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Research Article

Zero by Zero: The Patient Supply Chain- Delivering Every Surgical Patient Prepared, Supported, and On Time

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Zero by Zero is an operating system that applies supply-chain principles to preparing patients for surgery. Every applicable requirement receives an owner, due date, acceptance authority, validity window, and recovery path. Patient on-time-in-full (OTIF) measures whether preparation is complete by the readiness-lock date and the patient arrives on Day Zero prepared and on time.

INTRODUCTION: THE DAY ZERO FAILURE

The patient is in preoperative holding, and the anticoagulant regimen was never reconciled against an approved perioperative medication plan. The anesthesiologist now wants a cardiac evaluation even though the case has been scheduled for three months. The consent lists the wrong side because the patient changed the operative plan six weeks ago and the form was never updated. The patient was dropped off and has no ride home. We have reached Day Zero and are just learning about problems that could have been handled weeks earlier. The lead time is gone. The patient is physically present, but the patient and the system are not ready for surgery.

This scene is familiar because preparation occurs across the patient, caregivers, the surgeon's office, primary care, specialists, anesthesia, the facility, payer, laboratories, pharmacies, and rehabilitation services. Information moves

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through disconnected records, faxes, portals, calls, texts, and scanned documents. Staff must reconcile evaluations, orders, consents, clearances, tests, medication instructions, authorization, education, and discharge plans. The patient often becomes the courier for this fragmented system.

Preparing one hip or knee arthroplasty patient requires an estimated 8.45 cumulative hours of clinical staff work and $348 in personnel cost before testing, consultations, optimization, or the patient's time and travel (Constantinescu et al. 2022). Preparation also affects outcomes: anemia, frailty, malnutrition, hyperglycemia, obesity, and smoking are associated with worse postoperative outcomes, and selected timely interventions can reduce risk (Fowler et al. 2015; Becerra-Bolaños et al. 2024; Chen and Chen 2024; Mills et al. 2011).

Orthopedics already knows the components of good preoperative care: shared decision-making, medical optimization, education, enhanced-recovery pathways, and discharge planning. Psychological preparation may also improve selected outcomes, although the best arthroplasty-specific approach remains uncertain (Hall et al. 2025). The recurring failure is connecting these interventions across people, offices, records, and timelines.

In 12 by 12, we applied radical time transparency and standard work inside the operating room (DeCook and Statton 2022). Zero by Zero moves upstream to the patient supply chain, with the goal that no patient reaches Day Zero unready because of preventable preparation failure.

THE CORE PROBLEM: VISIBILITY OF READINESS

Every practice can see the date of surgery. Far fewer know which patients still have unresolved work, which requirement may delay surgery, which information is stale or conflicting, who owns the next action, whether the responsible clinician has reviewed and accepted the result, and whether enough time remains to recover. We know the promised delivery date, but the patient has no tracking number.

When a case is delayed or canceled, we often blame a person: the patient did not comply, an office did not send a record, or a scheduler missed a step. Supply-chain management instead asks what allowed the missing input to remain invisible. Because the pathway crosses organizations, records, and payment structures, recurrent failures require network discipline rather than another search for fault.

The bullwhip effect occurs when uncertain readiness and tentative dates masquerade as firm demand (Lee et al. 1997). Teams protect the schedule by holding dates, duplicating requests, batching work, or marking routine items urgent. Suppliers respond with triage and longer lead times, causing more expediting. One authoritative surgical order, explicit requested and promised dates, shared status, and controlled release of work reduce this amplification.

The preoperative readiness interval runs from the surgical decision to Day Zero. It often lacks a common clock, owner, or measure, although this is where incoming quality is built and most preventable last-mile failures mature.

Late discovery is expensive. An abnormal result found with lead time remaining can be addressed; the same result first reconciled in preoperative holding may consume staffed capacity, disrupt the schedule, and distress the patient and team (Crosby 1979).

Another checklist is insufficient. The practice needs one current view showing whether each item applies, who owns it, when it is due, whether it was accepted, when it expires, and what happens next.

THE ZERO BY ZERO OPERATING SYSTEM

The operating logic is straightforward. The promised surgical date anchors the plan. The readiness order defines the work required to make the patient ready by that date. Radical Patient Transparency makes the work visible and actionable. Patient OTIF reports whether the patient was ready and on time.

READINESS ORDER + RADICAL PATIENT TRANSPARENCY = ZERO BY ZERO OPERATING SYSTEM

The readiness order is the patient-specific specification for surgery: applicable requirements, completion and acceptance owners, dates, validity, evidence, and recovery actions.

Radical Patient Transparency is the shared operational view of completion, risk, ownership, and the next action.

Patient OTIF reports whether readiness was achieved by the lock date, the patient arrived as instructed, and every applicable requirement was completed or appropriately excepted.

DEFINITIONS USED IN ZERO BY ZERO

Zero by Zero. The operating system for managing the patient supply chain from the decision for surgery through Day Zero. It converts each patient's preoperative readiness pathway into assigned, time-bound, visible work and manages exceptions before they disrupt the patient or the surgical schedule.

Day Zero. The scheduled day of surgery and the final point at which the patient, accepted information, clinical team, facility, and physical resources must converge.

Surgical promise. The date offered to the patient with a reasonable, documented pathway to readiness. A tentative or requested date is not yet a promise.

Readiness order. The patient-specific specification of every applicable requirement, its completion owner, acceptance owner, due date, validity window, evidence of completion, dependency, and recovery action.

In full. Every requirement applicable to that patient is current, reviewed, and accepted, or an authorized clinician has documented an exception. In full does not mean that every patient receives every test or consultation.

Lead time and readiness-lock date. Lead time runs from the decision for surgery to Day Zero. The readiness-lock date is the final planned checkpoint before surgery

when each requirement must be accepted, excepted, or assigned a recovery disposition.

Radical Patient Transparency. Track-and-trace for surgical readiness: one shared, role-appropriate view of status, ownership, deadlines, source, freshness, dependencies, exceptions, and the next action.

Patient OTIF and anticipated Patient OTIF. Final Patient OTIF records whether the original commitment was delivered on time and in full. Anticipated Patient OTIF estimates, before the lock date, whether the current promise remains achievable.

Critical path, active constraint, and readiness buffer. The critical path is the dependent work with no remaining scheduling flexibility. The active constraint is the resource or requirement currently limiting flow. The readiness buffer is protected time between expected completion of uncertain work and the readiness-lock date.

Clinical exception and Return. A clinical exception is an authorized, documented decision to accept an unmet standard requirement. Return is the governed recovery pathway that preserves valid work, assigns rework, sets reassessment, and brings a disrupted patient back to scheduling.

Promise-date accuracy. The proportion of assigned dates that had a feasible, documented pathway to readiness when the promise was made. Original and revised dates remain visible.

Ready reserve. An opt-in group of patients who are already in full, want an earlier date, and can move safely into a compatible opening without repeating or invalidating required work.

HOW ZERO BY ZERO WORKS IN PRACTICE

Zero by Zero is a closed-loop operating system for surgical readiness. It begins when the surgeon and patient decide to proceed, converts the planned operation into patient-specific work, and ends when the prepared patient arrives on Day Zero or enters a controlled recovery pathway. Individual patients follow different readiness pathways, but the operating rules remain consistent.

THE SIX-STEP READINESS CYCLE

Choose the pathway. At the decision for surgery, the surgeon chooses one of three dispositions: a standard promised date, a conditional surgical date, or a reassessment date when the trajectory is too uncertain to support a credible promise.

Create the readiness order. The four domains—documentation, medical preparation, social preparation, and education—are reviewed, and only the requirements applicable to that patient are activated.

Assign the work. Every active requirement receives one completion owner, one acceptance owner, a due date, a validity window, and a next action. The promised surgery date pulls these commitments backward from Day Zero.

Run the exception queue. Routine work proceeds without surgeon involvement. Threatened deadlines, conflicting information, rejected inputs, and requested clinical exceptions are routed to the person authorized to resolve them.

Lock readiness. At the locally governed readiness-lock date, every applicable requirement is current and accepted or an authorized clinician has documented an exception. Anything else requires a recovery action or a revised surgery promise date.

Deliver or Return. The prepared patient arrives as instructed and proceeds. If the promise cannot safely be kept, valid work is preserved, remaining work is reassigned, a reassessment date is set, and the patient is returned deliberately to the surgical pathway.

Decide → Specify → Assign → Track → Lock → Deliver or Return

AN EIGHT-WEEK PRIMARY KNEE EXAMPLE

Decision day. The surgeon confirms the indication, procedure, side, and site-of-care plan and assigns the standard pathway with a promised surgery date eight weeks away.

Eight-week window. The readiness order is opened against the promised surgery date. Applicable requirements, completion owners, acceptance owners, due dates, and escalation rules are assigned.

Day -14: Authorization, the H&P, indicated testing, and triggered medical evaluations have been received, reviewed, and accepted with enough time to correct an abnormal or incomplete result.

Day -7: Education, medication instructions, caregiver support, transportation, equipment, and the expected discharge plan are complete.

Day -2: The team performs the readiness lock. Any unresolved requirement receives an authorized exception, immediate recovery action, or a revised surgical promise.

Day Zero. The patient arrives at the correct location and time with identity, procedure, support, medication, fasting, and last-minute clinical changes reconciled.

If disrupted. The Return pathway preserves valid work, assigns what must be repeated, sets the next reassessment, and gives the patient a defined route back to the schedule.

The dates are illustrative rather than universal. The practical requirement is that each practice define its own sequence prospectively and leave enough lead time for review, correction, and clinical judgment.

WHAT MUST BE READY

Most patient preparation falls into four segments. **Documentation** includes the H&P, orders, consent, indicated clearances and tests, authorization, and required records. **Medical preparation** addresses only conditions for which intervention is necessary and appropriate, including medical optimization and medical clearances. **Social preparation** covers the home, caregiver, transportation, equipment, and discharge plan. **Education** covers the class, expectations, medication instructions, reminders, and confirmation of understanding.

Every patient requires review of all four segments, but not every patient requires every test, consultation, intervention, or educational encounter. 'In full' means that every requirement applicable to that patient has been completed, accepted, or addressed through an explicit clinical exception. It does not mean forcing every patient through the same checklist.

The work may take an afternoon or more than a year. Segmenting it shows which domain governs readiness and preserves valid work when another requirement is delayed.

Standard cases may require only routine documents, education, and medication reminders; other patients may be constrained by authorization, medical improvement, social support, or several domains. Each pathway needs an expected lead time, buffer, review cadence, and escalation rule.

Reliable surgery also requires information, workforce, capacity, and physical resources to converge. Patient OTIF should therefore be reported alongside facility, workforce, and material readiness.

A CONCRETE READINESS ORDER FOR PRIMARY TOTAL KNEE ARTHROPLASTY

Table 1 organizes an illustrative primary-knee readiness order into the four domains used throughout Zero by Zero. It shows the requirement, who completes it, who accepts it, and when it is due or must be reopened. Each practice must replace these examples with its own clinical rules, payer requirements, facility policy, and applicable law.

At the readiness lock, all four domains must be current and accepted or have a documented clinical exception. These timing examples are not universal expiration rules. Hospital H&P requirements, ASC policy, test validity, consent, authorization, and orders remain governed by applicable regulation and local policy (CMS 2013, CMS 2019; ASA 2012; Thompson et al. 2024). Any new illness, symptom, treatment change, abnormal result, or change in procedure, site, or support immediately reopens the affected item.

THE SURGERY DATE IS A PROMISE

The default should be to assign a date when the surgeon and patient decide to proceed. The date creates a deadline and allows every requirement to be scheduled backward from Day Zero. Before the patient leaves, brief readiness triage should identify the required work, the likely rate-limiting requirement, expected lead time, necessary buffer, and available capacity. The date should reflect that pathway rather than the next vacant operating-room slot.

EARLIEST FEASIBLE SURGERY DATE = DECISION DATE + EXPECTED READINESS LEAD TIME + READINESS BUFFER, SUBJECT TO AVAILABLE CAPACITY

USE THE SURGERY DATE AS THE PULL SIGNAL

Once assigned, the date pulls every required action upstream. The readiness order sets due dates for authorization, documents, indicated testing and improvement, medication instructions, education, support, and the readiness lock. A date without backward scheduling is a reservation; a date linked to a readiness order is an operating plan.

Most patients should receive a date immediately because routine documents, medication planning, education, support, and disposition can be completed within a standard pathway.

Patients with a predictable medical constraint should also usually receive a date that reflects the intervention and reassessment interval. A patient after open-heart surgery may need a date six months away; modestly elevated glycemic measures may support a conditional date several months away with earlier checkpoints. These are examples, not universal clinical rules.

A minority should receive a reassessment date instead of a surgical date when the trajectory is too uncertain. A patient far from an agreed weight goal should leave with a written plan, support, a named owner, and a reassessment deadline rather than an indefensible promise.

USE THREE SCHEDULING DECISIONS

Date assigned—standard pathway. The remaining work is routine and predictable. Assign the date at the decision for surgery and calculate every requirement backward from it. The time required will vary by practice. An efficient practice may complete the standard pathway in a week; another may need a month or longer. Measuring actual lead time allows the readiness pathway to improve over time.

Date assigned - extended or conditional pathway. Meaningful preparation remains, but its expected duration is sufficiently predictable. Assign a farther date with explicit checkpoints and a governed point at which the promise will be confirmed, revised, or withdrawn.

No surgical date yet - reassessment date assigned. The amount or rate of improvement is too uncertain to support a credible surgical promise. Begin the preparation pathway immediately and assign the next reassessment before the patient leaves.

USE EXPECTED IMPROVEMENT, NOT A THRESHOLD ALONE

A threshold alone does not determine the schedule. The team must consider distance from the target, expected rate and variability of improvement, treatment access, reassessment timing, and whether an exception is reasonable. The pathway must name the intervention, owner, measure, re-

Table 1. Simplified readiness order for primary total knee arthroplasty

Readiness item	Completed by	Accepted by	Target timing and refresh rule
Documentation			
Procedure, side, and site-of-care plan	Surgeon	Surgeon	Set when surgery is chosen; reconfirm at the readiness lock and reopen after any plan change.
Payer eligibility and authorization	Authorization team	Scheduler	Verify at scheduling and 14 days before surgery; authorization must cover the final procedure, site, and date.
History and physical examination	Qualified physician, PA, or NP	Facility or anesthesia	Hospital example: complete within 30 days and update after registration; ASC timing follows facility policy. Reopen after a material clinical change.
Consent and operative orders	Surgeon or authorized clinician	Surgeon and facility	Complete within the locally governed interval; verify at the readiness lock and repeat after a procedure, laterality, or material plan change.
Indicated laboratory tests, ECG, and consultations	Laboratory, testing site, or named consultant	Ordering clinician, anesthesia, or surgeon	Receive early enough to review and correct, commonly at least 14 days before surgery. Validity depends on the test, clinical stability, and local policy.
Medical Preparation			
Condition-specific optimization	Named treating clinician	Surgeon; anesthesia for anesthetic risk	Set a treatment target and reassessment date. Review the latest evidence at least 7 days before the readiness lock.
Medication reconciliation and stop or restart plan	RN or pharmacist; authorized clinician approves	RN documents teach-back; clinician resolves exceptions	Reconcile 7 days before surgery and reconfirm holds 48 hours before surgery and on Day Zero. Reopen after any medication or clinical change.
Infection-prevention requirements when indicated	Patient with nursing or pharmacy support	Preoperative nurse	Begin on the locally governed schedule and verify by 48 hours before surgery. Modify after a date or clinical-status change.
Social Preparation			
Caregiver, transportation, and equipment	Patient or caregiver with navigator	RN or case manager	Complete 7 days before surgery and reconfirm 48 hours before surgery. Reopen if support or transportation changes.
Discharge destination and postoperative plan	Navigator or care team	Case manager; clinician for exceptions	Complete 7 days before surgery and reconfirm 48 hours before surgery. Reopen after a functional, clinical, insurance, or site-of-care change.
Education			
Joint class and expectations	Educator or digital pathway	RN verifies completion and understanding	Complete at least 7 days before surgery. Prior education may remain valid if the pathway is unchanged, but understanding must be reconfirmed.
Medication, fasting, bathing, arrival, and what-to-bring instructions	Facility or scheduler	Patient teach-back	Issue the final version 48 hours before surgery and confirm receipt. Reissue after any date, time, location, or medication-plan change.

assessment date, decision authority, and response if improvement does not occur.

Use a conditional date when the trajectory is predictable and a reassessment date when it is not. A threshold without treatment, follow-up, and a route back to scheduling is exclusion rather than optimization.

CONVERT THE PLAN INTO DATED COMMITMENTS

The surgical date cannot be the only deadline. Each requirement needs initiation, receipt, acceptance, and escalation dates; improvement work also needs reassessment. The shared view should distinguish work that is on track, delayed, blocked, threatening the lock, unrecoverable, or awaiting an exception.

ESTABLISH CHECKPOINTS BEFORE THE READINESS LOCK

Patients who need improvement require checkpoints before the readiness lock. For elevated HbA1c, these may include acceptance of the treatment plan, initiation, interim review, repeat testing, and final clinical acceptance. At each checkpoint, the team keeps the date, adds support, revises the plan, or activates Return while useful lead time remains.

MANAGE THE READINESS BUFFER

The readiness buffer. The readiness buffer is protected time between expected completion of the last uncertain requirement and the readiness-lock date. Its size reflects variability, the chance of rework, and the time needed to respond. Green work has adequate protection; yellow work is consuming the buffer; red work threatens the promise; and black work is no longer recoverable within the current date. The colors describe time risk, not patient quality (Bacelar-Silva et al. 2024).

Protect the patient and the schedule. The time buffer protects the individual patient's promise. A ready reserve protects the surgeon's schedule. The reserve consists of patients who are already in full, have asked to be considered for an earlier operation, and match the available procedure, facility, implant, staffing, authorization, and postoperative-support requirements.

Set a replacement decision point. Each scheduled case needs a latest practical date at which an unrecoverable readiness problem can still be converted into usable operating-room capacity. Yellow status triggers help, not removal from the schedule. When the critical-path work becomes red and the promised date is no longer defensible, the authorized owner decides whether to intensify recovery, approve an exception, or release the slot. Waiting until the readiness lock may be too late to refill it.

Pull a fully ready patient forward. When a slot is released, the practice offers it to the ready reserve using a prospectively governed order based on clinical priority, time already waiting, patient preference, and operational fit. Before the move, the team reconfirms authorization, validity windows, medication timing, transportation, caregiver support, facility acceptance, and the patient's consent to the earlier date. The displaced patient enters Return with valid work preserved and a specific reassessment or new promise date.

Do not hide the swap. The original promise, reason for release, replacement decision date, and revised date remain visible. A practice should measure the percentage of released slots refilled, time from release to refill, unused block time, patient OTIF, promise-date changes, and differences in who is advanced or delayed. The ready reserve is schedule recovery, not double booking, coercion, or a way to improve OTIF by moving difficult patients out of the denominator.

MANAGE THE CRITICAL PATH

Not every missing item threatens the date equally. The critical path is the dependent work with no remaining scheduling flexibility. The readiness view should show the current critical-path requirement, expected duration, remaining float, and next owner. When that requirement slips, the threatened completion date and next action should update so scarce attention goes to the work that can actually change the surgical promise.

MEASURE PROMISE-DATE ACCURACY

Promise-date accuracy is the proportion of dates assigned with a feasible, documented pathway to readiness within the available lead time. It complements anticipated OTIF by distinguishing poor execution after a reasonable promise from a date that was never realistically achievable. Original and revised dates must remain visible so performance cannot improve merely by repeatedly moving the promise.

Review promise-date accuracy by pathway segment, active constraint, procedure, practice, and reason for rescheduling. The goal is not perfect prediction; it is early learning about which patients can receive a standard date, which need an extended conditional date, and which should receive a reassessment deadline before operating-room capacity is committed.

MAKE READINESS VISIBLE AND ACTIONABLE

Preoperative readiness requires the same visibility that Radical Time Transparency brought to the operating room: each applicable requirement must be current, assigned, time-bound, and connected to a next action.

One overall readiness color is insufficient. Documentation, medical preparation, social preparation, and education should each retain a separate state because a green segment should not conceal the segment governing the promise. The overall anticipated OTIF state should summarize the episode while the segment states explain why it is on track or at risk.

TRACK EVERY REQUIREMENT THROUGH THE CHAIN

For each requirement, show why it applies, its status, completion and acceptance owners, due date, validity, source, dependencies, next action, and escalation path. Received is not the same as reviewed and accepted; stale, conflicting, or unreviewed information remains incomplete.

A control tower must act on what it displays. When work becomes late, stale, conflicting, or unlikely to meet the lock date, the operating system routes it to the responsible owner, shows remaining lead time, and escalates it. The patient sees an understandable version of the same status.

Access remains role-based. Clinical decisions stay with the authorized clinician, while the patient view separates patient tasks from staff-owned work and explains what an at-risk status means. The record must preserve the source, changes, review, and reconciliation of each item.

USE OTIF TO RUN THE SYSTEM, NOT MERELY GRADE IT

Supply chains use on-time-in-full to ask whether the original commitment was delivered completely and when promised. Applied to surgery, Patient OTIF is the proportion of eligible elective cases in which the patient becomes fully ready by the prospectively agreed readiness-lock date, arrives at the correct location within the instructed window, and has every applicable readiness requirement com-

Domain	Preparation action	Scheduling question	Governance safeguard
Anemia or iron deficiency	Identify the cause and treat when indicated; establish a perioperative blood-management plan.	Is there enough time to investigate, treat, reassess, and review the response before the readiness-lock date?	Avoid one hemoglobin cutoff without considering cause, symptoms, urgency, and procedure.
Diabetes or hyperglycemia	Assess control, address reversible contributors, coordinate treatment, and establish perioperative medication management.	Is the expected improvement sufficiently predictable to assign a date now, or should progress be demonstrated first?	Use individualized targets and exceptions; do not treat one HbA1c value as a universal eligibility test.
Nutrition or frailty	Screen for malnutrition and functional vulnerability; offer targeted nutritional, medical, or rehabilitation support.	What improvement is reasonably achievable, how will it be measured, and when will readiness be reassessed?	Do not substitute a screening score for comprehensive assessment or patient goals.
Obesity	Discuss absolute and relative risk, technical considerations, and available weight-management support.	Is the amount and pace of weight loss required compatible with a credible promise date?	Obesity alone should not create automatic or indefinite delay; monitor access and exception rates.
Nicotine use	Offer evidence-based cessation support and discuss procedure-specific risk.	What cessation interval is expected, how will it be supported, and when will the decision be revisited?	Provide support rather than a stand-alone prohibition; document urgency and patient preference.
Medication or comorbidity	Create a reconciled medication plan and obtain focused consultation when clinically indicated.	Can evaluation, treatment changes, reassessment, and final acceptance occur before the readiness-lock date?	Avoid indiscriminate testing and redundant clearance requirements.
Anxiety or depression	Screen when clinically indicated; provide or refer for evidence-based psychological support.	Could distress impair understanding, engagement, medication adherence, or recovery, and is there time for useful support before the readiness-lock date?	Do not make symptom scores automatic barriers; preserve patient preference, access, and clinical judgment.

Table 2. Illustrative segment-level control-tower view

Episode	Documentation	Medical	Social	Education	Overall state and next action
Patient A	Green	Green	Green	Green	On track - no exception
Patient B	Red	Green	Green	Green	At risk - navigator obtains cardiology report
Patient C	Green	Yellow	Green	Green	At risk - clinician finalizes medication plan
Patient D	Green	Green	Red	Green	At risk - coordinator confirms caregiver support

plete, current, reviewed, and visible or addressed through an explicit clinical exception.

PATIENT OTIF (%) = 100 X (ORIGINALLY PROMISED ELIGIBLE EPISODES MEETING ALL THREE CRITERIA / ALL ORIGINALLY PROMISED ELIGIBLE EPISODES)

At the decision for surgery, the team creates the readiness order and assigns its requirements, owners, dates, validity windows, dependencies, and exception authorities. Anticipated Patient OTIF is the current likelihood that the complete readiness order will be delivered by the lock date and that the patient will arrive as instructed. It turns OTIF from a retrospective score into a prospective work queue.

A non-OTIF episode should retain the failed requirement, failure origin, discovery point, and original and revised surgical dates. Otherwise performance can appear to improve by repeatedly moving the promise.

Anticipated OTIF asks which patient is unlikely to meet the lock date, why, and what action can still change the outcome. Final OTIF creates accountability; anticipated OTIF protects the promise.

MANAGE EXCEPTIONS BEFORE DAY ZERO

New illness, clinical change, patient preference, or a justified safety decision may appropriately change the plan. The standard is that incomplete preparation should not first become visible in preoperative holding.

Table 3. SCOR architecture applied to one primary knee replacement patient

SCOR process	Operational question	Application to the knee patient
Orchestrate	What rules govern readiness?	The practice establishes readiness criteria, acceptable exceptions, responsible roles, validity windows, escalation rules, and the Patient OTIF definition.
Plan	Can the patient become ready by the proposed date?	The surgeon considers the time required to improve an HbA1c of 8.2%, address a BMI of 42 kg/m^2^, complete medical evaluation, provide education, and establish a safe discharge plan before promising the date.
Order	What exactly must be completed, and by when?	Issue a patient-specific readiness order for medical evaluation, glycemic management or an accepted exception, testing, medication planning, consent, education, and home support. Give every requirement a due date.
Source	Who must produce and accept each requirement?	Name who requests, performs, receives, reviews, and accepts each test, consultation, authorization, record, or support service. 'Obtain clearance' is not an adequate assignment.
Transform	What must change before the patient is ready?	Complete diabetes and weight management when indicated, education, medication adjustments, caregiver preparation, and planning for the home environment and postoperative disposition.
Fulfill	Can the prepared patient be delivered reliably on Day Zero?	Confirm that the patient remains medically ready, knows when and where to arrive, has followed medication instructions, has transportation and home support, and has no unresolved requirement.
Return	What happens if readiness is lost?	Move the case through a defined recovery pathway, preserve work that remains valid, assign the unresolved condition and a reassessment date, and provide a clear route back onto the schedule.

The readiness-lock date is the final planned integration point before surgery. By that date, every applicable requirement should be complete and current, or a documented clinician should have accepted an exception. Items still at risk require an explicit disposition: intensify support, obtain an authorized exception, revise the site or procedure, change the surgical promise, or activate Return.

When readiness is lost, Return preserves valid work, identifies what must be repeated, assigns an owner and reassessment date, and defines re-entry to the schedule. Without treatment support, follow-up, and a route back, an optimization threshold becomes exclusion.

SCOR ARCHITECTURE FROM A SURGICAL DECISION TO A READY PATIENT

The Association for Supply Chain Management's SCOR Digital Standard provides the architecture for converting the decision for surgery into a reliable Day Zero (ASCM n.d.). Its value is not simply a new vocabulary. It separates the work of making a realistic surgical promise, issuing the necessary readiness requirements, assigning each requirement to a responsible source, preparing the patient, delivering the ready patient, and recovering when the original plan fails. These activities are organized as Orchestrate, Plan, Order, Source, Transform, Fulfill, and Return.

The architecture also identifies what kind of failure occurred. Scheduling this patient two weeks away when meaningful glycemic improvement requires several months is a Plan failure. Failing to identify who must obtain a repeat HbA1c is a Source failure. Completing the test but leaving the result unread reveals an Orchestrate failure in governance and acceptance. Discovering on Day Zero that the patient stopped the wrong medication is a failure of Transform and Fulfill. Removing the patient from the schedule without a defined route back is a Return failure. The distinction matters because each failure requires a different correction.

SCOR therefore prevents a checklist from masquerading as an operating system. Every readiness item must have a clear requirement and acceptance criterion, responsible source, completion deadline, validity window, authorized reviewer or exception authority, escalation date, and recovery pathway if it cannot be completed.

The surgeon does not need to manage these details personally. The surgeon defines the clinical boundaries and resolves borderline or judgment-dependent decisions. Routine tracking, reminders, document collection, deadline surveillance, and escalation belong to the operating system. For every scheduled patient, the practice should be able to identify what remains incomplete, who owns the next action, when it is due, whether the patient is still likely to be ready, and what will happen to the surgical slot if readiness becomes unlikely.

SCOR gives Zero by Zero its operating logic. It turns 'get the patient ready' into assigned, time-bound, measurable work and makes threats to the surgical promise visible while time remains to act.

OWNERSHIP, GOVERNANCE, AND THE READINESS LAYER

The surgeon is the clinical sponsor and retains decisions about indication, exceptions, and whether surgery proceeds. A coordinator owns daily flow; each requirement has one completion owner and one acceptance owner. The op-

erating system monitors deadlines and routes exceptions. The patient contributes to the plan but is not responsible for repairing the network.

The control tower should show which patients may miss the lock date, the requirement threatening each promise, remaining recoverable lead time, and the next owner. Leaders also need failure origin, promise-date accuracy, access, workload, and equity.

The patient is not the supplier. Suppliers are the functions producing episode inputs. Recurrent cancellations, expediting, duplicate testing, and late overrides should generate a corrective action, owner, and verification.

AUTOMATE ROUTINE WORK; ESCALATE JUDGMENT

In the age of AI, the surgeon should work only the cases that require surgical judgment: borderline candidacy, conflicting clinical information, an unexpected trajectory, a requested exception, or the final decision to proceed, postpone, or change the plan. A surgeon should not spend time searching for records, checking whether routine requirements are due, reconciling ordinary completion, sending reminders, or constructing a worklist.

Governed AI agents could become a primary execution layer for routine readiness coordination, reducing manual tracking and reconciliation after their safety and reliability have been validated. Governed agents can create the patient-specific work queue, request records, monitor receipt and freshness, compare completion with local rules, send instructions and reminders, identify contradictions, calculate threatened dates, and assemble the evidence needed for an exception decision. Clinical personnel should be redeployed toward work requiring human assessment, teaching, empathy, intervention, or accountability rather than serving as expensive interfaces between disconnected systems.

This substitutes labor without delegating licensure. AI should not independently diagnose, prescribe, clear a patient, accept a clinical exception, or decide that surgery should proceed. Those decisions remain with the qualified professional authorized by law and local governance. The greater the potential harm, the earlier a human should review the work. Any recommendation that influences care must expose its inputs and reasoning well enough for independent review (AMA 2023; FDA 2026). Routine coordination may become substantially automated after local validation, with role-based access, privacy safeguards, audit logs, verification of critical data, and clear escalation to qualified professionals.

OPERATE THE CHAIN AT THREE HORIZONS

Daily exception management. The coordinator reviews buffer penetration, critical-path requirements, newly conflicting or stale information, and cases requiring escalation. The meeting is a short decision forum, not a recitation of every patient.

Weekly demand-capacity reconciliation. The practice compares requested and promised surgical demand with readiness capacity, the active constraint, operating-room capacity, and site-of-care requirements. Leaders decide which cases are capable to promise, which dates require protection, and where capacity or release must change.

Monthly system improvement. The network reviews OTIF loss, promise-date changes, lead-time variation, near misses, source performance, access, equity, workload, and clinical outcomes. Recurrent defects receive a named corrective action and verification rather than another reminder to work harder.

Measure source performance by timely receipt, completeness, first-pass acceptance, correction rate, review delay, and variability. The purpose is to improve specifications, interfaces, capacity, or sourcing, not to publish a punitive scorecard.

WHY ZERO BY ZERO CREATES VALUE

The value proposition must be tested locally. Earlier discovery should reduce expediting, rework, lost capacity, patient disruption, and avoidable delay, but practices should claim gains only after measuring outcomes, experience, access, workload, and total episode cost.

The economic case extends beyond avoided cancellations. A deferred case may require another cycle of rescheduling, verification, patient contact, document review, and repeat testing. Preparation already consumes an estimated 8.45 staff hours and $348 per arthroplasty patient (Constantinescu et al. 2022), and one historic study attributed 73% of cancellation cost after admission to operating-theatre opportunity cost (Mangan et al. 1992).

Optimization attrition is another loss. One arthroplasty program reported that 20% of patients did not complete recommended optimization (Bernstein et al. 2018). In a BMI-focused cohort, 51.3% of patients with BMI at least 40 kg/m^2 did not return for a second visit (Foreman et al. 2020). These studies do not prove that coordination caused the loss, but they support measuring decision-to-ready conversion, stalled work, attrition, and successful Return.

Reliable preparation may also support appropriate ambulatory growth. In one review, 70.0% of 3,444 arthroplasty patients met institutional ASC criteria, including more than one-third of ASA III patients (Kingery et al. 2018). A later series found no higher 24- or 90-day complication rates among selected, optimized ASA III outpatients, although readmission and revision signals require attention (Strait et al. 2025). Readiness cannot make an inappropriate patient appropriate, but it can support better selection and deliberate optimization.

The practice must share in the productivity benefit. It bears the work of repeated calls, searches, reconciliation, and rescheduling even when the facility captures the cancellation savings. Measures should therefore include staff time, duplicate contacts, aging work, decision-to-ready time, retained patients, and released clinical capacity.

An ambulatory surgery center may make coordination easier because teams are smaller and incentives more aligned. One comparison found greater operating-room efficiency than in a hospital outpatient department, but se-

Table 4. How a joint-replacement practice knows Zero by Zero is working

Question the surgeon cares about	Practical measure	What it tells the practice
Are fewer patients arriving unready?	Patient OTIF and number of Day Zero readiness failures	Whether the system is accomplishing its central purpose.
Are we giving patients realistic surgery dates?	Promise-date accuracy and percentage of original dates changed	Whether dates are credible when assigned.
Are problems being found early enough to fix?	Days between first identification of a threatened requirement and Day Zero	Whether useful recovery time remains.
Is the office doing less chasing and rework?	Staff time, duplicate calls, faxes, document searches, and repeat testing per case	Whether the practice receives a productivity benefit.
Are patients disappearing during optimization?	Percentage progressing from the decision for surgery to ready and ultimately operated	Whether the Return pathway retains patients.
Can more appropriate patients use the ASC?	Patients moved from hospital-only consideration to appropriate ASC eligibility after preparation	Whether reliable readiness creates usable growth.
Are we improving value without harming patients?	Cancellations, complications, access, equity, patient experience, and staff workload	Whether reliability gains create unacceptable tradeoffs.

lection, staffing, and local workflow may explain the difference (Imran et al. 2019).

Zero by Zero should produce fewer Day Zero surprises, more credible dates, earlier recovery of threatened cases, less rework, better retention through optimization, and appropriate ambulatory use. Clinical outcomes, experience, access, equity, and workload remain balancing measures.

IMPLEMENTING ZERO BY ZERO: A 90-DAY PILOT

Begin with one surgeon, one site, and 50 consecutive patients. Define the pathway prospectively rather than reconstructing it after cancellations.

Days 1–14: define the work. Agree on the four readiness domains, the requirements that apply to an uncomplicated primary knee, local due dates and validity rules, the three scheduling pathways, the readiness-lock date, and the clinical decisions that always require human authorization.

Days 15–30: build the operating routine. Name one accountable readiness owner, configure the exception queue, assign completion and acceptance owners, create patient-facing instructions, and test escalation and Return with simulated incomplete, abnormal, stale, and conflicting inputs.

Days 31-90: enroll 50 consecutive eligible patients and follow each to surgery or a documented alternative disposition, including cancellations and postponements. Use the readiness order prospectively, review threatened promises every working day, perform the readiness lock before every case, and classify every non-OTIF episode by failed requirement, origin, owner, and discovery point.

THE MINIMUM OPERATING RHYTHM

Daily. The readiness owner reviews only red, black, newly conflicting, and critical-path work. The output is a named decision or next action, not a recitation of every patient.

Weekly. The practice reconciles promised demand with readiness and operating capacity and decides which dates require protection, revision, or additional support.

After 50 cases, review Patient OTIF, date changes, late discovery, staff time, optimization retention, appropriate ASC use, safety, and equity. Remove recurrent defects before expanding.

LIMITATIONS AND RESEARCH AGENDA

The patient supply chain is a metaphor that can objectify patients if its boundary is forgotten. This narrative perspective draws from varied populations and study designs. Patient OTIF is not a validated quality measure and can be gamed through exclusions, rescheduling, or restrictive criteria. Digital coordination may also add work or deepen disparities when access, language, disability, and data quality are ignored.

Broader adoption should be accompanied by patient-informed readiness domains, procedure-specific exception rules, validation of Patient OTIF, evaluation of outcomes and total episode cost, and measurement of access restriction, documentation burden, metric gaming, and other unintended effects across hospitals, ambulatory centers, and resource-constrained settings.

CONCLUSION

Zero by Zero manages the interval from the surgical decision to Day Zero. The readiness order defines patient-specific work; owners, deadlines, validity rules, track-and-trace, and a readiness lock make that work actionable;

Return keeps disrupted patients from disappearing from care.

AI agents should perform routine tracking, communication, and reconciliation. Surgeons and licensed clinicians should manage borderline candidacy, conflicting information, abnormal trajectories, exceptions, and proceed-or-postpone decisions. Clinical accountability remains human.

A practice can begin with one surgeon, one procedure, one readiness owner, one lock date, and 50 patients. The test is whether threatened work becomes visible while time remains to act. Zero by Zero feeds 12 by 12.

AUTHOR CONTRIBUTIONS

All authors contributed to conception and design, drafting and critical revision, approval of the final version, and accountability for the work.

DATA AVAILABILITY

Not applicable; this perspective generated no new dataset.

ETHICAL APPROVAL

Not applicable; no human participants or identifiable patient data were involved.

PRIOR WORK

This article is a companion to DeCook and Statton (2022) and extends that operating-room framework upstream.

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