Saudi Journal of Medicine and Public Health

https://saudijmph.com/index.php/pub

https://doi.org/10.64483/202412564

A Silent Storm: A Narrative Review of Systemic Manifestations of Odontogenic Infections and a Framework for Interdisciplinary Recognition from Pre-Hospital Care to Rehabilitation

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Abstract

Background: Odontogenic infections can progress from dental structures to cause severe, life-threatening systemic complications. These conditions represent a critical intersection of dental, emergency, critical care, and rehabilitation medicine, yet physical therapists' role in this continuum remains underrecognized. **Aim:** This narrative review synthesizes evidence on the pathophysiology, recognition, and interdisciplinary management of severe systemic complications from oral infections, proposing an integrated framework for early detection and rehabilitation from paramedic contact through ICU to physical therapy. **Methods:** A comprehensive literature search was conducted across PubMed, Scopus, and CINAHL (2010-2024). Included studies focused on epidemiology, management, and rehabilitation of severe odontogenic infections with systemic spread. **Results:** The review delineates infection pathways, identifies clinical red flags, and highlights rehabilitation needs. Two original frameworks are presented: a pre-hospital screening tool for paramedics/nurses and an integrated rehabilitation protocol incorporating physical therapy. **Conclusion:** Effective management demands seamless collaboration between all involved professions, including physical therapy for functional recovery. Standardized interdisciplinary protocols can significantly reduce morbidity and mortality while optimizing long-term outcomes.

Keywords: Odontogenic Infection, Sepsis, Interdisciplinary Care, Critical Care, Physical Therapy

Introduction

The oral cavity serves as a potential gateway for severe systemic disease with implications extending far beyond acute management into long-term functional recovery. Odontogenic infections—originating from teeth or supporting structures—represent a significant clinical challenge that transcends traditional professional boundaries (Hayek et al., 2019). What begins as localized dental pathology can, through complex anatomical pathways, evolve into life-threatening conditions such as Ludwig's angina, descending necrotizing mediastinitis, and cavernous sinus thrombosis, ultimately triggering sepsis and multi-organ failure (Caruso et al., 2022). While acute management rightly focuses on airway protection, surgical intervention, and antimicrobial therapy, the profound functional consequences of these severe infections and their treatments remain inadequately addressed in current care models. Patients frequently experience prolonged critical illness, significant deconditioning, neurological sequelae, and musculoskeletal impairments that directly impact their ability to return to pre-morbid functional status (Qu et al., 2018).

This review posits that optimal outcomes require an expanded interdisciplinary approach that integrates physical therapy from the earliest appropriate point in the care continuum. The management of severe odontogenic infections represents a critical nexus connecting dentistry,

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Receive Date: 22 December 2024, Revise Date: 30 December 2024, Accept Date: 31 December 2024

emergency medicine, paramedic science, nursing, critical care, and rehabilitation. We will synthesize current evidence on systemic manifestations and propose a structured framework for recognition, triage, and rehabilitation that specifically incorporates physical therapists as essential partners in recovery, addressing the gap between life-saving intervention and functional restoration.

Methodology

This narrative review employed a structured search strategy to capture contemporary literature on systemic complications of odontogenic infections and rehabilitation outcomes. Electronic databases PubMed, Scopus, CINAHL, and PEDro were searched for English-language articles published between January 2010 and December 2024. Search terms included: "odontogenic infection," "severe," "systemic," "Ludwig's angina," "descending necrotizing mediastinitis," "cavernous sinus thrombosis," "sepsis," "rehabilitation," "physical therapy," "deconditioning," "critical illness," "paramedic," "triage," "emergency nursing," and "interdisciplinary care." Boolean operators (AND, OR) combine terms. Inclusion criteria encompassed clinical trials, observational studies, case series (>10 patients), systematic reviews, and guidelines addressing acute management or rehabilitation. Articles focusing solely on localized infection without systemic spread or rehabilitation relevance were excluded. Data on epidemiology, management, rehabilitation outcomes, and interdisciplinary roles were extracted and thematically organized to construct this narrative and inform proposed clinical frameworks.

The Anatomical and Functional Consequences of Infection Spread

The propensity of odontogenic infections to cause systemic havoc is rooted in intricate anatomy with direct implications for functional recovery. Infections from mandibular molars can spread to submandibular and sublingual spaces, initiating Ludwig's angina, which often necessitates surgical airway management that can impact swallowing mechanics and cervical mobility long-term (Flynn, 2011). Descending necrotizing mediastinitis, traveling along cervical fascial planes to the thorax, frequently requires extensive thoracic surgical interventions that result in significant pain, respiratory compromise, and impaired shoulder girdle function (Reuter et al., 2023).

Neurological sequelae present particularly complex rehabilitation challenges. Cavernous sinus thrombosis can cause permanent cranial nerve deficits (III, IV, V, VI), resulting in diplopia, ptosis, facial sensory loss, and impaired ocular motility that profoundly affect balance, mobility, and activities of daily living (Craig et al., 2022). Furthermore, the systemic inflammatory response and prolonged ICU stays associated with severe sepsis lead to critical illness polyneuropathy and myopathy, characterized by symmetrical weakness, decreased deep tendon reflexes, and difficulty weaning from mechanical ventilation—conditions where early physical therapy intervention is crucial (Valerio et al., 2020). The microbiological profile, typically polymicrobial with tissue-invasive organisms like Fusobacterium necrophorum, contributes to the severity of tissue destruction and subsequent scar formation that can limit the range of motion, particularly in cervical and thoracic regions (Brooks et al., 2022). Figure 1 illustrates the progression of odontogenic infections from a primary dental focus to deep cervical fascial spaces and systemic involvement.

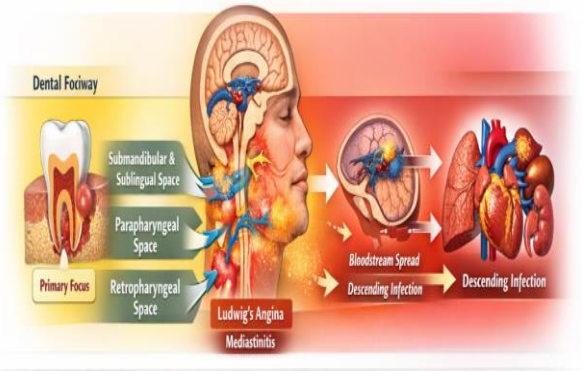

Figure 1. Anatomical Pathways and Systemic Spread of Odontogenic Infections

Life-Threatening Systemic Complications

Airway Compromise: Acute and Post-Acute Considerations

Ludwig's angina and deep neck space infections represent immediate airway emergencies requiring prompt surgical intervention (Bridwell et al., 2021). Beyond acute management, patients often experience prolonged trismus, cervical stiffness, and dysphagia resulting from both the infection and surgical access. These impairments directly impact nutritional intake, communication, and cervical mobility, necessitating structured rehabilitation (McDonnough et al., 2019). Physical therapists play a vital role in managing cervicofacial edema, restoring mandibular range of motion through therapeutic exercises, and addressing postural adaptations that develop during recovery (Kumar & Ambikavathy, 2012).

Descending Necrotizing Mediastinitis (DNM): Thoracic Implications

DNM's fulminant course typically requires aggressive thoracic debridement, often via thoracotomy, resulting in significant chest wall trauma. Patients develop restrictive pulmonary patterns, impaired cough effectiveness, and shoulder dysfunction due to pain and muscular inhibition (Sugio et al., 2021). Early mobilization and respiratory physiotherapy are essential to prevent pulmonary complications, while later stages require structured programs to restore thoracic mobility, scapulothoracic rhythm, and functional strength for activities involving upper body exertion.

Intracranial Complications: Neurological Rehabilitation

Cavernous sinus thrombosis presents unique rehabilitation challenges. Cranial neuropathies may result in persistent diplopia requiring prism lenses or occlusion therapy, impaired facial sensation affecting safety during eating, and compromised ocular motility affecting depth perception and balance (de Almeida et al., 2022). Physical therapists must address vestibulo-ocular dysfunction, implement fall prevention strategies for patients with visual-field deficits or diplopia, and develop adaptive approaches for mobility and ADLs in the context of persistent neurological impairment.

Sepsis and Critical Illness: Multisystem Deconditioning

Odontogenic sepsis often precipitates prolonged ICU stays, leading to the post-intensive care syndrome (PICS) constellation: muscle wasting, neuropathy, cognitive impairment, and mental health disorders (Goodacre et al., 2023). The rehabilitation needs are comprehensive, requiring physical therapists to address severe deconditioning through progressive mobilization, manage neuropathic pain, collaborate on cognitive rehabilitation strategies, and implement energy conservation techniques for patients with significantly reduced exercise tolerance (Morton et al., 2018).

The First Medical Contact: Paramedic Suspicion and Early Alert

Paramedics serve as crucial first responders in the odontogenic sepsis cascade. Their assessment in resource-limited environments must distinguish routine dental complaints from impending systemic emergencies. Key findings that should elevate suspicion include: Airway/Dysphagia Signs (stridor, drooling, "hot potato" voice); Systemic Signs (tachycardia disproportionate to pain, fever, hypotension); Swelling Characteristics (rapid progression, board-like neck swelling, trismus <2cm); and Neurological Signs (altered mentation, periorbital edema with cranial nerve findings) (Barlow, 2019; Riekert et al., 2019).

Beyond immediate management, paramedics can initiate the rehabilitation continuum through careful patient handling that considers potential cervical instability in extensive neck infections and early documentation of neurological status that provides baseline data for later rehabilitation assessment (Mukherji et al., 2019). Communication to the receiving ED must explicitly mention the suspected dental source and systemic red flags using structured tools like ATMIST, specifically noting any neurological deficits or functional limitations observed (Flynn et al., 2016).

Table 1: Pre-Hospital Odontogenic Infection Triage (POINT) Screening Tool for Paramedics

Category	Findings	Action Trigger
Airway	Stridor, drooling, dysphagia, voice change, tongue elevation.	**IMMEDIATE:** High-flow O2, rapid transport, alert ED to potential difficult airway/septic shock.
Breathing	Tachypnea (>22 rpm), SpO2 <94% on room air.	**URGENT:** O2 therapy, monitor for respiratory fatigue.
Circulation	Tachycardia (>100 bpm)*, hypotension (SBP <100 mmHg).	**URGENT:** IV access, fluid challenge per protocol, monitor for shock.
Disability (Neuro)	Altered GCS, periorbital edema with eye movement issues, facial asymmetry.	**URGENT:** Document neuro findings as rehab baseline; rapid transport.
Exposure (Swelling/Function)	Hard, rapidly expanding neck swelling; trismus; note any functional limitation (arm raise, grip).	**URGENT:** Document location/progression; note functional impairments for rehab team.

Hospital Care: Nursing Surveillance and Rehabilitation Initiation

Upon hospital arrival, nursing staff assume central surveillance and coordination roles, with increasing recognition of their part in early rehabilitation initiation. Monitoring extends beyond vital signs to include functional assessments that inform rehabilitation planning (Kabil et al., 2021).

Key nursing actions with rehabilitation implications include: Early Mobility Facilitation: Collaborating with physical therapists to implement early mobilization protocols for stable septic patients, even while in the ICU, to prevent deconditioning (Ramos-Zayas et al., 2021). Swelling and Function Documentation: Serial measurement of neck circumference and inter-incisal distance provides objective data for physical therapists managing trismus and cervical mobility. Neurological Baseline Documentation: Detailed recording of initial cranial nerve deficits, strength, and sensation establishes a crucial baseline for rehabilitation progress monitoring (Heim et al., 2019). Pain Management for Function: Administering analgesia to facilitate participation in physical therapy sessions rather than merely achieving pain score targets (Table 2).

Table 2: Integrated Hospital Assessment Protocol for Odontogenic Infections (IHAP-OI)

Parameter	Frequency (Initial 24 hrs)	Interdisciplinary Action
Airway & Breathing	Hourly respiratory parameters; daily cough effectiveness.	RN: Airway vigilance. **PT:** Begin breathing exercises when stable.
Circulation & Sepsis	Hourly vitals; daily lactate if elevated.	RN/MD: Sepsis protocol. **PT:** Initiate bed mobility/positioning per hemodynamic stability.
Swelling & Mobility	4-hourly neck circumference; daily cervical AROM.	RN: Document progression. **PT:** Begin gentle ROM exercises for trismus/cervical spine when acute phase resolves.
Neurological Function	4-hourly GCS; daily cranial nerve screen.	RN: Document deficits. **PT/OT:** Baseline functional assessment; commence neuro rehab if deficits present.
Functional Status	Daily assessment of bed mobility, sitting balance.	**PT:** Formal evaluation; progressive mobility protocol. **RN:** Assist with mobility per PT plan.

The Essential Role of Physical Therapy in Functional Recovery Across the Care Continuum

Physical therapists provide indispensable expertise throughout the recovery trajectory of severe odontogenic infections, addressing multifaceted impairments that stem from both the pathophysiology of the infection and the necessary but invasive treatments (Thompson et al., 2019). Their role bridges the gap between critical care survival and meaningful functional restoration, targeting the neuromuscular, cardiopulmonary, and musculoskeletal sequelae that frequently persist long after infection resolution.

During the ICU and Acute Phase, the primary physical therapy focus shifts to mitigating the profound effects of critical illness and immobility. Interventions are carefully calibrated to hemodynamic stability and include positioning strategies to manage edema and prevent pressure injuries, along with passive and later active-assisted range of motion exercises to preserve joint integrity (Wong et al., 2015). For patients with extensive cervical involvement or post-surgical status from neck explorations, therapists must ensure cervical spine protection protocols are maintained while initiating early, gentle scapular mobilization and thoracic breathing exercises. This proactive approach is crucial to prevent the secondary stiffness and restrictive pulmonary patterns that can complicate recovery (Wang et al., 2022). Early mobilization protocols, even at the level of sitting at the edge of the bed or standing with support, are initiated as soon as clinically feasible to combat critical illness polyneuropathy and myopathy, which are common in sepsis survivors (Weise et al., 2019).

As patients transition to the Post-Acute and Outpatient Rehabilitation phases, physical therapy interventions become more intensive and specifically targeted. Cervicothoracic rehabilitation is paramount, as surgical access, scar tissue formation, and prolonged guarding lead to significant restrictions in neck and shoulder girdle mobility. This is addressed through a combination of manual therapy, therapeutic exercises for deep neck flexor and scapular stabilizer strengthening, and comprehensive postural retraining to reverse adaptations acquired during the acute illness (Sugio et al., 2021). For patients with neurological sequelae such as cranial nerve deficits from cavernous sinus thrombosis, rehabilitation is particularly specialized. Interventions may include vestibular rehabilitation for balance disorders secondary to vestibulocochlear nerve involvement or oculomotor dysfunction, often in close collaboration with ophthalmology or neuro-optometry (Alves & Deana, 2016).

Sensory reintegration techniques are employed for managing facial hypoesthesia, and compensatory strategies are taught for activities of daily living impacted by ptosis or diplopia. Managing systemic deconditioning requires implementing graded, functional exercise programs that progressively address deficits in strength, cardiovascular endurance, and overall fatigue management, utilizing energy conservation techniques to facilitate participation (Rababa et al., 2022). Furthermore, while dysphagia management falls primarily within the speech-language pathology domain, physical therapists play a supportive role by optimizing respiratory mechanics for effective cough clearance and coordinating breathing patterns to aid swallowing rehabilitation, thereby addressing the intricate link between airway protection and pulmonary health (Thiele et al., 2018).

Recommendations and Conclusion

The optimal management of severe odontogenic infections necessitates the deliberate dismantling of professional silos to create a seamless, patient-centered continuum from emergency response to functional restoration and community reintegration. Achieving this requires systemic changes in education, communication, and clinical protocols. We propose the following evidence-based recommendations to foster this essential integration. First, the development of interdisciplinary education modules is critical. Joint training for paramedics, nurses, and physical therapists should focus not only on the recognition of severe odontogenic infections but also on cultivating a deep understanding of each profession's distinct and complementary role across

the care continuum, thereby fostering mutual respect and anticipatory collaboration (Mukherji et al., 2019; Hayek et al., 2019).

Second, healthcare institutions must formalize early rehabilitation integration through clear, protocol-driven referral pathways to physical therapy. Criteria for ICU consultation should be established, such as a diagnosis of sepsis, anticipation of prolonged mechanical ventilation, or the presence of observed neurological deficits, ensuring that rehabilitation begins at the earliest safe opportunity to mitigate the effects of prolonged immobility (Ramos-Zayas et al., 2021). Third, the implementation of standardized interdisciplinary communication tools is non-negotiable for ensuring continuity. Handover frameworks should be adapted to include functional status metrics—such as mobility level, specific neuromuscular impairments, and exercise tolerance—alongside traditional medical data, ensuring crucial rehabilitation information is transmitted from the emergency department through to the ward and outpatient settings (Fitzpatrick et al., 2018).

Fourth, the structure of care delivery should be reformed to include regular interdisciplinary rounds that actively involve all key professions, including physical therapy. These rounds serve to simultaneously coordinate acute medical management and rehabilitation planning, allowing for real-time adjustment of goals based on the patient's evolving clinical and functional status (Pham Dang et al., 2020). Finally, the creation of structured long-term follow-up protocols is essential to address late-emerging or persistent complications, such as chronic trismus, thoracic stiffness, or residual balance disorders, ensuring patients have access to targeted outpatient rehabilitation resources to achieve their fullest recovery potential (Weise et al., 2019).

In conclusion, severe odontogenic infections represent a profound biomedical and rehabilitative challenge that extends far beyond the immediate goal of survival to encompass the complex journey of functional recovery. By strategically expanding the traditional interdisciplinary team to include physical therapists as core members from the early stages of acute care, healthcare systems can significantly improve long-term patient outcomes, reducing disability and enhancing quality of life. The proposed frameworks of the Pre-Hospital Odontogenic Infection Triage (POINT) tool and the Integrated Hospital Assessment Protocol for Odontogenic Infections (IHAP-OI) provide practical, actionable structures for improving recognition, triage, and integrated management. Ultimately, the goal is to transform the patient journey from one defined by surviving a life-threatening infection to one characterized by achieving optimal functional recovery and successful community reintegration. This vision can only be realized through truly collaborative, person-centered care that recognizes, values, and leverages the unique contribution of every profession involved—from the first paramedic response on the street to the sustained support of rehabilitation professionals guiding the path back to daily life.

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