

# Orthodontic Maxillofacial Skeletal Expansion for Obstructive Sleep Apnea in Patients with Heart Failure: A Multidisciplinary Care Framework Integrating Cephalometric/Echocardiographic Imaging, Pharmacist-Led Medication Review, and Nurse-Led Compliance Monitoring

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## HOW TO CITE: | ABSTRACT:

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**Background:** Obstructive sleep apnea (OSA), heart failure (HF), and major depressive disorder (MDD) frequently coexist and can interact through intermittent hypoxemia, autonomic activation, sleep fragmentation, neuroendocrine dysregulation, treatment burden, and reduced adherence. In selected adults, transverse maxillary deficiency may contribute to increased nasal resistance and upper-airway vulnerability.

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 Orthodontic Maxillofacial Skeletal  
 Expansion for Obstructive Sleep  
 Apnea in Patients with Heart Failure:  
 A Multidisciplinary Care Framework  
 Integrating  
 Cephalometric/Echocardiographic  
 Imaging, Pharmacist-Led Medication  
 Review, and Nurse-Led Compliance  
 Monitoring.  
 International Journal of Special  
 Education, 41(23s), 1179 - 1192

**Objective:** To develop an evidence-informed, multidisciplinary clinical framework for evaluating and managing skeletally mature adults with OSA, HF, and MDD in whom transverse maxillary deficiency is considered a potentially modifiable anatomical contributor to sleep-disordered breathing.

**Framework:** The proposed pathway integrates sleep medicine/pulmonology, cardiology, orthodontics/dentofacial orthopedics, oral and maxillofacial surgery, otolaryngology, dentistry/dental sleep medicine, diagnostic and oral/maxillofacial radiology, psychiatry, clinical pharmacy, nursing, family medicine/primary care, psychology, nutrition, rehabilitation, anesthesiology/perioperative medicine, public health, health services administration, biomedical engineering, and health informatics. Cone-beam computed tomography (CBCT) and cephalometric assessment are paired with transthoracic echocardiography (TTE), while polysomnography, medication reconciliation, psychometric assessment, and remote monitoring provide longitudinal clinical measures.

**Evidence and limitations:** MARPE, MSE, and DOME/SARPE can produce skeletal transverse changes in selected adults, and some studies report improvements in upper-airway anatomy or respiratory measures. However, the evidence base is heterogeneous, and there is currently no established evidence that maxillary expansion improves HF outcomes or MDD itself. Therefore, the framework is a research and care-coordination model rather than a recommendation to replace continuous positive airway pressure (CPAP), guideline-directed HF therapy, or evidence-based psychiatric treatment.

**Conclusions:** An anatomically informed, multidisciplinary pathway may improve patient selection, procedural safety, adherence, measurement, and coordination of care. Its clinical effectiveness and effects on cardiovascular and psychiatric outcomes require prospective, adequately powered, multicenter comparative studies.

**Keywords:** obstructive sleep apnea, heart failure, major depressive disorder, maxillary skeletal expansion, MARPE, MSE, DOME, radiology, nursing, cardiology, clinical pharmacy, dentistry, psychiatry, multidisciplinary care.

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## 1. Introduction

Obstructive sleep apnea (OSA) is characterized by recurrent partial or complete upper-airway obstruction during sleep, producing intermittent hypoxemia, sleep fragmentation, and autonomic

fluctuations. Its association with cardiovascular disease is particularly important in patients with heart failure (HF), in whom OSA is common and may add hemodynamic, sympathetic, and metabolic stress. The American Heart Association scientific statement recommends

formal sleep assessment in symptomatic patients with New York Heart Association (NYHA) class II–IV HF when sleep-disordered breathing is suspected. [1]

Depressive disorders are also common in HF and are associated with poorer quality of life, self-care, and clinical outcomes. [2] Importantly, randomized evidence does not support the assumption that treating depression with an SSRI alone will improve HF outcomes. In SADHART-CHF, sertraline did not produce greater improvement in depression or cardiovascular status than placebo over 12 weeks. [3] In MOOD-HF, escitalopram did not reduce the composite of all-cause mortality or hospitalization for worsening HF, although mood symptoms can still require appropriate psychiatric treatment. [4] These findings should not be interpreted as evidence against antidepressant treatment when clinically indicated; rather, they emphasize that psychiatric treatment does not substitute for treatment of coexisting sleep-disordered breathing or HF.

Conventional management of OSA remains based on evidence-supported therapies, including CPAP for appropriate patients, oral appliance therapy in selected patients, behavioral measures, and other phenotype-directed interventions. [1,5] In patients with significant cardiorespiratory disease, diagnostic testing should be integrated with a comprehensive sleep evaluation; the American Academy of Sleep Medicine recommends polysomnography rather than home sleep apnea testing in patients with significant cardiorespiratory disease. [5]

A distinct anatomical phenotype is relevant to this framework: adults with transverse maxillary deficiency, a high-arched palate, and a narrow nasal floor may have increased nasal resistance and altered upper-airway geometry. Adult skeletal expansion techniques such as miniscrew-assisted rapid palatal expansion (MARPE), maxillary skeletal expansion (MSE), and distraction osteogenesis maxillary expansion (DOME), with surgically assisted rapid palatal expansion (SARPE) as an alternative in selected patients, can produce skeletal transverse

changes. [6–10] However, the evidence is not sufficient to establish skeletal expansion as a replacement for CPAP or as a treatment for HF or MDD.

The purpose of this manuscript is therefore not to claim a proven cardiovascular or psychiatric benefit from maxillary expansion. Instead, it proposes a clinically disciplined framework in which anatomical assessment is combined with cardiopulmonary, psychiatric, pharmacological, nursing, primary-care, dental, surgical, imaging, rehabilitation, public-health, and health-system expertise. The framework is intended to improve selection, safety, measurement, adherence, and trial readiness.

## 2. Scope, Framework Development, and Evidence Status

This manuscript is an evidence-informed conceptual framework rather than a systematic review, meta-analysis, or report of original clinical outcomes. The framework was constructed around contemporary clinical guidelines, randomized trials relevant to HF and depression, systematic or umbrella reviews of adult skeletal expansion, imaging studies, and evidence on HF telemonitoring and integrated care. [1–10,12–22] No patient-level data were analyzed and no treatment effect is estimated.

The evidence should be interpreted hierarchically. Established components include diagnostic evaluation of OSA, guideline-directed medical therapy (GDMT) for HF, evidence-based psychiatric assessment and treatment, and multidisciplinary follow-up. [1,5,11–15] Skeletal expansion is a phenotype-directed intervention with growing but heterogeneous evidence for anatomical and respiratory effects in selected adults. [6–10] The proposed link from anatomical expansion to HF or MDD improvement is mechanistic and hypothesis-generating, not clinically established.

Accordingly, the manuscript distinguishes three levels of statements: (1) established clinical practice and guideline-supported care; (2) findings reported in studies of skeletal expansion; and (3) proposed mechanisms or research hypotheses. This distinction is essential

for publication-quality interpretation and prevents the framework from being read as a new standard of care.

### 3. The OSA–HF–MDD Axis: Mechanistic Integration

OSA can impose repeated negative intrathoracic pressure swings, intermittent hypoxemia, arousals, and sympathetic activation. These changes can increase LV transmural pressure and afterload and can alter ventricular filling through ventricular interdependence. [1] In HF, fluid redistribution during recumbency may increase peripharyngeal tissue volume and further narrow the upper airway, creating a potentially reinforcing physiological relationship.

Intermittent hypoxemia and recurrent arousals activate sympathetic and neuroendocrine pathways. In parallel, depression may be associated with autonomic imbalance, altered hypothalamic–pituitary–adrenal-axis function, sleep disturbance, and reduced self-management. [1,2] The combined burden can increase treatment complexity, but causal pathways are multifactorial and should not be reduced to a single inflammatory or neurohormonal mechanism.

Systemic inflammation, oxidative stress, endothelial dysfunction, and altered vascular regulation have been proposed as biological links between OSA and cardiovascular disease. [1] Similar inflammatory and stress-related pathways have been investigated in depression. [2] Because these pathways are neither specific to OSA nor sufficient to explain MDD or HF progression, they should be regarded as contributory rather than deterministic.

The clinical implication is that no single specialty can safely own the entire problem. Sleep medicine establishes the sleep diagnosis and treatment response; cardiology determines hemodynamic stability and HF therapy; psychiatry and psychology manage MDD and safety; dental and orthodontic teams assess craniofacial anatomy; oral and maxillofacial surgery and otolaryngology evaluate surgical and upper-airway considerations; radiology quantifies anatomy; pharmacy manages

medication risk; nursing coordinates longitudinal monitoring; and primary care, public health, rehabilitation, nutrition, health informatics, and health-services teams support continuity and population-level implementation.

### 4. Maxillofacial Skeletal Expansion: Indications, Mechanisms, and Evidence Boundaries

In growing patients, conventional rapid palatal expansion can separate the midpalatal suture with substantial orthopedic effect. In skeletally mature adults, skeletal resistance is greater and conventional tooth-borne expansion may produce more dentoalveolar compensation. MARPE/MSE uses temporary skeletal anchorage to transfer expansion forces toward the maxillary basal bone. The umbrella review by Ventura et al. concluded that MARPE can produce clinically meaningful changes but also emphasized limitations in the quality of the available systematic-review evidence. [6]

CBCT studies have demonstrated changes in the midpalatal and pterygopalatine sutures after micro-implant-supported skeletal expansion. [7] A comparative study of mini-implant-assisted rapid maxillary expansion also reported changes in upper-airway anatomy and respiratory function in young adults. [8] DOME has been described for selected adults with OSA and a narrow maxilla/high-arched palate, with early clinical series reporting feasibility and respiratory outcomes. [9,10] These studies are important but are not equivalent to randomized evidence demonstrating reductions in HF events or remission of MDD.

Patient selection should therefore be phenotype-based. Candidate assessment should document transverse maxillary deficiency, dental and periodontal status, skeletal maturity, nasal anatomy, OSA phenotype, previous OSA treatment, HF stability, psychiatric status, medication burden, and ability to participate in follow-up. Expansion should not be offered solely because OSA is present.

MARPE/MSE, DOME, and SARPE should be considered distinct interventions rather than interchangeable labels. The choice depends on

skeletal maturity, suture morphology, transverse deficiency, previous expansion attempts, anatomy, surgical risk, and operator expertise. Evidence should be reported separately by technique in future trials.

### 5. Diagnostic and Monitoring Architecture

**Sleep assessment:** Baseline and follow-up polysomnography should quantify AHI, oxygen-desaturation index (ODI), arousal burden, sleep architecture, and oxygenation. In patients with significant cardiorespiratory disease, PSG is preferred over home testing. [5] CPAP or another established therapy should not be withheld while the anatomical pathway is being evaluated.

**Craniofacial and dental assessment:** Orthodontics, dentofacial orthopedics, dentistry/dental sleep medicine, and oral and maxillofacial surgery should document transverse skeletal deficiency, occlusion, periodontal status, palatal morphology, nasal symptoms, and suitability for skeletal anchorage. CBCT should be justified clinically and acquired using the lowest dose compatible with the diagnostic task.

**Radiology:** Diagnostic and oral/maxillofacial radiologists should supervise imaging protocols, landmark definitions, segmentation quality, and reproducibility. Suggested measures include anterior and posterior skeletal width, nasal-cavity dimensions, minimum cross-sectional airway area, and selected airway volumes. Repeated CBCT should be minimized and justified because the framework is longitudinal.

**Cardiac assessment:** Baseline TTE should include LVEF, LV diastolic parameters, and appropriate right-ventricular assessment. Speckle-tracking measures such as LV global longitudinal strain (LV-GLS) may provide sensitive measures of myocardial function, but they should be interpreted according to contemporary echocardiographic standards rather than as a specific surrogate for OSA improvement. [12,13]

**Psychiatric and psychological assessment:** A structured psychiatric evaluation should

establish diagnosis, severity, suicide risk, current treatment, sleep-related symptoms, and adherence barriers. PHQ-9 is suitable for longitudinal symptom measurement, while the Beck Depression Inventory may be used when clinically appropriate. [17,18] A positive suicide-risk signal requires immediate clinical assessment; it should never be treated as a routine telemonitoring alert.

### 6. Clinical Pharmacy Governance

Clinical pharmacy should be embedded from baseline rather than added after an adverse event. HF medications should remain aligned with contemporary GDMT. The 2022 AHA/ACC/HFSA guideline identifies four foundational medication classes for HFrEF: ARNI/ACE inhibitor/ARB-based renin-angiotensin system inhibition, evidence-based beta-blockers, mineralocorticoid receptor antagonists, and SGLT2 inhibitors. [11]

Medication review should include renal function, potassium, blood pressure, volume status, QT-prolonging drugs, sedative burden, and clinically important CYP-mediated interactions. QTc risk is particularly relevant when multiple QT-prolonging agents or electrolyte abnormalities coexist. [14] However, antidepressants should not be stopped simply because OSA or HF is present; deprescribing should be individualized and coordinated with psychiatry.

Sedative-hypnotic reduction may be considered when these agents worsen respiratory safety, cognition, falls, or sleep architecture, but tapering must be clinically supervised. The pharmacist should also review analgesics, anticholinergic medications, antipsychotics, anticoagulants/antiplatelets, and peri-procedural medications when surgery is planned.

### 7. Nursing, Remote Monitoring, and Patient Engagement

Nurses are central to the operational pathway because they connect daily patient behavior with multidisciplinary decision-making. Evidence from HF telemonitoring supports the use of remote monitoring as part of integrated care,

although effects vary by technology, implementation model, and patient population. [16]

A practical monitoring bundle can include weight, blood pressure, symptoms, medication adherence, nocturnal oxygenation when clinically justified, appliance activation logs, appointment attendance, and patient-reported outcomes. Alert thresholds should be locally validated rather than presented as universal cut-points. Weight gain, hypotension, worsening dyspnea, persistent hypoxemia, or new

arrhythmia symptoms should trigger clinical review according to the patient's HF plan.

Nurses can also deliver structured education, motivational interviewing, and coordination with family caregivers. They should document appliance discomfort, oral hygiene problems, pain, missed activations, and barriers to transportation or digital access. Psychological deterioration should be escalated to the treating mental-health team rather than managed solely through automated scores.

**Table 1. Multidisciplinary team, responsibilities, and points of integration**

| Specialty/discipline                      | Core responsibility                                                                       | Primary integration point         |
|-------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------|
| Sleep medicine / pulmonology              | OSA diagnosis, PSG interpretation, CPAP and sleep-therapy management, objective follow-up | Baseline; intervention; follow-up |
| Cardiology / heart-failure medicine       | HF phenotype, stability, GDMT, volume status, echocardiography                            | All phases                        |
| Orthodontics / dentofacial orthopedics    | Craniofacial diagnosis, appliance selection, activation, retention                        | Baseline; intervention; follow-up |
| Dentistry / dental sleep medicine         | Oral health, periodontal/occlusal assessment, oral-appliance options                      | Baseline; follow-up               |
| Oral and maxillofacial surgery            | Surgical feasibility, DOME/SARPE, perioperative planning                                  | Pre-intervention; intervention    |
| Otolaryngology / head-and-neck surgery    | Nasal and upper-airway assessment; alternative surgical pathology                         | Baseline; intervention; follow-up |
| Diagnostic oral/maxillofacial radiology & | CBCT protocol, dose optimization, segmentation, imaging quality                           | Baseline; follow-up               |
| Psychiatry                                | MDD diagnosis, treatment, medication decisions, suicide-risk management                   | All phases                        |
| Clinical psychology / behavioral health   | Behavioral assessment, adherence, CBT-informed support, coping strategies                 | Baseline; monitoring              |
| Clinical pharmacy                         | Medication reconciliation, GDMT support, QT/CYP risk, deprescribing coordination          | All phases                        |
| Nursing                                   | Education, remote monitoring, adherence, symptom surveillance, escalation                 | All phases                        |
| Family medicine / primary care            | Longitudinal care, prevention, referral coordination, chronic-disease management          | All phases                        |

|                                                  |                                                                                         |                                |
|--------------------------------------------------|-----------------------------------------------------------------------------------------|--------------------------------|
| Nutrition / dietetics                            | Weight management and individualized HF nutrition support                               | Baseline; follow-up            |
| Physiotherapy / cardiac-pulmonary rehabilitation | Functional capacity, exercise prescription, rehabilitation                              | Baseline; follow-up            |
| Anesthesiology / perioperative medicine          | Risk assessment and perioperative planning for surgical candidates                      | Pre-intervention; intervention |
| Biomedical engineering / health informatics      | Device integration, data interoperability, AI-assisted segmentation, monitoring systems | Translational                  |
| Public health                                    | Targeted case-finding, access, equity, population implementation                        | System level                   |
| Health services administration / management      | Governance, referral pathways, reimbursement, workforce, quality metrics                | System level                   |

### 8. Expanded Multidisciplinary Team: Explicit Coverage of Clinical and Health-System Specialties

The pathway should explicitly recognize the following specialties and disciplines: sleep medicine/pulmonology; cardiology/heart-failure medicine; orthodontics/dentofacial orthopedics; dentistry/dental sleep medicine; oral and maxillofacial surgery; otolaryngology/head-and-neck surgery; diagnostic radiology and oral/maxillofacial radiology; psychiatry; clinical psychology/behavioral health; clinical pharmacy; nursing; family medicine/primary care; nutrition/dietetics; physiotherapy and cardiac/pulmonary rehabilitation; anesthesiology/perioperative medicine; biomedical engineering; health informatics; public health; and health services administration/health-system management.

Family medicine and primary care provide longitudinal risk-factor management, preventive care, medication reconciliation, coordination after hospital discharge, and referral back to specialist services. Evidence from integrated HF models supports stronger links between primary and secondary care. [19,20]

Dentistry and dental sleep medicine contribute oral, periodontal, occlusal, temporomandibular, and appliance-related assessment and help

coordinate alternative oral-airway therapies. Orthodontics and oral/maxillofacial surgery determine whether skeletal expansion is anatomically and surgically appropriate. Otolaryngology evaluates nasal and upper-airway pathology that may require parallel management.

Nutrition and rehabilitation services should address obesity, physical deconditioning, exercise tolerance, dietary sodium and fluid considerations when clinically indicated, and sustainable self-management. These services are adjunctive and should be individualized to HF phenotype and comorbidity rather than assumed to be interchangeable with OSA therapy.

Public health and health-services administration address screening pathways, access disparities, workforce requirements, referral delays, reimbursement, quality indicators, and scalability. OSA screening evidence demonstrates that population-wide screening of asymptomatic adults is not established as an effective universal strategy; targeted case finding in clinically relevant risk groups is more defensible. [21]

Biomedical engineering and health informatics can support device integration, remote monitoring, image segmentation, data quality, interoperability, and computational modeling.

These technologies should be treated as decision-support tools requiring prospective validation, not autonomous clinical decision-makers.

### **Explicit Specialty Integration: Radiology, Nursing, Cardiology, Pharmacy, Dental Care, and Psychiatry**

This framework is intentionally multidisciplinary rather than orthodontic-led. The six core specialties requested for the clinical model—Radiology, Nursing, Cardiology, Pharmacy, Dental care, and Psychiatry—have distinct decision-making responsibilities, measurable outcomes, and safety functions. Their contributions are complementary and should be documented prospectively rather than treated as parallel consultations.

#### **8.1 Radiology**

Radiology provides the objective structural phenotype on which patient selection and treatment planning depend. Diagnostic and oral/maxillofacial radiology should jointly standardize CBCT acquisition, radiation-dose optimization, field of view, patient positioning, segmentation, and reproducibility of skeletal and airway measurements. Key measurements include transverse maxillary width, ANS/PNS skeletal separation, nasal-floor dimensions, nasal-cavity volume, and minimum cross-sectional airway area. Radiologists should also identify incidental findings and clinically relevant sinonasal, dental, osseous, or temporomandibular abnormalities that may alter treatment. CBCT should not be repeated solely for research convenience when an equivalent low-radiation assessment is available; cumulative radiation exposure must be explicitly considered. Recent evidence supports CBCT for evaluating skeletal effects of MARPE, while airway-volume changes should not automatically be equated with OSA resolution. [7,8,23]

#### **8.2 Nursing**

Nursing provides longitudinal coordination and patient-safety surveillance across the entire pathway. Nurse coordinators should perform structured education, monitor adherence to the

prescribed expansion protocol, assess pain and oral-soft-tissue problems, review home blood pressure/weight and nocturnal oxygenation data when clinically indicated, and coordinate escalation to cardiology, sleep medicine, dentistry/orthodontics, pharmacy, or psychiatry. Nursing assessment should also include barriers to adherence, health literacy, caregiver support, and social determinants of health. Telemonitoring should augment—not replace—clinical assessment and should use predefined escalation pathways rather than isolated device alerts. [15,16]

#### **8.3 Cardiology**

Cardiology determines whether the patient is sufficiently hemodynamically stable for an elective dental/orthodontic or surgical intervention and remains responsible for HF phenotype classification, volume-status assessment, GDMT, arrhythmia risk, blood-pressure management, and interpretation of echocardiographic findings. The cardiology team should distinguish HFrEF, HFmrEF, and HFpEF and should not assume that improvement in OSA will produce reverse cardiac remodeling. Echocardiographic variables such as LVEF, LV-GLS, diastolic indices, TAPSE, RV strain, and estimated pulmonary pressures are monitoring and research endpoints rather than guaranteed treatment targets. [1,11–13,19,22]

#### **8.4 Pharmacy**

Clinical pharmacy provides medication reconciliation and medication-safety governance. Pharmacists should review GDMT, diuretic requirements, renal function and electrolytes, sedative-hypnotics, antidepressants, antipsychotics, anticoagulants/antiplatelets where relevant, QT-prolonging combinations, and clinically important CYP-mediated interactions. Pharmacotherapy for MDD should remain individualized and guideline-concordant; the negative cardiovascular findings of SADHART-CHF and MOOD-HF do not justify stopping effective antidepressant treatment. The pharmacist's role is risk mitigation and optimization, not therapeutic

substitution of skeletal expansion for evidence-based HF or psychiatric care. [3,4,11,14]

### 8.5 Dental Care

Dentistry is a core component of the framework, not an ancillary service. The dental team should evaluate oral health, periodontal status, caries, occlusion, tooth mobility, palatal anatomy, temporomandibular-joint status, oral hygiene, and the condition of the dentition before appliance placement. Orthodontists/dentofacial orthopedists select and activate MARPE/MSE or coordinate SARPE/DOME when indicated, while oral and maxillofacial surgeons manage surgical components when required. Dental follow-up should document miniscrew stability, mucosal integrity, dental tipping, root/periodontal effects, occlusal changes, retention, and relapse. Dental sleep medicine should also coordinate conventional OSA treatments, including oral appliance therapy, when indicated. Available adult evidence suggests that maxillary expansion may improve selected OSA outcomes, but evidence remains heterogeneous and, for surgically assisted expansion, has been rated very low quality in systematic review. [6,9,10,23,24]

### 8.6 Psychiatry

Psychiatry remains responsible for diagnostic confirmation of MDD, suicide-risk assessment, psychopharmacologic management, treatment

of comorbid anxiety or insomnia when present, and escalation when symptoms worsen. PHQ-9 or BDI scores should support—not replace—clinical assessment. Psychiatric treatment must continue according to established indications even if an anatomical intervention is pursued. Particular attention should be given to adherence, procedure-related distress, insomnia, substance use, and the possibility that persistent depressive symptoms may reflect inadequate psychiatric treatment rather than residual OSA alone. [2–4,17,18]

### 8.7 Cross-specialty governance

For Q1-level implementation, each specialty should have a named accountable clinician, predefined entry and exit criteria, standardized documentation, and shared outcome definitions. A multidisciplinary case conference should be required before elective expansion in patients with clinically significant HF or active MDD. The case should document: (1) confirmed OSA and phenotype; (2) objective transverse maxillary deficiency; (3) cardiac stability; (4) psychiatric stability and suicide-risk assessment; (5) medication-safety review; (6) dental and periodontal suitability; (7) radiologic feasibility; and (8) a contingency plan for CPAP/oral-appliance continuation or rescue therapy. This structure prevents fragmentation and makes each specialty's contribution auditable, as shown in the follow

**Table 2.**

| Specialty  | Core responsibility                                                | Minimum documented outputs                                         | Escalation triggers                                                       |
|------------|--------------------------------------------------------------------|--------------------------------------------------------------------|---------------------------------------------------------------------------|
| Radiology  | CBCT/cephalometric acquisition, segmentation, structural phenotype | Standardized measurements; dose/scan protocol; incidental findings | Unexpected lesion; inadequate scan; unsafe repeat imaging                 |
| Nursing    | Education, adherence, telemonitoring, coordination                 | Monitoring record; symptom/adherence assessment                    | HF deterioration; hypoxemia trend; severe pain; psychiatric warning signs |
| Cardiology | HF stability, GDMT, hemodynamic risk                               | HF phenotype; volume status; ECG/TTE review                        | Decompensated HF; unstable arrhythmia; hypotension/hypertension           |

|                              |                                                                  |                                                                            |                                                                                    |
|------------------------------|------------------------------------------------------------------|----------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Pharmacy                     | Medication reconciliation and interaction/safety review          | GDMT and psychotropic review; QTc/electrolytes; sedative risk              | QTc risk; renal/electrolyte abnormality; major interaction                         |
| Dental / Orthodontics / OMFS | Dental suitability, appliance selection, expansion, retention    | Dental/periodontal assessment; activation record; skeletal/dental outcomes | Miniscrew failure; periodontal injury; asymmetric expansion; surgical complication |
| Psychiatry                   | MDD diagnosis, treatment, suicide-risk and behavioral assessment | Clinical assessment; PHQ-9; medication plan; safety plan                   | Suicidal ideation; severe deterioration; inability to participate safely           |

## 9. Operational Clinical Pathway

### Phase 1 – Screening and baseline (weeks –4 to 0)

Confirm OSA with appropriate sleep testing; classify HF phenotype and stability; establish psychiatric diagnosis and safety; perform dental/orthodontic and ENT assessment; obtain clinically justified CBCT; perform baseline TTE; and complete medication reconciliation. Establish the patient's current standard OSA therapy and do not discontinue effective therapy solely to test the framework.

### Phase 2 – Stabilization and shared decision-making (weeks 0–2)

Cardiology confirms clinical stability; pharmacy addresses medication risks; psychiatry/psychology establishes a treatment and safety plan; orthodontics/OMFS confirms feasibility; nursing establishes monitoring; and the patient receives balanced information about expected benefits, uncertainties, alternatives, and procedural risks. Informed consent should explicitly state that cardiovascular and psychiatric benefits of expansion are unproven.

### Phase 3 – Intervention and early monitoring (weeks 2–8)

Perform the selected expansion procedure according to specialist protocol. Monitor pain, mucosal or dental complications, activation, blood pressure, HF symptoms, sleep symptoms, and psychiatric status. Surgical candidates should receive perioperative assessment

appropriate to their HF status and procedure complexity.

### Phase 4 – Consolidation and reassessment (weeks 8–24 and beyond)

Assess skeletal/dental stability, sleep outcomes, cardiac status, psychiatric outcomes, adverse events, and patient-reported quality of life. Repeat imaging only when clinically justified. Long-term OSA therapy should be determined by objective follow-up rather than by anatomical change alone.

## 10. Outcomes for Future Prospective Trials

A Q1-level research program should predefine outcomes across five domains. The primary sleep outcome could be change in AHI or a validated hypoxic-burden measure, with secondary outcomes including ODI, T90, arousal index, sleep architecture, and patient-reported sleepiness. Cardiovascular outcomes should include HF hospitalization, cardiovascular mortality, blood pressure, NT-proBNP where appropriate, LVEF, LV-GLS, diastolic indices, and RV/pulmonary measures. Psychiatric outcomes should include validated symptom scales, remission, quality of life, adherence, and safety events. Contemporary evidence syntheses should be incorporated into protocol design; a 2026 systematic review/meta-analysis reported a pooled reduction in AHI with MARPE but emphasized the need for larger and longer-term validation. [23]

Anatomical outcomes should include reproducible skeletal expansion, nasal-cavity dimensions, airway minimum cross-sectional

area, and selected volumetric measures. Health-system outcomes should include time to diagnosis, referral completion, adherence, patient experience, adverse events, costs, resource utilization, and equity of access. Cost-effectiveness should be evaluated separately from clinical efficacy.

Future trials should use an appropriate comparator, stratify by OSA phenotype and HF phenotype, predefine rescue treatment, and report adverse events. Randomized controlled trials are needed before any claim of cardiovascular or psychiatric benefit can be made.

**Table 3. Recommended outcome domains for future prospective studies**

| Domain           | Primary/priority measures                                                                                         | Interpretation                                                               |
|------------------|-------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Sleep physiology | AHI; hypoxic burden/ODI; T90; nadir SpO <sub>2</sub> ; arousal index                                              | Objective treatment response; should be measured with standardized protocols |
| Anatomy          | ANS/PNS skeletal expansion; nasal-cavity dimensions; minimum airway cross-sectional area; selected airway volumes | Mechanistic and anatomical response                                          |
| Cardiovascular   | HF hospitalization; mortality; LVEF; LV-GLS; diastolic indices; RV function; NT-proBNP where appropriate          | Clinical and mechanistic cardiovascular outcomes; not assumed to improve     |
| Psychiatric      | Validated depression scale; remission; quality of life; treatment adherence; safety events                        | Psychiatric outcome should be assessed independently of airway anatomy       |
| Patient-centered | Sleepiness, symptoms, oral discomfort, treatment satisfaction, functional status                                  | Acceptability and real-world benefit                                         |
| Health-system    | Referral completion, time to treatment, adverse events, costs, resource utilization, equity                       | Implementation feasibility and value                                         |

## 11. Safety, Contraindications, and Ethical Boundaries

The proposed framework should be suspended or deferred when the patient is medically unstable, when the procedural risk exceeds expected benefit, or when psychiatric safety cannot be adequately maintained. Acute decompensated HF, uncontrolled clinically significant arrhythmia, unstable ischemic disease, uncontrolled infection at the surgical site, or active psychiatric crisis require stabilization before elective skeletal expansion. Exact contraindications remain procedure-specific and should be determined by the treating specialists.

The framework must preserve standard-of-care treatment. CPAP, oral appliance therapy, weight management, HF GDMT, and psychiatric treatment should continue or be adjusted according to established indications. Maxillary expansion should not be represented as a substitute for any of these treatments until comparative evidence demonstrates otherwise.

Radiation exposure, surgical complications, miniscrew failure, dental/periodontal effects, relapse, asymmetric expansion, nasal symptoms, pain, and treatment burden should be prospectively monitored. Ethical implementation requires transparent

communication of uncertainty and avoidance of therapeutic misconception.

## 12. Implementation Science, Public Health, and Health-System Considerations

Successful implementation requires a defined referral pathway, shared documentation, standardized outcome definitions, and a governance structure for escalation. Health services administration should define responsibility for scheduling, cross-specialty communication, reimbursement, data governance, and quality assurance. Public-health teams can identify populations with limited access to sleep testing, dental specialty care, or digital monitoring and develop equitable referral strategies.

Integrated HF care literature indicates that multidisciplinary pathways can improve coordination, self-management, and selected service outcomes, although implementation is context dependent. [20] A scalable model should therefore use core mandatory elements—sleep diagnosis, HF stabilization, psychiatric safety, anatomical assessment, medication reconciliation, and longitudinal follow-up—while allowing local adaptation of staffing and technology.

Economic evaluation should include the full care pathway rather than only the appliance or procedure. Costs of imaging, specialist visits, PSG, nursing time, remote-monitoring infrastructure, hospitalizations, rescue OSA treatment, and patient travel should be considered. This is particularly important because adult orthodontic and maxillofacial procedures may fall across separate dental and medical reimbursement systems.

## 13. Limitations and Research Priorities

This framework has important limitations. First, the central hypothesis—that correction of transverse maxillary deficiency will produce clinically meaningful downstream improvements in HF and MDD—has not been established in randomized trials. Second, available expansion studies are heterogeneous in age, skeletal maturity, technique, OSA phenotype, outcome

definition, and follow-up. [6–10] Third, changes in airway anatomy do not necessarily translate into clinically important changes in sleep physiology, and neither necessarily translates into cardiovascular or psychiatric benefit.

Fourth, the proposed monitoring thresholds and timelines are operational examples, not validated clinical decision rules. Fifth, the framework may be resource intensive and may be difficult to implement in settings without coordinated dental, medical, psychiatric, and digital-health services. Sixth, repeated CBCT requires careful justification. Finally, the broad multidisciplinary scope may create role ambiguity unless local governance explicitly defines clinical accountability.

## 14. Conclusions

OSA, HF, and MDD frequently coexist and create a high-complexity clinical problem that crosses conventional specialty boundaries. The current evidence supports integrated diagnosis and management of OSA, HF, and depression, but it does not establish maxillary skeletal expansion as a cardiovascular or psychiatric treatment.

In appropriately selected skeletally mature adults with OSA and demonstrable transverse maxillary deficiency, MARPE/MSE or DOME/SARPE may be considered as phenotype-directed anatomical interventions within specialist care. The principal contribution of the present framework is to place that intervention inside a coordinated pathway involving sleep medicine, pulmonology, cardiology, orthodontics, dentistry/dental sleep medicine, oral and maxillofacial surgery, otolaryngology, diagnostic and oral/maxillofacial radiology, psychiatry, psychology, clinical pharmacy, nursing, family medicine, nutrition, rehabilitation, anesthesiology, biomedical engineering, health informatics, public health, and health services administration.

Prospective multicenter trials should determine whether anatomical improvement translates into objective sleep benefit, better patient-reported outcomes, and—most importantly—clinically

meaningful cardiovascular or psychiatric outcomes. Until such evidence is available, this manuscript should be understood as an

evidence-informed multidisciplinary framework and research agenda, not as a new standard of care.

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