

Original Research Article

Optimizing digital documentation of invasive oral surgery procedures to improve patient safety: a quality improvement project at a dental centre

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ABSTRACT

Background: Incomplete documentation of invasive oral and maxillofacial surgery (OMFS) procedures compromises patient safety and continuity of care, and jeopardizes compliance with International Patient Safety Goal (IPSG) 4, which mandates 100% adherence to safe-surgery documentation. Baseline audits revealed documentation completeness as low as 7-22%.

Methods: A multidisciplinary QI project was conducted at the OMFS outpatient clinic of Prince Sultan Military Medical City, Riyadh, from August 2023 to August 2024. The Model for Improvement was applied through iterative Plan-Do-Study-Act (PDSA) cycles, with root-cause analysis using fishbone and Pareto diagrams. Interventions included structured education and reorientation, audit-and-feedback, extended documentation time, a blended auto-populated electronic form in the R4 dental software, and monthly revision of incomplete records.

Results: At baseline (August-September 2023), completeness was 7-22%. After educational and feedback interventions, compliance rose to 53-67%, then declined to ~53% (January-March 2024). Following workflow redesign and system-level changes, it increased steadily, reaching 97% by August 2024 (overall median 62%). Component-level gains included a 61% increase in invasive procedure record completion, 58-59% in site marking, and 30% in informed consent documentation.

Conclusions: A structured, multicomponent QI intervention markedly improved digital documentation of invasive OMFS procedures, aligning practice with IPSG4 and strengthening patient safety. Combining system-level redesign with education, feedback, and routine auditing produced sustainable gains and offers a transferable model for other dental and surgical services.

Keywords: Documentation, Electronic health record, IPSG4, Oral and maxillofacial surgery, Patient safety, Quality improvement

INTRODUCTION

High-quality documentation of invasive procedures is fundamental to patient safety, effective communication between providers, and regulatory compliance in all surgical specialties, including oral and maxillofacial surgery (OMFS).¹ Incomplete or inconsistent documentation of informed consent, surgical site marking, and procedure details may contribute to wrong-site surgery, diagnostic and therapeutic errors, and medicolegal risk, and it undermines adherence to the International Patient Safety Goals (IPSG) on safe surgery.² OMFS is recognized as a high-risk domain within dentistry, and several authors have called for robust safety programs, including local safety standards for invasive procedures (LocSSIPs), structured checklists, and clear documentation pathways to reduce avoidable harm.³ Evidence from other surgical settings suggests that optimizing electronic health record (EHR) systems and documentation workflows, when combined with education and feedback, leads to better compliance and fewer errors.⁴ However, poorly designed systems and insufficient time allocation can increase cognitive burden, contribute to burnout, and paradoxically reduce documentation quality.⁵

At Prince Sultan Military Medical City (PSMMC) Dental Center, Riyadh, Saudi Arabia, the R4 dental software is used for digital documentation, with institutional forms for informed consent and invasive procedures, and a dedicated icon for recording surgical site marking. Despite these tools, internal audits in the OMFS clinic revealed very low rates of complete documentation for invasive procedures. This gap threatened patient safety, continuity of care, and compliance with IPSG4. The OMFS service also has a key educational role, training residents who carry their documentation habits into future practice.⁶

The aim of this quality-improvement (QI) project was to optimize digital documentation of invasive procedures in the OMFS outpatient department at PSMMC by addressing both system-level barriers and human factors. The specific objective was to achieve 100% compliance in the completion of invasive surgical procedure documentation (informed consent, site marking, and invasive procedure record) in the R4 dental software for OMFS outpatients by 31 December 2024.

METHODS

Study design and setting

This single-center QI project was conducted in the OMFS outpatient clinic at PSMMC Dental Center, Riyadh, Saudi Arabia, over a 12-month period from August 2023 to August 2024. The project applied the Model for Improvement and iterative Plan-Do-Study-Act (PDSA) cycles and was reported in accordance with SQUIRE 2.0 principles.⁷ The aim was to improve completeness of

electronic documentation for OMFS invasive procedures in alignment with IPSG4 safe-surgery standards. Documentation was performed using the R4 dental software; prior to the intervention, procedure documentation components were entered in separate electronic locations.

Project team and stakeholders

The QI team comprised a CQI/patient-safety consultant (team lead), OMFS and endodontic patient-safety champions, a QI specialist, and a statistician/data analyst. The team worked collaboratively with OMFS residents and staff, dental center leadership, the hospital CQI and patient-safety division, and the information technology (IT) department. OMFS residents were the primary users responsible for completing documentation.

Baseline measurement

Baseline performance was assessed via retrospective audits conducted in August–September 2023. A random sample of OMFS invasive procedure cases was extracted from the R4 system and evaluated for completeness of three core elements: informed consent, surgical site marking, and invasive procedure record. At baseline, only 7–22% of cases had complete documentation across all three elements.

Diagnostic assessment

A structured root-cause analysis was conducted using a fishbone (Ishikawa) diagram and Pareto charts to identify key contributors to incomplete documentation. The dominant root causes identified were restricted clinic time in the face of high patient volume, system usability challenges in the R4 software, and knowledge gaps among residents regarding documentation requirements and standards.

Interventions and PDSA cycles

Based on baseline findings, a bundled intervention was implemented through sequential PDSA cycles commencing 7 October 2023. The intervention comprised four components: (1) structured education and orientation sessions on IPSG4 requirements and the R4 documentation workflow; (2) regular audit-and-feedback to residents and staff (weekly initially, subsequently monthly); (3) revision of clinic session workflow to increase time allocated for documentation (introduced March 2024); and (4) development and full implementation of a blended electronic documentation form in R4 that integrated informed consent, site marking, and invasive procedure record into a single interface with auto-populated fields and embedded checklists (fully deployed May 2024). A systematic process for monthly auditing and revision of incomplete records, coordinated by patient-safety champions with oversight from the division head, was also established.

The basic surgical documentation process in the R4 dental system, and the same process after the QI

interventions were applied, are illustrated in Figure 1.

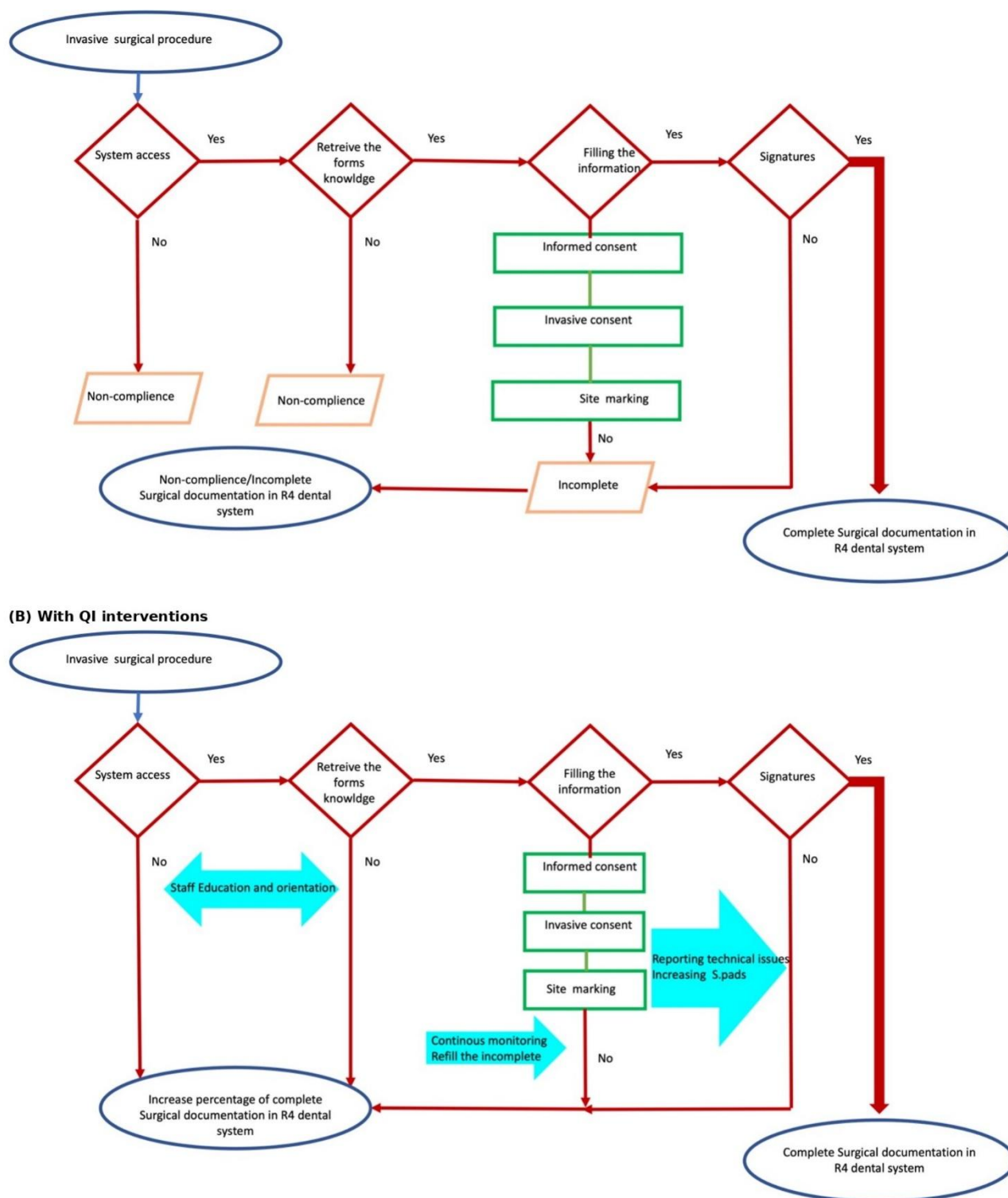


Figure 1: Flowchart of the surgical documentation process and outcome- basic and with interventions.

Panel (A) shows the baseline workflow for documenting an invasive oral and maxillofacial surgery procedure in the R4 dental system, where breakdowns at any of the system-access, forms-knowledge, information-entry, or signature steps lead to non-compliant or incomplete documentation. Panel (B) shows the same workflow after the bundled QI interventions (staff education and orientation, continuous monitoring with refilling of incomplete records, and reporting of technical issues with increased standardization pads), which together drive an increased proportion of complete surgical documentation in R4.

Data collection and analysis

Documentation completeness was monitored through monthly audits of randomly sampled OMFS invasive procedure cases extracted from the R4 system, assessed using a standardized audit tool. Data were entered into spreadsheets and summarized descriptively to assess trends over time in relation to intervention milestones. Qualitative feedback from residents and staff was collected through informal structured interviews and team meetings.

Ethical considerations

This project was conducted as a service-improvement initiative at PSMHC. It was reviewed and approved by the institutional review board (IRB approval number E-2638) and conducted in accordance with the principles of the Declaration of Helsinki. No identifiable patient data were reported. The requirement for individual patient informed consent was waived given the QI nature of the project. No external funding was received and no conflicts of interest were declared.

RESULTS

At baseline (August-September 2023), documentation audits of OMFS invasive procedures revealed that only 7-22% of sampled cases had fully complete documentation across all three required components. Pareto analysis confirmed that a small number of dominant causes- principally restricted clinic time combined with high patient volume, and weaknesses in quality control and system knowledge- accounted for the majority of documentation failures.

Following the introduction of educational and reorientation sessions and initiation of regular audit-and-feedback in October 2023, documentation compliance improved substantially, with monthly completeness rates rising to between 53% and 67%. However, between January and March 2024, a transient decline to approximately 53% was observed, coinciding with holiday periods, workload fluctuations, system adjustments, and the arrival of a new cohort of residents less familiar with documentation requirements.

Table 1: Overall documentation completeness (all three elements complete) over time.

Period / Month	Compliance (%)	Key notes
August-September 2023 (baseline)	7-22	Baseline audit; very low full documentation across all three components
October-December 2023	53-67	Improvement after initial education and audit/feedback commencement
January-March 2024	~53	Temporary regression during transition and planning phase; new resident cohort
April-August 2024	Upward trend to 97	Sustained improvement following major system-level and workflow changes
Overall (October 2023-August 2024)	Median = 62	Reported overall median compliance across the full intervention period

Table 2: Documentation completeness by intervention milestone.

Date / Phase	Key intervention(s)	Observed effect on compliance
August-September 2023	Baseline audit and Pareto analysis	Lowest performance identified (7-22%); priority root causes determined
October 2023	Education/orientation and audit/feedback initiated	Rapid improvement to 53-67% range
January-March 2024	Transition period; new resident cohort	Transient decline observed (~53%)
March 2024	Extended clinic documentation time	Marked and sustained improvement thereafter
May 2024	Blended R4 form and systematic monthly audit/revision process	Additional improvement; fewer missing components across all domains
August 2024	Mature phase	Peak performance: 97% overall documentation completeness

Table 3: Effect of extended clinic time (introduced March 2024) by documentation component.

Documentation component	Direction of change	Reported change
Invasive procedure record	Increased	+80%
Site marking	Increased	+58% to +59%
Informed consent	No meaningful change	Consistently high throughout; no additional gain from this intervention alone

Table 4: Effect of monthly audit and systematic revision (started May 2024) by documentation component.

Documentation component	Improvement attributed to audit/revision	Interpretation
Informed consent	+30%	Improved completion after targeted follow-up on missing items
Invasive procedure record	+61%	Largest gain with structured correction and accountability mechanisms
Site marking	+58%	Substantial improvement with monitoring, feedback, and oversight

The most marked improvements occurred after March 2024, when intensive system-level and workflow interventions were implemented. Extension of clinic session time reduced time pressure and enabled residents to complete records more thoroughly. From May 2024 onwards, the blended documentation form was introduced into R4, integrating informed consent, invasive procedure record, and site marking into a single digital interface with auto-populated fields and checklists, reducing duplication and the risk of missed steps. Simultaneously, a systematic monthly auditing and revision process was established.

These combined interventions produced a steady and sustained improvement in documentation completeness. Overall compliance reached 97% by August 2024, with a median compliance of 62% across the full observation period (Table 1). Component-level analysis demonstrated that invasive procedure record documentation showed an approximate 80% increase in completeness following extension of clinic time, and a further 61% increase after the blended form and systematic auditing were fully implemented. Site-marking records improved by approximately 59% after clinic time adjustments and a further 58% with the audit and revision process. Informed consent documentation improved by approximately 30% attributable to the structured audits and correction mechanisms (Tables 2-4). The temporal trend in monthly documentation completeness across the project period, including target and median lines, is displayed in Figure 2.

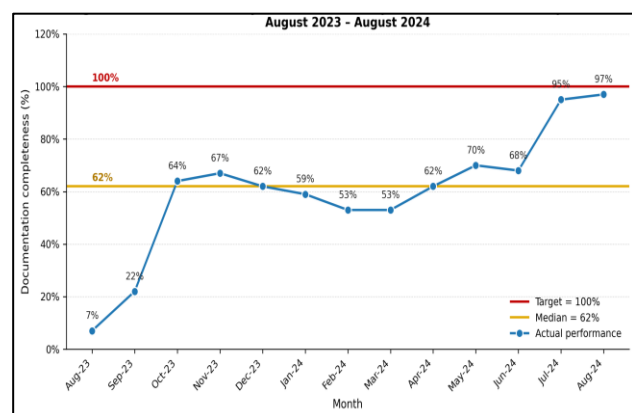


Figure 2: Run chart showing monthly documentation completeness for invasive oral and maxillofacial surgery procedures from August 2023 to August 2024.

Target compliance was set at 100%; the overall median was 62%.

Qualitative data from residents and staff supported these quantitative findings. Clinicians reported the blended form to be more intuitive and less prone to omissions. Auto-population of key data elements and embedded checklists were perceived to save time and reduce cognitive load. Staff emphasized that extended documentation time reduced stress and allowed focus on both clinical and documentation tasks without feeling rushed. Regular audit feedback and visible leadership engagement contributed to a stronger sense of accountability.

DISCUSSION

This QI project demonstrated that a structured, multifaceted intervention can substantially improve digital documentation of invasive procedures in an OMFS clinic and move practice closer to the requirements of IPSG4.⁸ Starting from a baseline where only a small proportion of procedures were fully documented, the combination of workflow redesign, system optimization, education, and active quality control ultimately yielded a compliance rate of 97%. The improvement trajectory was not linear, and the mid-project regression observed between January and March 2024 highlights the reality that QI efforts frequently encounter setbacks when contextual factors- including workload peaks, staff turnover, or system changes- interact with the change process.

The pattern of results suggests that different elements of the intervention bundle contributed in complementary ways. Educational measures increased awareness and improved performance initially, but alone were insufficient to achieve high reliability. The decline in compliance following the arrival of a new resident cohort underlines that knowledge-based interventions are inherently vulnerable to turnover unless embedded into structured orientation and supported by system-level safeguards.⁹ The extension of clinic time dedicated to documentation appears to have been a pivotal change that addressed one of the major root causes identified- insufficient time in the face of high patient volume.¹⁰ By reducing time pressure, this intervention bridged the gap between clinicians' intention to comply and their ability to do so within the constraints of the clinic schedule.¹¹

The development of a blended, user-friendly documentation form within the R4 system further strengthened reliability. By integrating informed consent, invasive procedure record, and site marking into a single interface with auto-populated fields and checklists, the new form reduced fragmentation and lowered the risk of missed steps. This is consistent with the broader literature on LocSSIPs and surgical safety checklists in OMFS and other dental contexts, which emphasizes the importance of standardization and clear process design in avoiding wrong-site surgery and other avoidable harms.^{12,13} The experience also aligns with studies demonstrating that well-designed electronic tools, combined with training and thoughtful workflow integration, can enhance documentation compliance and patient safety outcomes.^{14,15} Critically, concerns regarding EHR-related burden and clinician burnout were proactively addressed here through usability improvements and additional time allocation, rather than imposing additional documentation obligations on already pressured clinicians.¹⁶

The systematic auditing and revision of incomplete records played a pivotal role in consolidating gains. By creating a feedback loop in which incomplete documentation was identified, assigned, and corrected under the oversight of patient-safety champions and the division head, the team built a mechanism for continuous learning and reinforcement. This process likely contributed to a cultural shift towards viewing documentation as an essential element of safe care rather than an administrative burden.¹⁷ Staff feedback indicating reduced anxiety and improved satisfaction supports the idea that making documentation processes more manageable and meaningful yields benefits for both clinicians and patients.

The project has several strengths: it addressed a clearly defined and locally important safety problem using established QI methods; the interventions were developed from a thorough diagnostic phase including root-cause analysis and Pareto prioritization; implementation proceeded through iterative PDSA cycles; and a multidisciplinary team with senior leadership support increased credibility and sustainability. The combination of quantitative outcome data and qualitative staff feedback provided a richer understanding of both outcomes and mechanisms of change.¹⁸

Limitations include the single-center design in a military dental facility with specific organizational structures, which may limit generalizability. The analysis relied on descriptive statistics and time-trend interpretation rather than formal statistical process control. The outcome measure focused on documentation completeness rather than on the accuracy of documentation or downstream clinical outcomes such as adverse events. Use of monthly samples, while systematic, may not capture all variation in practice. Sustainability beyond the project period depends on continued leadership support, ongoing staff training, and maintenance of audit processes.

For similar OMFS services and dental centers, this project offers a practical model for achieving high levels of documentation compliance through system redesign, education, and continuous quality control. Future work could link documentation improvements to clinical outcomes, employ formal statistical process control methods, and explore how EHR-embedded alerts and mandatory fields can further prevent incomplete submissions.

CONCLUSION

A structured, multicomponent QI intervention transformed digital documentation of invasive procedures in an OMFS outpatient clinic from low and inconsistent compliance to high and sustained reliability, achieving 97% overall documentation completeness by August 2024. By tackling root causes- limited time, fragmented forms, and weak feedback systems- through a blend of workflow redesign, a unified electronic documentation form, structured education, and systematic audit, the intervention aligned practice with IPSP4 and strengthened the local patient-safety culture. The approach and lessons learned are transferable and may serve as a practical blueprint for other dental and surgical services seeking to improve the safety and quality of their documentation processes.

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REFERENCES

1. Kupka JR, Sagheb K, Al-Nawas B, Schiegnitz E. Surgical safety checklists for dental implant surgeries: a scoping review. *Clin Oral Investig*. 2022;26(11):6469-77.
2. Giles SJ, Rhodes P, Clements G, Cook GA, Hayton R, Maxwell MJ, et al. Experience of wrong site surgery and surgical marking practices among clinicians in the UK. *Qual Saf Health Care*. 2006;15(5):363-8.
3. Tagar HK. Preventing wrong tooth extraction in primary care oral surgery: developing local safety standards for invasive procedures (LocSSIPs). *Prim Dent J*. 2022;11(3):31-8.
4. Chimbo B, Motsi L. The effects of electronic health records on medical error reduction: extension of the DeLone and McLean information system success model. *JMIR Med Inform*. 2024;12:e54572.

5. McBride S, Alexander GL, Baernholdt M, Vugrin M, Epstein B. Scoping review: positive and negative impact of technology on clinicians. *Nurs Outlook*. 2023;71(2):101918.
6. Krishnan B, Prasad GA, Madhan B. Improving the quality of oral and maxillofacial surgical notes in an Indian public sector hospital in accordance with the Royal College of Surgeons guidelines: a completed audit loop study. *J Maxillofac Oral Surg*. 2016;15(3):315-20.
7. Ogrinc G, Davies L, Goodman D, Batalden P, Davidoff F, Stevens D. SQUIRE 2.0 (Standards for Quality Improvement Reporting Excellence): revised publication guidelines from a detailed consensus process. *BMJ Qual Saf*. 2016;25(12):986-92.
8. Lee JW. Rapid transition to digital healthcare and the role of oral and maxillofacial surgeons. *J Korean Assoc Oral Maxillofac Surg*. 2022;48(5):247-8.
9. Portela Dos Santos O, Melly P, Hilfiker R, Giacomino K, Perruchoud E, Verloo H, et al. Effectiveness of educational interventions to increase skills in evidence-based practice among nurses: the EDITcare systematic review. *Healthcare*. 2022;10(11):2206.
10. Carvalho R, Lobo M, Oliveira M, Oliveira AR, Lopes F, Souza J, et al. Analysis of root causes of problems affecting the quality of hospital administrative data: a systematic review and Ishikawa diagram. *Int J Med Inform*. 2021;156:104584.
11. Kandula UR. Impact of multifaceted interventions on pressure injury prevention: a systematic review. *BMC Nurs*. 2025;24(1):11.
12. Saksena A, Pemberton MN, Shaw A, Dickson S, Ashley MP. Preventing wrong tooth extraction: experience in development and implementation of an outpatient safety checklist. *Br Dent J*. 2014;217(7):357-62.
13. Tagar HK. Preventing wrong tooth extraction in primary care oral surgery: LocSSIPs- key aspects of implementation for achieving and sustaining compliance. *Prim Dent J*. 2023;12(1):110-6.
14. Zayas-Cabán T, Haque SN, Kemper N. Identifying opportunities for workflow automation in health care: lessons learned from other industries. *Appl Clin Inform*. 2021;12(3):686-97.
15. Joo Y, Jang Y, Kwon OY. Contents and effectiveness of patient- and family-centred care interventions in adult intensive care units: a systematic review. *Nurs Crit Care*. 2024;29(6):1290-302.
16. Johnson KB, Neuss MJ, Detmer DE. Electronic health records and clinician burnout: a story of three eras. *J Am Med Inform Assoc*. 2021;28(5):967-73.
17. Rosen MA, DiazGranados D, Dietz AS, Benishek LE, Thompson D, Pronovost PJ, et al. Teamwork in healthcare: key discoveries enabling safer, high-quality care. *Am Psychol*. 2018;73(4):433-50.
18. Bradley C, Sumethasorn M, Kim JS, Wang S, Martinez L, Chang M, et al. Plan-do-study-act (PDSA) interventions to improve real-world endoscopy unit productivity. *Endosc Int Open*. 2024;12(5):E642-8.

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