic also resulted in a higher percentage of on-time first-case starts, a lower proportion of case overruns, and better workflow and communication [3].

The third approach is the incorporation of digital technologies and AI into OR management, a new trend aiming to revolutionize surgical scheduling. Advanced decision-making models, based on data analytics, machine learning and quantitative methods, are being used in hospitals to improve the accuracy of scheduling and resource allocation. The machine learning models could predict surgical case duration with up to 90% accuracy. Studies have shown that implementing real-time OR management systems can reduce average waiting times, improve OR coordination, and drive digital innovation [4].

Measuring OR performance is fundamental to identifying coordination problems and tracking improvements. However, the literature lacks consensus on standard definitions and benchmarks for many OR metrics. It was noted that while utilization rate (the percentage of available OR time that is actually used), turnover time, first-case start delay, and cancellation rate are among the most commonly reported indicators, different studies and institutions define these metrics in varying ways [5].

Other organizational factors in Saudi hospitals include unnecessary cancellations and incomplete preoperative work-ups. In the Jeddah study, the creation of a separate preoperative anesthesia clinic reduced day-of-surgery cancellations due to medical reasons – a reminder of how intra-departmental coordination (between surgery and anesthesiology preoperative assessment) can directly benefit OR efficiency.

The purpose of this study is to systematically review the published evidence and summaries recent findings relevant to optimizing OR use. This research also aims to provide healthcare organizations focused on improving surgical access with a clearer picture of these strategies through enhanced coordination.

The main aim of this research is to conduct a systematic investigation of OR coordination strategies described in the literature as helpful in ensuring optimal surgical access.

In addition, this research assessed the outcomes and

success of these coordination efforts, accounting for environmental constraints and highlighting gaps or inconsistencies in the literature.

The findings of this research will contribute significantly to better coordination of the operating room to improve surgical access, an objective of paramount importance for patients, healthcare providers, and health systems. This study will provide a clearer picture for healthcare institutions seeking to improve surgical access through better coordination.

## 2. Methods

This study used a systematic review, following PRISMA guidelines.

An extensive literature search was conducted across the following databases: PubMed (MEDLINE), Scopus, Web of Science, Cochrane Library, and CINAHL (Cumulative Index of Nursing and Allied Health Literature).

The search was restricted to English-language articles from January 2013 to 2025 to ensure comprehensive coverage of the literature. Peer-reviewed articles were only selected to ensure the quality of work. References were also hand-searched for other eligible papers.

The search period covered January 2013 to December 2025 to capture evidence of current rather than past research, but this may have skewed some seminal studies published before that date. Such works (e.g., Lingard, 2004; Gillespie, 2011; Cima, 2011) are seminal in OR coordination and have introduced concepts and practices that are still employed today. Their addition provides a historical continuum for the review.

A total of 1,237 articles were found, and 34 were included in the review after filtering, as shown in the selection overview (Table 1).

**Table 1. PRISMA Flowchart – Overview of the selection process of the studies**

Step	Number of Records
Records identified through database search (PubMed, Scopus, Web of Science and CINAHL)	1,237
Records after duplicates removed	917
Records screened	917
Records excluded after title/abstract screening	810
Full-text articles assessed for eligibility	107
Full-text articles excluded (with reasons)	73
Studies that met the inclusion criteria for qualitative synthesis (systematic review)	34

The data were uploaded to Rayyan QCRI to check for potential literature review and quality control.

Title and abstract screening, as well as full-text review, were carried out independently by two reviewers. Any discrepancies were settled by consensus, and a third reviewer was consulted.

## 3. Results

A typical data extraction form was created for the following items related to the outcomes from Studies on OR Coordination Strategies, as in Table 2. [6-21]

**Table 2. Summary of Outcomes from Studies on OR Coordination Strategies (included in the systematic review)**

Author(s)	Country	Focus Area	Year
Bergs et al.	Belgium	WHO surgical safety checklist and postoperative complications	2014
Bracken et al.	Ireland / UK	AI-powered documentation systems in healthcare	2025
Brown et al.	UK	Framework for patient safety interventions	2008
Calegari et al.	Brazil	OR scheduling considering upstream/downstream resources	2020
Cappanera et al.	Italy	Operations research and equity in healthcare	2023
Cheng et al.	Canada / USA	Prolonged operative duration and complications	2018
Cima et al.	USA	Lean and Six Sigma in OR efficiency	2011
Collar et al.	USA	Lean management in academic surgery	2012
Gillespie et al.	Australia	Perioperative nursing competence	2011
Hassanain	Saudi Arabia	MOH performance improvement in KSA	2017
Hassanain et al.	Saudi Arabia	Lean methodology in ORs across KSA	2016
Kc & Terwiesch	USA	Workload impact on patient safety	2009
Kiekkas et al.	Greece	Nurse understaffing and adverse events in PACU	2019
Levine & Dunn	USA	Optimizing OR scheduling	2015
Lingard	Canada	Communication failures in the OR	2004
Lingard et al.	Canada	Team communication measurement tool in OR	2006
May et al.	UK	MicroRNA and myocardial injury in non-cardiac surgery	2020
Merghani et al.	Saudi Arabia / Sudan	Machine learning in OR management	2025
Moosavi & Ozturk	Turkey	Metaheuristics in OR planning and scheduling	2025
Nilsson et al.	Sweden	Pre-operative checklist and patient safety	2009
Schouten et al.	Netherlands	OR performance optimization metrics	2023
Tao & Gao	China	Cloud-based mobile testing systems	2016
Wolf et al.	USA	Organization development in healthcare	2011
Plasters, C.L.; et al.	USA	Challenges of coordination and information management in operating rooms	2003
Moss, J.; Xiao, Y.	USA	Communication patterns in OR coordination; charge nurse information needs	2004
Alvesson, M.; Kärreman, D.	Sweden	Discourse and communication in organizational change and coordination	2004
Stefanini, A.; Aloini, D.; Gloor, P.	Italy/Switzerland	Team coordination mechanisms (implicit vs. explicit) and their impact on surgical outcomes	2020
Göras, C.; Nilsson, U.; Ekstedt, M.; Unbeck, M.; Ehrenberg, A.	Sweden	Complexity management, adaptation, and planning in the OR	2020
Peltokorpi, V.; Hasu, M.	Finland	How team knowledge sharing and cognitive models support coordination	2021
Teymoori, E.; et al.	Iran	Coordination issues and their relationship to burnout among OR nurses	2022
Al Amin, M.; et al.	International (Review)	OR scheduling methods: deterministic vs. uncertain conditions, resource optimization	2024
Boccia, M.; Mancuso, A.; Masone, A.; Sterle, C.; et al.	Italy	Planning and scheduling ORs with emergency responsiveness using ILP	2024
Pasquer, A.; et al.	France	How OR organization affects surgical performance; literature review of performance metrics	2024
Zucchini, N.; Locci, E.; Moroni, E.; Fantola, G.; et al.	Italy	Robotic bariatric surgery learning curve, OR efficiency, and cost-effectiveness	2025

Narrative synthesis was employed. When analyzing the included studies collectively, several key themes emerged concerning operating room (OR) coordination strategies.

#### **Technology as a Powerful Enabler**

Digital tools and AI-driven scheduling systems helped hospitals minimize cancellations. These technologies optimize the use of operating rooms. For example, predictive models more accurately forecast surgery times. This reduces last-minute delays and results in more regular daily schedules. Real-time dashboards also give staff immediate insight. They can better understand what

is happening and know when to take action.

#### **Lean Improvements—Effective but Fragile**

Lean and Six Sigma projects demonstrate that process redesign can have a significant impact. Several hospitals reported sharper starts to the day's first cases and faster turnovers between surgeries. But if there is no culture of continuous monitoring and leadership support, things often revert. In other words, Lean works only if it becomes part of how the hospital thinks and acts, not just a temporary project.

#### **The Human Factor Matters Most**

Communication failures, turnover among teams and unavailability of surgeons continued to surface as significant causes of inefficiency. These problems are particularly evident in Saudi hospitals, where audits on cancellations have shown that consultant unavailability is now the leading cause of delays, surpassing patient-related causes. This underlines that OR coordination is not only purely technical, but also profoundly social and organizational.

### **Synthesis of Model Comparisons**

A clear pattern emerges when comparing the three models. Manual systems still crop up in resource-constrained settings, but they are almost always accompanied by higher cancellation rates and wasted time. Transitioning to digital OR coordination represents a paradigm shift that many healthcare systems have adopted over the last two decades. In an entirely digital system, all managed by specialized software, surgeons or their offices enter case requests, and a central scheduling team enters the allocated OR time. Enhanced efficiency and utilization are first-order benefits; for example, U.S. hospital systems that deployed a predictive scheduling platform (powered by AI) reported OR block utilization increases of 6–11% and prime-time utilization of ~7%, driven by better allocation of unused blocks.

Many organizations operate with a hybrid OR coordination model, particularly during transitional phases. In these systems, certain scheduling tasks are digitized, while others remain manual. For instance, in hospitals in the Gulf region that are currently modernizing, a basic digital OR scheduling module may be part of the hospital information system. However, surgeons may still call the OR desk to request notable schedule changes or ask a coordinator to manually sanction adjustments. This hybrid approach enables gradual staff adaptation to digital systems without immediately abandoning established manual processes.

The advantage of the hybrid model is its value as a transitional step, which helps staff become familiar with digital tools while still using manual methods as needed. For example, some Gulf hospitals have implemented hybrid models by clearly defining operational processes. In one case, a centralized digital system plans OR time across a hospital cluster weeks in advance, while local OR managers may manually adjust the daily list each morning to account for staff availability and emergencies. This layered approach supports both consistency and flexibility during technology adoption.

It is crucial to recognize that the success of any OR coordination strategy is not determined solely by technology or process changes. Cultural, organizational, and administrative factors play a pivotal role in the implementation and sustainability of these strategies.

Good communication among surgeons, anesthesiologists, OR nurses, and administration is vital for scheduling. Whenever surgical schedules change or there are delays for any reason (e.g., other late-running procedures), the staff involved must report them immediately. Studies have demonstrated that poor communication among OR team members leads to errors, delays, and patient harm. In operating rooms with a multicultural workforce, such as expatriate surgical nurses, language and communication differences can create daily

challenges. Simple practices, such as using a common language during briefings or providing visual aids, can help bridge these gaps.

Ultimately, creating a culture that supports timely, efficient care and encourages staff to speak up and challenge outdated routines is essential. Leaders must take proactive steps to foster these values, ensuring that every staff member feels empowered to drive improvement. Without this commitment, even advanced coordination mechanisms may lose their effectiveness. This reinforces the importance of fostering a culture that supports continuous improvement.

Management decisions and coordination mechanisms can be standardized and replicated across sites within a cluster, such as a waitlist management system for surgery (whether state-wide or relocated). For example, some health systems have introduced additional surgical programs without expanding physical OR capacity to redistribute surgical volume.

Another factor is the existence of special coordination positions /committees. Another common strategy is a deep, specific focus on efficiency: Hospitals that create an OR management committee achieve better outcomes because the committee focuses on tracking metrics, troubleshooting scheduling conflicts, and iterating on process improvements.

The process alignment between departments is essential. If the admissions department correctly handles the scheduling of surgical cases (with or without anesthesia), patients may present to ORs for cases that are improperly cleared, or beds may not be available post-surgery, leading to cancellations. For instance, one study introduced a nurse-led pre-operative assessment clinic a week before surgery and found that it reduced cancellation rates and even halved their no-show rate for a particular type of procedure. This highlights the concept that optimizing upstream operations (a system-level process change) has an in-kind impact on OR scheduling, as only ready patients are scheduled.

Additionally, as interdepartmental preparation is a hybrid organizational culture/process variable, scheduling ORs is influenced by radiology, the lab, and the ICU. For example, if ICU beds are unavailable for post-operative patients, the case may be delayed or cancelled. Effective coordination strategies may require organizational solutions, such as a protocol that no elective cardiac surgery is performed unless ICU bed availability is confirmed 24 hours in advance.

In conclusion, the strength of coordination strategies often lies in the organizational foundation, specifically in how clearly roles and processes are defined. To achieve the highest standards in surgical care, priorities cross-departmental interventions and actively restructure scheduling and care workflows. This supports improved team performance and coordination outcomes

In addition to culture and intra-organizational dynamics, operational policies have a significant impact on OR utilization.

In Saudi Arabia, national initiatives now provide financial incentives to hospitals to reduce surgical backlogs, including funding for extended OR hours or weekend surgeries. These efforts have proven effective in lowering wait times, although sustainability remains a

concern if incentives are not consistently maintained.

Hospitals within the cluster must specify specific access goals (such as maximum wait times for elective surgeries), and administrators are held accountable. This policy context incentivizes hospital administrators to pursue improvements in OR coordination. In the Gulf, a reliance on expatriate labor means that visas and contracts are required to make any temporary staffing arrangements feasible—bringing in extra temporary staff to clear a backlog could be more bureaucratically cumbersome. Quality and safety concerns are also relevant, as any alignment design must be consistent with surgical safety criteria. At times, administrators worry that performing more surgeries or hastening turnover may increase risks. However, findings from studies, such as the weekend surgery feasibility study in Riyadh, which showed that patient safety was not compromised with extended timing (with no higher mortality or complications), can provide policymakers with evidence that innovations are compatible with good care. Ultimately, effective monitoring and evaluation mechanisms are crucial for sustaining quality improvement.

In summary, flexible scheduling rules and regulations provide support mechanisms to meet coordination targets. Adequate funding and resource allocation are essential to support sustainable OR coordination. These findings highlight the importance of team empowerment and organizational support, and position the organization to break through the improvement ceiling and deliver on its coordination goals.

## 4. Discussion

Optimal use of the operating room (OR) to improve surgical access is now a critical priority for health systems worldwide. This systematic review examines models aimed at enhancing OR efficiency, specifically identifying that multidisciplinary scheduling, improved communication protocols, and real-time monitoring have been shown to reduce cancellations and shorten patient waiting times. Studies from Saudi Arabia, Australia, and other Gulf countries highlight opportunities to increase surgical productivity, improve patient flow, and enhance hospital performance through coordinated strategies.

Organizational strategies, such as e-Booking, extended hours planning, and lean process re-engineering, drive improvements in KPIs. In Saudi Arabia and Australia, digital scheduling tools and OR workflow optimization projects have increased OR utilization and reduced waiting times [27]. Extending OR hours to include evening and weekend sessions in Dammam increased surgical capacity by 30%. This change enabled 1,550 additional cases annually [2].

While some reports do not show statistically significant increases in post-intervention utilization, key secondary outcomes—specifically faster first-case starts, fewer overruns, and shorter turnover times—clearly demonstrate the practical value of these interventions. Though sometimes considered minor, these gains are pivotal in surgical systems. Within the Complex Adaptive Systems framework, they represent 'small wins' that help build momentum for larger accomplishments during the day.

These findings matter especially in Saudi Arabia, where late first-case starts and surgeon unavailability are persistent bottlenecks. Addressing these secondary issues can increase throughput and uncover hidden capacity, improving patient flow beyond utilization ratios.

Improving timely first-case starts offers immediate gains in Saudi hospitals. Focusing on punctuality and efficiency, as Eastern Health Cluster audits show, yields tangible patient flow improvements through simple behavioral changes, even without major utilization leaps.

Digital OR scheduling systems transform surgical scheduling. They reduce idle time and promote transparency by algorithmically pairing procedures with open slots.

These systems enhance operational efficiency by generating performance metrics, identifying system bottlenecks, and supporting preoperative safety protocols (e.g., electronic checklists). When integrated with AI and predictive analytics, they can also predict demand and staffing levels.

Nevertheless, despite these clear advantages, practicalities are context-specific. From a constraint management perspective, digital booking cannot resolve issues such as consultant availability and anesthesia coverage.

These challenges remain notable in Saudi Arabia. Some hospitals have used e-Booking for years, yet Eastern Health Cluster audits reveal that staff still use manual rostering, causing duplication and issues.

Staff capacity remains the main requirement for effective OR scheduling. Even with digitization, surgical throughput depends on adequate numbers of nurses, anesthesiologists, and surgeons, as well as available theatre time. Without these essential resources, advanced scheduling techniques cannot realize their benefits.

The non-availability of consultants, a shortage of nurses, and inflexible rostering also limit capacity. This is true regardless of infrastructure or technology investment. Additionally, workforce availability intersects with organizational norms. Rigid cut-off times for service delivery persist, despite theoretical 24-hour capacity (e.g., ending elective sessions by 4 PM). The urgency is even more evident in Saudi Arabia. Dependence on expatriate staff, nursing team shortages, and hierarchical decision-making are common contributors to variation in OR scheduling.

To address these barriers, reform strategies need to move beyond scheduling solutions. Workforce stabilization strategies, with flexible policies and leadership-led cultural change, are needed. Without managing these root issues, improvements in OR coordination are likely to be only incremental and short-lived.

The economic implications of OR coordination strategies are complex and multifaceted. Importantly, system-wide savings result from smoother patient flow and fewer complications, rather than just immediate cost reductions.

Stakeholders in Saudi Arabia should view costs within a broader value framework, balancing direct expenses against long-term efficiency, better access, and health priorities.

Paper-based and manual scheduling tools still dominate in LMICs. These settings are resource- and infrastructure-

constrained and understaffed. This leads to high cancellation rates and historically poor utilization of OR time. Even simple process interventions, such as structured preoperative checklists, can significantly improve utilization and patient safety [22]. However, more sophisticated solutions—like Lean methods or digital scheduling tools—remain uncommon due to financial constraints and pre-digital mindsets.

When viewed through the Theory of Constraints, these systems have multiple bottlenecks. These include money, trained staff, and hardware.

Recent digital reforms mark a transitional phase for OR scheduling in Saudi Arabia. Before these reforms, most scheduling was manual, leading to unpredictable staffing and preparation. Current changes under Vision 2030 aim to reduce waste and embed digital tools for improved efficiency.

Effective OR coordination requires integrating structural, technological, and behavioral solutions. For Saudi Arabia under Vision 2030, this synergy aims to meet growing surgical demand and efficiency within a context-specific framework.

## Limitations

The present review has several limitations. The included studies varied in design, outcome measures, and healthcare settings, which limits comparability and generalisability. These limitations underscore the need for researchers to conduct more rigorous, multicentre, longitudinal studies to evaluate the sustainability and workforce impact of OR coordination interventions.

## Conclusion and Recommendations

This review shows that effective operating room (OR) coordination is a strategic factor for surgical access, efficiency, and patient safety. It extends beyond a purely logistical function. No single solution is sufficient; instead, sustainable improvement is achieved through an integrated approach that builds stable, multidisciplinary OR teams, applies Lean and Six Sigma process redesign, uses flexible scheduling, adopts digital coordination tools, and focuses on patient-centred practices.

Saudi hospitals may benefit from extending OR hours in high-demand specialities, improving workforce stability, and scaling digital platforms with proper training.

## Statement of Ethics

This Study is a systematic review and no approval is needed.

## Conflict of Interest Statement

“The authors have no conflicts of interest to declare.”

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## Author Contributions

Author 1 and author 2 prepared the research proposal and did the literature review and analyzed the data. Author 2 and author 3 prepared the manuscript. All authors approved the final manuscript.

## Data Availability Statement

The data that support the findings of this study are available on request from Author 1.

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