

A Hospitalist-Led, Tele-ICU-Supported Model for Critical Care and Transfer Decisions in Rural Hospitals: A Conceptual Framework

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ABSTRACT

Rural hospitals in the United States regularly care for critically ill patients, yet most operate without on-site intensivists, maintain only a handful of monitored beds, and depend on transfer to regional referral centers that are often full. In these hospitals the hospitalist is usually the only physician at the bedside when a patient deteriorates, and must decide, often at night- and under-time pressure, whether the patient can be managed locally or must be moved. Tele-critical care (tele-ICU) can bring intensivist expertise across distance, but it has largely been organized as a remote monitoring service rather than as support for this decision, which leaves the role of the bedside clinician poorly defined and the transfer decision largely unstructured. This study used a theory-informed narrative synthesis to develop a conceptual framework that places the rural hospitalist at the center of critical care and transfer decisions while drawing on tele-ICU as a structured partner. In the proposed model, the hospitalist remains the accountable clinical leader, and the remote intensivist team contributes continuous surveillance, specialist consultation, protocol support, and an independent view on whether care should continue locally. Signs of deterioration prompt a joint bedside and virtual assessment that places each patient in local care, in local co-management with intensive remote support, or on a pathway to prompt transfer. That placement is revisited as the patient's condition, local staffing, weather, referral-center capacity, and family preferences change, so the same patient may warrant a different decision on a different day. Coordinated action and shared case review close the loop, allowing every transfer and every patient kept locally to inform future protocols, training, and transfer agreements. The framework connects these elements to outcomes for patients, care processes, the regional health system, and the rural workforce, and it yields testable propositions and an agenda for evaluation. Treating tele-ICU as decision support for the hospitalist, rather than as a substitute for bedside leadership, offers a practical route to safer care closer to home, better use of scarce referral-center beds, and a more sustainable rural physician workforce.

Keywords: rural health; hospitalist; tele-ICU; tele-critical care; interhospital transfer; critical access hospital; conceptual framework; decision support

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INTRODUCTION

Critical illness does not respect geography. Patients with sepsis, respiratory failure, diabetic ketoacidosis, gastrointestinal hemorrhage, and decompensated cardiopulmonary disease present to small rural hospitals every day, and many of them deteriorate after admission. Yet the organization of American critical care has concentrated intensivists, advanced technology, and procedural capability in larger urban and academic centers (Angus et al., 2000; Halpern & Pastores, 2015; Kahn & Rubenfeld, 2015; Wallace et al., 2015). Rural communities have absorbed a steady wave of hospital closures and service-line reductions over the last two decades, leaving

fewer local options and longer distances to definitive care (Cecil G. Sheps Center for Health Services Research, 2025).

In this environment, two default responses to a critically ill rural patient dominate. The first is to keep the patient locally with whatever expertise is on hand, which risks undertreatment when the needed resources are absent. The second is to transfer, which carries its own risks: delays, transport hazards, information loss at handoff, separation from family, financial burden, and the consumption of referral-center beds that may be needed by patients who cannot be cared for anywhere else (Iwashyna et al., 2009; Kahn et al., 2006; Mohr et al., 2017; Mueller et al., 2017; Usher et al., 2016). Neither default is

reliably correct, and the decision between them is frequently made under time pressure by a single physician, often at night, without structured support.

That physician is, increasingly, a hospitalist. Hospital medicine has become the dominant model of inpatient physician care in the United States (Wachter & Goldman, 1996, 2016), and in rural and community hospitals without dedicated intensivists, hospitalists commonly manage ICU and step-down patients, perform or arrange procedures, and decide when to escalate or transfer (Siegal et al., 2012; Sweigart et al., 2018). In parallel, tele-critical care has matured into a widely adopted means of extending intensivist expertise across distance (Fusaro et al., 2019; Kahn et al., 2014, 2016; Lilly et al., 2011, 2014; Subramanian et al., 2020; Wilcox & Adhikari, 2012). However, the two developments have tended to evolve separately. Tele-ICU programs are often conceived as remote monitoring layered onto an existing ICU, and the role of the bedside hospitalist in a tele-supported model is rarely specified.

We address that gap here. Our purpose is to articulate a conceptual framework for a hospitalist-led, tele-ICU-supported model for critical care and transfer decisions in rural hospitals. The central idea is that the bedside hospitalist is the clinical leader and decision owner, while the tele-ICU team functions as an expert partner that adds surveillance, specialist knowledge, protocolized support, and an independent second view on the decision to retain or transfer. The framework is intended to serve three audiences: rural hospital leaders and clinicians designing programs, health systems and tele-ICU providers seeking to partner with rural facilities, and researchers who need a structured model from which to derive testable hypotheses.

The novelty of this work lies in treating the retain-or-transfer decision itself, rather than ICU monitoring, as the primary object of tele-ICU support, and in positioning the rural hospitalist, not the remote intensivist, as the accountable decision owner. To our knowledge, no prior framework has combined these elements with a tiered disposition model, an explicit allocation of roles, and a named set of contextual moderators that legitimately shift the decision from one day to the next. Section 2 describes the research method and its theoretical basis. Section 3 presents and discusses the results: the synthesized evidence, the resulting framework, testable propositions, and implications for implementation, evaluation, and limitations. Section 4 concludes.

RESEARCH METHOD

Study design and evidence synthesis

We developed the framework through a theory-informed narrative synthesis rather than a systematic review, because the aim was to integrate evidence from several distinct literatures into a coherent model rather than to estimate a pooled effect. We searched PubMed, Google Scholar, and publisher databases for peer-reviewed studies, reviews, and

professional society statements on rural critical care capacity and outcomes, hospitalist and intensivist staffing, tele-critical care and tele-emergency services, interhospital transfer, recognition of clinical deterioration, clinical decision support, and implementation science, prioritizing work published between 2005 and 2025. We supplemented this with related literature on health infrastructure, digital health governance, health informatics, cybersecurity, supply chains, and workforce management that bears on the operating conditions of rural hospitals.

Framework construction proceeded in three steps. First, we extracted recurring findings and identified tensions between them, such as the protective role of early local resuscitation set against the volume-outcome argument for regionalization. Second, we mapped these findings onto three theoretical lenses (Donabedian's structure-process-outcome model, distributed cognition, and the Consolidated Framework for Implementation Research) to organize components and relationships. Third, we specified the decision process, roles, moderators, and outcomes, and translated the expected relationships into testable propositions and an evaluation agenda. Every reference was checked against its source before inclusion.

Theoretical foundations

The framework draws on three core theoretical lenses, supplemented by complementary implementation theories.

Donabedian's structure-process-outcome model

Donabedian's model holds that the structures in which care is delivered shape the processes of care, which in turn determine outcomes (Donabedian, 1988). It provides the backbone of the framework: tele-ICU technology, staffing, protocols, and transfer agreements are structural inputs; the shared decision cycle is the process; and patient, process, system, and workforce indicators are the outcomes. The model is also useful for evaluation because each component suggests measurable indicators. International quality indicators for critical care have been organized along the same structure, process, and outcome lines (Rhodes et al., 2012).

Distributed cognition

Distributed cognition views complex work as cognition spread across people, artifacts, and environments rather than residing in a single individual (Hutchins, 1995). In rural critical care, the information needed for a good decision is genuinely distributed: the bedside hospitalist and nurse hold direct examination findings, local resource knowledge, and patient and family context; the tele-ICU intensivist holds specialty expertise, pattern recognition across many patients, and knowledge of regional capacity; monitoring systems and the electronic health record (EHR) hold trend data. The framework treats the hospitalist and tele-ICU team as a single cognitive system with deliberate mechanisms for sharing information, rather than as two separate clinicians exchanging opinions. The design also aligns with policy guidance that treats shared

decision-making in the ICU as a spectrum matched to patient values and family preferences (Kon et al., 2016). Evidence from emergency departments that structured multidisciplinary collaboration is associated with better patient outcomes (Ohunyon et al., 2023) supports this design choice.

Consolidated Framework for Implementation Research (CFIR)

CFIR organizes the determinants of implementation success into the intervention, the outer and inner settings, the individuals involved, and the implementation process (Damschroder et al., 2009), and its 2022 update separates outer and inner settings more clearly and adds constructs concerning the people who receive an innovation (Damschroder et al., 2022). It informs the implementation considerations in Section 3.4, particularly the importance of local adaptability, leadership engagement, payment and policy context, and clinician beliefs about telemedicine. Prior commentary has emphasized that telemedicine succeeds only when it is integrated with existing care relationships rather than imposed upon them (Kahn, 2015).

Complementary implementation theories

Normalization process theory explains how new practices become routine through coherence, cognitive participation, collective action, and reflexive monitoring (May & Finch, 2009), which fits the challenge of making joint huddles habitual. RE-AIM (Glasgow et al., 2019) and Proctor's implementation outcomes (Proctor et al., 2011) provide vocabulary for reach, adoption, fidelity, and sustainability that complements Donabedian's outcome categories. Organizational frameworks for technology adoption and employee readiness (Akhigbe et al., 2024) and multi-site performance frameworks built on data-driven indicators (Akin-Oluyomi & Akhigbe, 2023) add a management perspective that is often missing from clinical implementation studies.

RESULTS AND DISCUSSION

The results are presented in two parts. Section 3.1 reports the synthesized evidence that defines the problem the framework must solve, and Sections 3.2 and 3.3 present the framework and the propositions derived from it. Sections 3.4 to 3.6 discuss implementation, evaluation, and limitations.

Synthesis of the evidence

The rural critical care gap

Rural hospitals, including the more than 1,300 critical access hospitals (CAHs) limited to 25 inpatient beds, typically maintain a small number of monitored or ICU beds, have limited subspecialty coverage, and may lack around-the-clock respiratory therapy, laboratory, or imaging support. The relationship between hospital volume and outcome in conditions such as mechanical ventilation (Kahn et al., 2006) has been used to argue for regionalization of critical care, and informal transfer networks already move large numbers of critically ill patients from smaller to larger hospitals (Iwashyna

et al., 2009). At the same time, evidence that rural patients with severe sepsis who bypass local hospitals may have worse outcomes (Mohr et al., 2017) suggests that the local hospital has a real, and sometimes protective, role in early resuscitation. The policy challenge, therefore, is not simply to move patients toward volume but to make each local disposition decision well. Persistent rural-urban gaps in access to diagnostic infrastructure and specialist expertise (Aminu-Ibrahim et al., 2020), together with evidence that telehealth can narrow some of these gaps (Oparah et al., 2024a), make the quality of that local decision a matter of equity as well as safety.

The quality gap is measurable. Critical access hospitals have been shown to have fewer clinical capabilities, lower process-of-care scores, and higher 30-day mortality for common acute conditions than other hospitals (Joynt et al., 2011), and rural hospitals continue to show higher mortality and fewer procedures for myocardial infarction and stroke (Loccoch et al., 2022). Rural residents also face higher mortality after traumatic injury (Jarman et al., 2016). Low-income and rural communities have markedly poorer local access to intensive care beds (Kanter et al., 2020), and only about half of US acute care hospitals have any intensivist on staff, with those hospitals concentrated in metropolitan areas (Halpern et al., 2019). During the COVID-19 pandemic, rural areas entered the crisis with fewer hospital beds per expected admission than urban areas (Kaufman et al., 2020), and in-hospital mortality for non-COVID time-sensitive conditions rose more steeply at rural than at urban hospitals (Jiang et al., 2024).

These pressures rest on a fragile financial base. Rural hospitals that close tend to show weak profitability, liquidity, and volume in the years beforehand (Kaufman et al., 2016), financial viability diverges sharply by ownership and state policy (Bai et al., 2020), and nearly 200 rural hospital closures and conversions have been recorded since 2005 (Cecil G. Sheps Center for Health Services Research, 2025). Closures lengthen emergency medical services transport times (Miller et al., 2020) and are accompanied by losses in the local physician workforce (Germack et al., 2019), while the rural physician workforce is aging faster than it is being replaced (Skinner et al., 2019). Work on health infrastructure reinforces that physical and diagnostic capacity is itself a determinant of population health outcomes (Aminu-Ibrahim & Ogbete, 2023; Ilodigwe & Adesemoye, 2019b; Ogbete & Aminu-Ibrahim, 2024), that resilient laboratory networks underpin care under public health stress (Aminu-Ibrahim et al., 2018, 2022, 2025a; Ogbete et al., 2023), and that infrastructure investment must be governed and measured across its life cycle to deliver value (Aminu-Ibrahim et al., 2021, 2024, 2025b; Ogbete et al., 2025). Financing and payment design shape whether such capacity can be sustained (Ilodigwe & Adesemoye, 2019a), and pharmacy-led and last-mile distribution models show how access to essential therapies can be protected in underserved settings (Asiedu & Asiedu, 2022, 2023, 2024; Ilodigwe &

Adesemoye, 2020).

The growth of national ICU bed supply has been concentrated in larger and urban hospitals (Halpern & Pastores, 2015; Wallace et al., 2015), and periodic surges such as the COVID-19 pandemic have repeatedly exposed the fragility of transfer pathways when referral centers are full. Rural hospitals have experienced long waits for accepting beds, prolonged boarding of critically ill patients in emergency departments and general wards, and, in some cases, transfers over hundreds of miles. These episodes made visible a structural reality: rural hospitals must be able to safely care for, or at least stabilize for extended periods, patients who would previously have been transferred quickly. Earlier qualitative work found that clinicians viewed loss of referring-hospital autonomy as a key barrier to formal regionalization and favored collaborative inter-hospital models instead (Kahn et al., 2008), and transfers from community hospitals were often shaped by informal relationships rather than by the quality of the receiving hospital (Bosk et al., 2011). Equity concerns in rural care extend beyond critical illness to maternal and chronic disease services, for which integrated, policy-driven models have been proposed (Akinse et al., 2023; Omaghomni et al., 2025).

Hospitalists as the de facto rural intensivist

The intensivist workforce has long been projected to fall short of demand (Angus et al., 2000), though the extent and nature of the shortage are debated (Kahn & Rubenfeld, 2015). Regardless of national supply, intensivists are scarce in rural settings. Professional societies have explicitly acknowledged that hospitalists provide a substantial share of critical care in community and rural hospitals and have proposed pathways for hospitalists to acquire structured critical care training (Siegal et al., 2012). Surveys of hospitalists show that many routinely care for critically ill patients, often without formal critical care training, and that many report discomfort with procedures, ventilator management, and the complexity of decisions they are asked to make (Sweigart et al., 2018). Small rural hospitals adopt hospitalist programs largely to cover call and improve quality, and rural hospitalists frequently hold several roles beyond inpatient medicine (Casey et al., 2014). A prospective comparison found no overall difference in adjusted mortality between hospitalist-led and intensivist-led medical ICU care, although intensivists achieved shorter stays for some ventilated patients (Wise et al., 2012). High-intensity intensivist staffing is associated with lower mortality overall (Wilcox et al., 2013), yet intensivist supply remains short and unevenly distributed (Halpern et al., 2013), burnout is common among intensivists (Pastores et al., 2019), and both very low and very high patient-to-intensivist ratios are associated with worse outcomes (Gershengorn et al., 2017; Ward et al., 2013).

The hospitalist is well suited to lead rural critical care for reasons that are independent of tele-medicine: the hospitalist is physically present, knows the local nursing staff and resources, understands the hospital's capability on any

given night, and often has continuity with the patient and family. What the hospitalist frequently lacks is timely access to intensivist-level expertise, a second clinician to share cognitive load during complex resuscitations, and a structured framework for deciding when the local capability is no longer adequate. Workload also matters: higher hospitalist census is associated with longer stays and higher costs (Elliott et al., 2014), hospitalists report unsafe workloads less often where census caps exist (Michtalik et al., 2013), and roughly half of hospitalists report burnout (Roberts et al., 2014). Mindfulness-based interventions are one evidence-based option for reducing that stress (Osinem et al., 2023). Bedside nursing is equally decisive, since better ICU nurse work environments and a more highly educated critical care nursing workforce are associated with lower mortality among ventilated older adults (Kelly et al., 2014), and deliberate development of nurse leadership strengthens frontline capacity (Ohunyon et al., 2025). Frameworks for workforce optimization, retention, and staffing volatility developed in other sectors offer transferable lessons for small rural medical staffs (Falemi et al., 2023a, 2023b).

Evidence on tele-ICU

Intensivist involvement in care has been associated with improved outcomes (Pronovost et al., 2002), although the specific value of on-site nighttime intensivist staffing in hospitals already served by daytime intensivists is less clear (Wallace et al., 2012). Tele-ICU emerged as a way to provide intensivist oversight without on-site presence. Landmark before-and-after studies of tele-ICU implementation that reengineered care processes reported lower mortality, shorter length of stay, and better adherence to best practices (Lilly et al., 2011, 2014). Systematic reviews and meta-analyses have generally found reductions in ICU mortality and length of stay, though with considerable heterogeneity (Fusaro et al., 2019; Wilcox & Adhikari, 2012). A national effectiveness study found that benefits varied widely across programs, with some showing improvement and others none (Kahn et al., 2016), suggesting that how tele-ICU is organized and integrated matters at least as much as whether it exists.

Later syntheses broadly confirm these signals while underlining their limits. Early pooled analyses linked tele-ICU coverage to lower ICU mortality and length of stay but not consistently to lower hospital mortality (Young et al., 2011), and a subsequent meta-analysis reported reductions in both ICU and hospital mortality alongside substantial first-year costs (Chen et al., 2018). An ethnographic study showed that effectiveness depended on leadership, on how much bedside clinicians valued the service, and on organizational features that allowed the program to be integrated and responsive (Kahn et al., 2019). Most strikingly, a cluster-randomized trial in Brazilian public ICUs found that weekday tele-rounds did not reduce length of stay or mortality compared with usual care (Pereira et al., 2024), which strengthens the argument

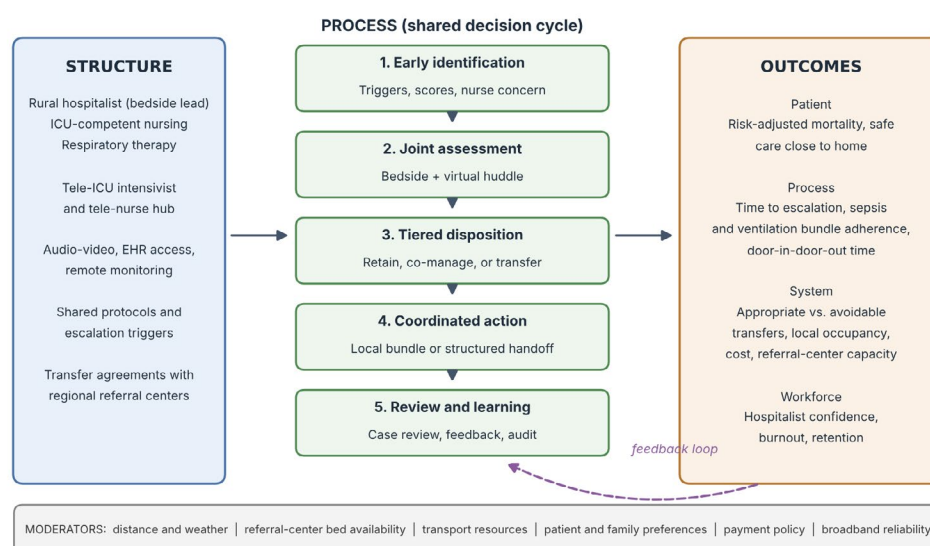
that tele-ICU must be embedded in redesigned care processes rather than simply added on.

Adoption has grown substantially (Kahn et al., 2014), reaching roughly 18% of US hospitals by 2018, although critical access hospitals were less likely to have adopted it (Ofoma et al., 2021), but cost remains a barrier (Kumar et al., 2013), and most published programs were built around larger ICUs. Health-system models such as the Veterans Affairs and integrated delivery networks have demonstrated hub-and-spoke tele-critical care that includes smaller facilities (Fortis et al., 2014). Professional guidance has described a spectrum of tele-critical care delivery models, from continuous monitoring to scheduled and on-demand consultation (Subramanian et al., 2020). Tele-emergency programs in rural emergency departments have also reported transfers averted through remote consultation (Ward et al., 2021). Rural evidence is particularly relevant. Rural staff valued tele-ICU most for keeping critically ill patients locally, and satisfaction rose with use and program maturity (Ward et al., 2015). Acceptance depended on training, perceived usefulness, and relationships, with workflow disruption and a sense of being watched acting as barriers (Moeckli et al., 2013), and role clarity between bedside and remote teams determined how consistently services were used (Krupp et al., 2021). Hospitals with tele-ICU coverage or central venous access capability had about 31% lower odds of transferring patients with severe sepsis (Ilko et al., 2019). Tele-emergency programs avoided transfers at a net societal saving (Natafqi et al., 2018), shortened time to provider and emergency department stays for transferred patients (Mohr et al., 2018a, 2018b), accelerated stroke imaging (Mohr et al., 2019), and improved sepsis bundle adherence (Mohr et al., 2021), although they did not improve hospital-free days overall in a multicenter sepsis cohort (Mohr

et al., 2023). In pediatric care, video consultation with critical care physicians reduced interfacility transfers by about 19% compared with telephone consultation (Marcin et al., 2023). Reviews of AI-enabled remote monitoring further show that clinician and patient trust, privacy protections, and clear regulatory governance largely determine whether remote technologies are used in practice (Akintola et al., 2025). Related work on AI-driven early detection, comparative governance of AI in health care, organizational readiness for generative AI, and privacy-preserving data models shows that the same governance questions apply to any remote or algorithmic layer added to clinical care (Afrihyia et al., 2023, 2024a, 2024b, 2025), and that telemedicine services carry their own fraud and financial-integrity risks (Ekechi et al., 2022). Collectively, this literature supports the feasibility of tele-supported rural critical care but leaves the bedside role and the transfer decision process under-specified.

The interhospital transfer decision

Interhospital transfer is common, highly variable across hospitals, and often only loosely tied to measured patient characteristics (Mueller et al., 2017). Transferred patients are vulnerable to communication failures, and the quality of information transmitted at handoff has been associated with outcomes (Usher et al., 2016). Transferred patients also tend to have longer stays and higher resource use at the receiving hospital (Sokol-Hessner et al., 2016). Referring physicians, accepting physicians, and families often disagree about why a transfer occurred (Wagner et al., 2013), handoff practices vary widely and records are rarely shared electronically across systems (Herrigel et al., 2016), and during the pandemic clinicians reported moral distress from refused transfers and



waitlists (Harlan et al., 2023). Transfer decisions are typically made through an unstructured phone call between a referring and an accepting physician who have no shared view of the patient and no shared criteria. The result is that some patients are transferred who could have remained safely, while others remain locally too long.

The costs of transfer are concrete. Transferred patients with sepsis were far less likely to receive appropriate initial antibiotics and timely fluids than patients who presented directly (Faine et al., 2015), and interhospital transfer in a rural-state sepsis cohort was associated with higher mortality and cost (Mohr et al., 2016). Among ventilated patients with sepsis, transfer conferred no mortality benefit and lengthened total hospital stay (Rush et al., 2018), while Black and Hispanic patients were less likely to be transferred to specialized centers (Tyler et al., 2018). Nighttime transfers carried higher adjusted mortality (Mueller et al., 2019), roughly one in fifteen urgent ground critical care transports involves a critical event such as new hypotension (Singh et al., 2014), and critically ill patients who wait six hours or more in the emergency department before ICU admission have higher mortality (Chalfin et al., 2007), a problem compounded by widespread boarding of critically ill patients (Mohr et al., 2020). In rural trauma systems, between one in ten and one in four transfers may represent secondary overtriage (Con et al., 2015; Sorensen et al., 2013).

The problem statement for this framework is therefore as follows. Rural hospitals need a reliable way to provide intensivist-informed critical care locally when that is safe, and to transfer promptly and safely when it is not, using the clinician already at the bedside as the leader and tele-ICU as the source of expertise and decision support.

The proposed framework

Figure 1 presents the framework. Structural inputs enable a five-step shared decision cycle that produces outcomes at the patient, process, system, and workforce levels. Contextual moderators influence how the decision cycle unfolds, and outcomes feed back into the cycle through review and learning.

Core principles

• Five principles underpin the model

- **Bedside leadership**The rural hospitalist is the attending of record and the final decision owner for local care, including the decision to request transfer. The tele-ICU team advises, monitors, and may intervene within agreed protocols, but does not displace the bedside leader.
- **Shared situational awareness.** Both parties see the same data at the same time through shared EHR access, live monitoring, and audio-video assessment, so that discussion is about interpretation rather than reconstruction of facts.
- **Right care, right place.** The goal is neither to minimize nor to maximize transfers but to match each patient's needs to the setting that can safely meet them, considering clinical risk, local capability at that moment, regional capacity,

and patient preference.

- **Explicit criteria with room for judgment.** Shared escalation triggers and disposition criteria reduce unwarranted variation, while clinical judgment remains central for situations that criteria do not anticipate.
- **Learning system.** Every transfer and every deterioration managed locally is a source of feedback that refines criteria, training, and protocols.

Structural components

The structural layer consists of people, technology, protocols, and relationships.

- **People.** A hospitalist group with defined critical care competencies; ICU-competent or cross-trained nursing staff; respiratory therapy coverage; and a tele-ICU hub with board-certified intensivists, critical care nurses, and, where available, pharmacists and advanced practice providers. Safe local retention presupposes adequate nurse staffing, which benefits from governance-driven workforce planning and attention to nurse-patient ratios (Omaghomi et al., 2023).
- **Technology.** High-definition audio-video carts or in-room cameras, remote physiologic monitoring, bidirectional EHR access with order-entry rights defined by agreement, and reliable broadband with a tested contingency plan for outages. Security should follow zero-trust principles and HIPAA-compliant data architecture (Adebayo et al., 2025; Aliliele et al., 2024), with clinical record protection and data governance built in from the start (Ilodigwe & Adesemoye, 2021; Nnaji & Akinlolu, 2024a; Peteranaba et al., 2022). Documentation workflows for remote clinical staff, including tele-ICU nurses and physicians, should likewise be designed for data integrity and HIPAA compliance (Peteranaba et al., 2023a).
- **Protocols.** Shared, locally adapted protocols for sepsis resuscitation, noninvasive and invasive ventilation, vasopressor use, sedation, glycemic emergencies, and gastrointestinal bleeding, plus explicit escalation triggers that prompt tele-ICU involvement. Sepsis protocols should align with the Surviving Sepsis Campaign guidelines (Evans et al., 2021), and the model can borrow from structured nursing protocols for monitoring, infection prevention, fall prevention, wound care, and pain communication that have been formalized in other acute care settings (Akinlolu et al., 2025; Fapohunda et al., 2024; Ohunyon et al., 2024; Omaghomi et al., 2022, 2024).
- **Supplies and diagnostics.** Local Tier 1 and Tier 2 care depends on reliable access to vasopressors, sedatives, and antibiotics, which in turn depends on resilient pharmaceutical supply chains, drug shortage early-warning systems, and lean inventory management (Asiedu, 2025; Awulu et al., 2022; Eze et al., 2022; Obukadata et al., 2021), supported by real-time supply risk dashboards (Filani et al., 2022) and by analytics for vendor performance

management and supply forecasting (Abdulrazaq et al., 2025). It also depends on local laboratory diagnostics with short turnaround (Abdulrazaq et al., 2019; Asiedu, 2023; Yusuf & Abdulrazaq, 2018; Yusuf et al., 2025), although smaller laboratories face recognized barriers to adopting more specialized diagnostic techniques (Abdulrazaq et al., 2021) and on regional antimicrobial resistance data to guide empiric therapy (Yusuf et al., 2020), with biomarker-based decision support adding further guidance when infection is suspected (Abdulrazaq et al., 2023).

- Relationships and agreements. Written transfer agreements with one or more regional referral centers, ideally with a single point of contact or transfer center, and governance documents that define credentialing, liability, documentation, and quality review responsibilities.

The shared decision cycle

The process layer is a five-step cycle that is repeated as a patient's condition evolves.

• Step 1: Early identification

Deterioration is detected through a combination of automated early warning scores, tele-ICU surveillance of trends, defined clinical triggers (for example, rising oxygen requirement, hypotension despite fluids, rising lactate, or new altered mental status), and, importantly, bedside nurse concern. Any of these triggers prompts the next step; nurse concern alone is treated as a valid trigger. Real-time informatics and performance analytics can shorten the interval between a change in the patient's condition and a clinical decision (Nnaji & Akinlolu, 2022), and AI-assisted risk prediction may further sharpen surveillance, provided that its limitations and the risk of automation bias are actively managed (Ilodigwe & Adesemoye, 2025; Osinem, Eribenne, Peteranaba, et al., 2025b). Validated tools already exist: the National Early Warning Score discriminates patients at risk of cardiac arrest, unanticipated ICU admission, and death (Smith et al., 2013), electronic scores such as eCART outperform simpler systems (Churpek et al., 2014), and early warning scores outperform qSOFA and SIRS criteria for detecting deterioration in infected ward patients (Churpek et al., 2017). These tools form the afferent limb of a rapid response system, with the joint huddle serving as its efferent response (Jones et al., 2011). Time matters, since each additional hour to complete a sepsis bundle or give antibiotics is associated with higher mortality (Seymour et al., 2017). Work on cardiovascular risk stratification and AI-based early detection of noncommunicable disease illustrates how layered risk information can sharpen bedside judgment (Abah et al., 2025; Afrihyia et al., 2023; Amadi et al., 2025; Okwah, 2022), although trials of clinical decision support show only modest average gains in adherence to recommended care (Kwan et al., 2020), a caution against expecting algorithms alone to change outcomes.

• Step 2: Joint assessment

The hospitalist and the tele-ICU intensivist conduct a structured virtual huddle with the bedside nurse and, when relevant, the respiratory therapist. The huddle uses a standard format that covers the clinical picture, severity of illness, anticipated trajectory over the next 12 to 24 hours, the resources needed to meet that trajectory, and the resources actually available that day. Patient goals of care and family preferences are explicitly included, consistent with professional guidance on shared decision-making in the ICU (Kon et al., 2016), and the huddle uses the closed-loop, multidisciplinary communication that is associated with better emergency outcomes (Ohunyon et al., 2023).

• Step 3: Tiered disposition

The team assigns the patient to one of three disposition tiers (Table 1). The tier represents a shared, documented judgment and is revisited whenever the patient's status or the local or regional context changes.

• Step 4: Coordinated action

For patients managed locally, the team implements an agreed plan with explicit reassessment times and pre-specified criteria that would trigger escalation to a higher tier. For patients to be transferred, the tele-ICU team supports stabilization during the wait for transport, assists with identifying an accepting bed, and contributes to a structured handoff that includes the shared assessment, so that the receiving team inherits a coherent picture rather than a fragmented telephone summary. This step draws on frameworks for coordinating emergency response across hospital units (Fapohunda et al., 2025a), for improving patient flow through interdepartmental coordination and digital tracking (Fapohunda et al., 2025c), and for structured care coordination that protects continuity across care transitions (Akinlolu et al., 2023). Facility preparedness and disaster frameworks (Akinlolu et al., 2024), crisis response systems that span several hospitals (Fapohunda et al., 2025b), and humanitarian logistics models that combine predictive analytics with localized distribution (Anene & Clement, 2022) offer further templates for coordinating scarce resources across sites. Continuity after the acute episode, including home health governance and mobile monitoring of chronic disease, reduces the risk that a patient retained locally or returned from a referral center is readmitted (Ogundipe & Ominde, 2024; Oparah et al., 2021b). Care plans that integrate medical, behavioral, and community services around the social determinants of health extend that continuity for underserved patients (Peteranaba et al., 2024).

• Step 5: Review and learning

Selected cases are reviewed jointly: all transfers, unplanned escalations, deaths, and cases in which the hospitalist and intensivist disagreed. Findings feed back into protocols, triggers, education, and transfer agreements.

Table 1: Three-tier disposition model

<i>Tier</i>	<i>Typical patient profile</i>	<i>Care model</i>	<i>Tele-ICU intensity</i>
Tier 1: Retain locally	Moderate illness within local capability; expected stabilization within 24 to 48 hours (e.g., sepsis responding to fluids, DKA without complications, stable noninvasive ventilation)	Hospitalist-managed with protocolized bundles	Scheduled rounds plus continuous surveillance; on-demand consultation
Tier 2: Co-manage locally	Higher-acuity illness that local resources can support with intensive remote input (e.g., low-dose vasopressors, short-term invasive ventilation, while awaiting bed or weather clearance)	Hospitalist at bedside with active tele-intensivist co-management; defined reassessment intervals	Continuous monitoring; frequent video reassessment; real-time order support
Tier 3: Transfer	Need for services unavailable locally (e.g., interventional cardiology, neurosurgery, ECMO, dialysis-dependent shock) or trajectory exceeding local capacity	Expedited transfer with tele-supported stabilization and structured handoff	Active support until departure; assistance with bed search and handoff

Roles and accountability

Clear role definition prevents both gaps in responsibility and conflicting orders. Table 2 summarizes the proposed allocation.

When the hospitalist and tele-intensivist disagree, the framework recommends a defined escalation path, such as a second tele-intensivist opinion or involvement of the rural hospital's medical director, rather than unilateral action. Disagreement is not a failure; it is information, and such cases are prioritized for review. When algorithms inform disposition, accountability for automated recommendations should be explicit, consistent with emerging governance standards for automated decision systems and anti-discrimination law (Annan, 2025; Ominyi & Anichukwueze, 2024), and data sharing across institutions should follow clear privacy governance (Annan, 2022).

Contextual moderators

The same patient may warrant different dispositions on different days. The framework names moderators that legitimately influence the decision and should be made explicit during joint assessment:

Geography and weather, which determine transport time and whether air transport is available. Climate and environmental data can be integrated into mortality risk prediction (Oparah et al., 2024b), environmental exposures shape the underlying burden of illness in many rural and resource-extraction communities (Osinem, Eribenne, Gbaraba, et al., 2025), and inclusive, multilingual emergency alerting systems help communities and facilities respond to severe weather and other hazards (Odejide, 2023, 2024, 2025). Federal hazard mitigation funding offers one route to strengthening the resilience of climate-vulnerable communities and the facilities that serve them (Hilliman et al., 2025).

Referral-center bed availability, which may make a local Tier 2 strategy safer than waiting in a queue for an uncertain transfer. Decision-support tools for hospital operations and resource planning can make this capacity visible in near real time (Adelanwa et al., 2024a), and risk stratification tools

developed for public health emergency preparedness can anticipate regional surges (Oparah et al., 2021a).

Local capability at that moment, including nurse staffing, respiratory therapy availability, and the hospitalist's concurrent workload (Omaghomi et al., 2023).

Patient and family preferences and goals of care, including the value many rural patients place on remaining close to home and family (Kon et al., 2016).

Payment and policy context, including reimbursement for tele-critical care and the rules governing critical access hospitals and the Rural Emergency Hospital designation (Centers for Medicare & Medicaid Services, 2023).

Technology reliability, since a broadband outage, or a cybersecurity incident such as a ransomware attack on a hospital network, can remove the monitoring and EHR access that a Tier 2 plan depends upon (Ozowara et al., 2025); cyber risk and cybersecurity investment also carry measurable financial consequences for hospitals (Adebayo et al., 2023; Ozowara et al., 2022).

Outcomes

Outcomes are organized at four levels. Patient outcomes include risk-adjusted mortality, complications, functional status, and patient and family experience. Functional status can be assessed through activities of daily living, whose support is increasingly framed as a clinical intervention in its own right (Osinem et al., 2021). Because survivors and families may carry trauma-related symptoms after critical illness, follow-up can also draw on integrative treatment-planning models developed for trauma and behavioral dysregulation (Eribenne et al., 2024). Process outcomes include time from trigger to joint assessment, adherence to sepsis and ventilation bundles, door-in-door-out time for transferred patients, and completeness of handoff documentation. System outcomes include the proportion of transfers judged appropriate or potentially avoidable, local ICU occupancy and case-mix retention, costs, and the effect on referral-center capacity. Linking these clinical and financial measures follows the logic of value-based healthcare

Table 2:. Role allocation in the hospitalist-led, tele-ICU-supported model

<i>Function</i>	<i>Rural hospitalist</i>	<i>Tele-ICU team</i>
Clinical leadership	Attending of record; final authority on local care and on requesting transfer	Consultant and co-manager; recommends and, within agreed protocols, may place orders
Surveillance	Bedside assessment; responds to nurse concerns	Continuous trend monitoring; alerts the hospitalist to deterioration
Procedures	Performs within competency (e.g., central line, intubation) with backup plan	Real-time procedural coaching and checklist support
Disposition	Co-assigns tier; communicates with patient and family	Co-assigns tier; offers independent risk assessment and knowledge of regional capacity
Transfer	Requests transfer; completes local documentation	Assists with bed search and contributes to structured handoff
Quality and learning	Participates in joint case review; leads local protocol adaptation	Provides audit data; contributes to education and protocol updates

measurement (Osinem, Eribenne, Peteranaba, et al., 2025a). Workforce outcomes include hospitalist confidence, perceived support, burnout, and recruitment and retention, which are especially important in rural settings where a single departure can destabilize a medical staff. Patient-level and population-level indicators can draw on established quality measure sets such as HEDIS (Ekemezie et al., 2023a).

Propositions

The framework yields the following propositions, each of which can be tested empirically

- P1. Structured joint assessment between the bedside hospitalist and a tele-ICU intensivist will reduce the proportion of potentially avoidable transfers without increasing risk-adjusted mortality among patients retained locally.
- P2. Tele-ICU surveillance combined with nurse-concern triggers will shorten the interval between physiologic deterioration and escalation of care.
- P3. For patients who are transferred, tele-supported stabilization and structured handoff will reduce door-in-door-out time and the frequency of early clinical deterioration or information gaps at the receiving hospital.
- P4. The magnitude of benefit will depend on the degree of integration (shared protocols, shared EHR access, defined roles, and joint case review) rather than on the mere presence of tele-ICU technology.
- P5. Hospitalists working within the model will report greater confidence and lower moral distress in managing critically ill patients, which will in turn be associated with better retention.
- P6. The effects of the model on transfer rates will be moderated by referral-center capacity, distance, and weather, with the greatest relative value during periods of regional strain.

Implications for implementation

The framework reframes tele-ICU in rural hospitals from a monitoring service into structured support for a bedside-led decision. This and the following subsections consider what that shift requires in practice, how it should be evaluated, and where its limits lie.

Using CFIR as a guide, several determinants are likely to shape implementation success (Damschroder et al., 2009).

Intervention characteristics. The model should be adaptable. A small CAH may begin with on-demand consultation for a limited set of conditions, while a larger rural hospital with a dedicated ICU may adopt continuous surveillance. Starting with a high-yield condition such as sepsis allows early wins and builds trust.

Outer setting. Reimbursement for tele-critical care, state licensure and credentialing requirements (credentialing by proxy can reduce administrative burden), and broadband infrastructure are external constraints. Partnerships with a regional health system can align incentives, because the referral center benefits when its beds are reserved for patients who need them most. Financial frameworks developed for safety-net hospitals, which emphasize cost transparency, working-capital management, and access to capital, are relevant to rural facilities facing similar margin pressures (Odeyemi & Idowu, 2025).

Inner setting. Leadership commitment, nursing buy-in, and a culture that treats calling for help as competence rather than weakness are essential. Hospitalists who perceive tele-ICU as surveillance of their performance, or as a threat to their autonomy, are unlikely to engage. The explicit principle of bedside leadership is intended to address this concern directly. Experience in health system transformation suggests that technology yields durable gains only when matched by organizational strategy, operational discipline, and workforce capability (Ilodigwe & Adesemoye, 2024b).

Table 3: Proposed core measures

<i>Domain</i>	<i>Measure</i>	<i>Data source</i>
Structure	Tele-ICU coverage hours; proportion of hospitalists with critical care training; protocol availability	Program records; training logs
Process	Time from trigger to joint assessment; bundle adherence; documentation of disposition tier; handoff completeness	EHR; tele-ICU logs; chart audit
Transfer	Transfer rate per critically ill admission; potentially avoidable transfer rate; door-in-door-out time	Transfer center data; structured review
Patient	Risk-adjusted mortality (local and post-transfer); readmission; patient and family experience	Linked hospital data; surveys
System	Local case-mix retention; cost per episode; referral-center bed-days	Financial and utilization data
Workforce	Hospitalist confidence, burnout, intent to stay; nurse perceptions of support	Validated surveys; interviews

Individuals. Hospitalists benefit from targeted critical care education, including simulation for airway management, ventilator management, and shock resuscitation (Siegal et al., 2012). Work on transitional clinical training in low-resource hospitals highlights the role of supervision models in preparing clinicians for unfamiliar acute care responsibilities (Peteranaba et al., 2023b). Tele-intensivists benefit from orientation to each rural site's capabilities so that their recommendations are realistic for that hospital on that day. Data-informed learning platforms, real-time training dashboards, and learning analytics can track competency development in health professionals (Orise & Niniola, 2020, 2022, 2024b), provided learner data are handled ethically (Orise & Niniola, 2023) and access to training is equitable for clinicians in under-resourced settings (Orise & Niniola, 2024a). Nurse-led interventions have improved outcomes in other populations (Obi et al., 2025) and support an expanded nursing role in surveillance.

Process. Implementation should proceed through engagement of champions in both groups, co-design of protocols and triggers, a pilot phase with frequent feedback, and a measurement plan agreed in advance. Early joint case reviews are valuable not only for quality improvement but also for building the interpersonal trust on which the model depends. Performance intelligence and analytics-driven workflow models (Adelanwa et al., 2024b; Nnaji & Akinlolu, 2023), together with digital operations models that strengthen information flow (Nnaji & Akinlolu, 2024b), can support this feedback loop.

Evaluation agenda

Because tele-ICU effectiveness has varied widely across programs (Kahn et al., 2016), evaluation should measure both outcomes and the fidelity of the decision process. Table 3 proposes a core measure set aligned with the framework. Its structure borrows from tiered, KPI-based accountability models used in quality monitoring (Ekemezie et al., 2023b), and real-world evidence and predictive analytics methods can generate risk-adjusted comparisons from routinely collected

data (Ilodigwe & Adesemoye, 2024a). Indicators should be specified in advance (Rhodes et al., 2012), and implementation outcomes such as acceptability, adoption, fidelity, and sustainability should be measured alongside clinical outcomes (Glasgow et al., 2019; Proctor et al., 2011).

Suitable designs include stepped-wedge cluster implementation across a network of rural hospitals (Hemming et al., 2015), interrupted time series using pre-implementation baselines, and mixed-methods studies that pair quantitative outcomes with qualitative exploration of how hospitalists and tele-intensivists actually reach shared decisions. Defining “potentially avoidable transfer” requires a structured, reproducible review method, such as transfer with a short receiving-hospital stay and no specialized intervention, supplemented by clinician panel review. Equity analyses should examine whether benefits extend across age, race and ethnicity, insurance status, and distance from referral centers, drawing on public health informatics approaches for protecting vulnerable populations (Anioke & Atima, 2023c; Yusuff et al., 2025) and on dashboards and business intelligence tools for transparent resource allocation (Anioke & Atima, 2023a, 2023b; Oparah et al., 2023, 2025; Owoade et al., 2022). Data quality must be audited throughout, as surveillance experience shows how weak data undermine evaluation (Ekemezie et al., 2018; Ogunboye et al., 2023).

Limitations

This is a conceptual framework and has not yet been empirically validated as a whole, although each component draws on existing evidence. Several limitations deserve mention. First, the evidence base for tele-ICU derives mainly from larger hospitals, and effects in very small rural facilities may differ. Second, the model assumes a minimum level of local nursing and respiratory therapy capability; in facilities lacking these, Tier 2 care may not be feasible regardless of tele-support. Third, the framework depends on reliable connectivity, which remains a challenge in parts of rural America. Fourth, financial sustainability is uncertain and will

depend on payment policy and health-system partnerships (Odeyemi & Idowu, 2025). Finally, shared decision-making between two physicians introduces questions of liability and accountability that must be addressed through governance agreements, and these vary by jurisdiction.

CONCLUSION

Rural hospitals will continue to care for critically ill patients, and the hospitalist will continue to be the physician at the bedside. The question is whether that physician will make high-stakes care and transfer decisions alone, or as the leader of a deliberately designed, tele-supported team. The framework presented here proposes the latter. By pairing bedside leadership with remote intensivist expertise, structuring the decision through a shared cycle and a tiered disposition model, making contextual factors explicit, and building in continuous learning, the model aims to keep patients close to home when that is safe, to transfer them promptly and well when it is not, and to sustain the rural clinicians on whom these communities depend. The propositions and evaluation agenda offered here are intended to move the field from promising programs toward a tested, generalizable model of rural critical care.

DECLARATIONS

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflicts of interest

The authors declare no conflicts of interest.

Data availability

No new data were generated or analyzed. This article is based on previously published literature cited in the reference list.

Author contributions

[To be completed by the authors.]

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