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The Role of Multidisciplinary Healthcare Professionals in Improving Patient Outcomes Integrating Health Administration, Health Information Management, Nuclear Medicine, Emergency Medical Services, and Dentistry

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ABSTRACT: Improving patient outcomes in modern health systems depends on the coordinated contribution of many professions, including several whose roles are frequently overlooked in discussions of teamwork. Patient care does not begin at the hospital door, nor does it rest only on physicians and nurses. It begins with the paramedic who reaches the patient within minutes of an emergency; it relies on the accurate, accessible information curated by health information management professionals; it is guided by functional and molecular diagnoses from nuclear medicine; it encompasses oral health, which is closely linked to systemic disease; and it is made possible by health administrators who design and resource the system.

This paper examines the role of five professions — health administration, health information management (HIM), nuclear medicine, emergency medical services (EMS), and dentistry — in improving patient outcomes through multidisciplinary integration. Drawing on Donabedian's structure–process–outcome model, Reason's Swiss cheese model, the SEIPS work-system model, the continuum-of-care concept, and the IPEC interprofessional competencies, it analyses each profession's distinctive contribution, the interdependencies between them, and the evidence linking their integration to safety, timeliness, effectiveness, efficiency, and patient experience.

The paper considers the Saudi context, including the Model of Care, health clusters, the Saudi Red Crescent Authority, national digital health platforms such as Nphies and the Seha Virtual Hospital, and the regulatory roles of CBAHI, SCFHS, and the Nuclear and Radiological Regulatory Commission. It identifies barriers to integration and proposes the ALIGN Framework — Aligned patient-centred goals, Linked information flows, Integrated roles and pathways, Governance and leadership, and Navigating outcomes through measurement. It concludes that the professions often regarded as peripheral are, in fact, essential links in the chain of patient outcomes.

1. INTRODUCTION

Discussions of healthcare teamwork have traditionally centred on the doctor–nurse relationship at the hospital bedside. This focus is understandable, but it captures only part of the reality of modern care. A patient's journey typically spans the pre-hospital environment, the emergency department, diagnostic services, inpatient and outpatient care, and the community. Along this journey, many professions shape outcomes in ways that are less visible but no less decisive. Consider a patient who suffers a heart attack. Their survival depends first on emergency medical services personnel who reach them, recognise the condition, record a pre-hospital electrocardiogram, and alert the receiving hospital. Their subsequent diagnosis and risk assessment may involve nuclear medicine myocardial perfusion imaging. Their records — from the ambulance report to the discharge summary — must be accurately captured, coded, and made available to every clinician involved, which is the work of health information management. Their oral health may matter more than expected, given the links between periodontal disease and cardiovascular and metabolic conditions, and given the need for dental assessment before certain cardiac and oncological treatments. And the entire pathway — from ambulance dispatch to cardiac rehabilitation — exists only because health administrators have designed, staffed, and funded it.

Every patient outcome is the product of a chain. The professions least visible at the bedside often hold the links on which the whole chain depends.

The report To Err Is Human emphasised that most preventable harm arises from system failures rather than individual negligence (Kohn et al., 2000). Many of these failures occur at the boundaries between professions and settings: when the ambulance hands over to the emergency department, when a diagnostic result is not communicated, when records are incomplete or inaccessible, or when oral health problems complicate medical treatment because the dental team was never consulted. Strengthening integration across these boundaries is therefore one of the most powerful levers for improving outcomes. This paper focuses on five professions that together span the organisational, informational, diagnostic, pre-hospital, and oral-health domains of care: **health administration, health information management, nuclear medicine, emergency medical services, and dentistry**. Each brings a distinctive form of expertise; together, they illustrate how a broader conception of the healthcare team can produce safer, more timely, and more effective care.

1.1 Aim and Objectives

The aim of this paper is to examine how the integration of these five professions within multidisciplinary care improves patient outcomes, and to propose a practical framework for strengthening their collaboration in the Saudi health system. Its objectives are to:

- ◆ clarify the concepts of multidisciplinary and interprofessional practice across the continuum of care;
- ◆ review the theoretical models that explain how integration influences outcomes;
- ◆ describe the distinctive contribution of each of the five professions;
- ◆ analyse the interdependencies and integration mechanisms between them;
- ◆ synthesise evidence linking their contributions to patient outcomes;
- ◆ examine the Saudi context and the barriers to integration;
- ◆ propose an integrated framework and practical recommendations.

1.2 Methodological Approach

This paper adopts a narrative, integrative review design. It synthesises foundational theory on quality, safety, and teamwork; systematic reviews and key studies relating to each profession; international guidance from the World Health Organization and professional bodies; and Saudi health policy and regulatory sources. The intention is conceptual and practical synthesis to inform health-care leaders and practitioners, rather than quantitative pooling of results.

2. CONCEPTUAL FOUNDATIONS

2.1 From Multidisciplinary to Interprofessional Care

In a multidisciplinary model, professionals from different disciplines contribute their own expertise in parallel, often coordinated by a lead clinician. Interdisciplinary models go further, with shared goals and integrated plans, while interprofessional collaboration describes health workers from different professional backgrounds working together with patients, families, and communities to deliver the highest quality of care (World Health Organization [WHO], 2010). For the five professions examined here, integration often occurs not around a single bedside but across settings and time — from the roadside to the hospital, from the diagnostic department to the clinic, and from the dental chair to the medical ward.

2.2 The Continuum of Care

The continuum of care describes the sequence of services a patient may need over the course of an illness or a lifetime: prevention, pre-hospital emergency care, acute hospital care, diagnosis, treatment, rehabilitation, and long-term management. Outcomes depend not only on the quality of care at each stage but on the quality of transitions between stages. The five professions in this paper are distributed along this continuum, and their integration is essentially an exercise in managing transitions and information flows.

Table 1. The Five Professions Across the Continuum of Care

Profession	Primary Point on the Continuum	Core Domain
Emergency Medical Services	Pre-hospital emergency care and inter-facility transfer	Time-critical assessment, stabilisation, and transport
Nuclear Medicine	Diagnosis, staging, monitoring, and targeted therapy	Functional and molecular imaging; radionuclide therapy
Dentistry	Prevention, primary care, and specialist hospital care	Oral health and its links to systemic disease
Health Information Management	Across the entire continuum	Accuracy, integrity, accessibility, and use of health data
Health Administration	Across the entire system	Planning, resourcing, governance, and coordination

3. THEORETICAL FRAMEWORK

3.1 Donabedian's Structure–Process–Outcome Model

Donabedian (1988) proposed that quality of care can be assessed through structure, process, and outcome. This model is particularly helpful for the professions examined here, because several of them act primarily on structure and process rather than delivering direct bedside care. Health administration shapes structure through resources, staffing, and organisation; HIM

shapes both structure (information systems) and process (documentation and data flow); EMS, nuclear medicine, and dentistry shape clinical processes; and all contribute to outcomes.

3.2 Reason's Swiss Cheese Model

Reason (2000) described how harm occurs when holes in successive layers of defence align. Each of the five professions provides a distinct defensive layer: the paramedic who recognises a stroke and pre-alerts the hospital; the HIM professional whose data-quality checks catch a duplicate or mismatched record; the nuclear medicine team whose safety procedures prevent radiation incidents and misadministration; the dentist who identifies an oral infection before chemotherapy or cardiac surgery; and the administrator who corrects an unsafe system condition. Weakness in any layer increases the probability of harm.

3.3 The SEIPS Model

The Systems Engineering Initiative for Patient Safety (SEIPS) model holds that care processes and outcomes are shaped by the work system — people, tasks, tools and technologies, environment, and organisation (Carayon et al., 2006). The model highlights that collaboration depends on enabling conditions, such as interoperable records, communication equipment in ambulances, clear policies, and adequate staffing, which are largely the domain of health administration and HIM.

3.4 Interprofessional Competencies and Teamwork Science

The Interprofessional Education Collaborative (2016) identifies four competency domains — values and ethics, roles and responsibilities, interprofessional communication, and teams and teamwork. Teamwork science adds that effective teams share mental models, use closed-loop communication, monitor each other's performance, and provide backup behaviour (Salas et al., 2005; Rosen et al., 2018). These principles apply equally to professions working across settings, where communication is often mediated by technology rather than face-to-face contact.

Table 2. Theoretical Models and Their Application to the Five Professions

Model	Core Concept	Application
Donabedian (1988)	Structure → process → outcome	Captures the contribution of non-bedside professions to outcomes
Reason (2000)	Layered defences against harm	Each profession adds an independent safety layer
SEIPS (Carayon et al., 2006)	Work system shapes care	Highlights administrative and informational enablers
Continuum of care	Care spans settings and time	Emphasises transitions between EMS, diagnosis, treatment, and follow-up
IPEC (2016)	Interprofessional competency domains	Shared framework for training and evaluation
Quadruple Aim (Bodenheimer & Sinsky, 2014)	Experience, health, cost, workforce wellbeing	Defines the outcomes integration should improve

4. THE CONTRIBUTION OF EACH PROFESSION

4.1 Health Administration: Architect of the System

Health administrators plan, organise, finance, staff, and evaluate health services. Their decisions determine whether ambulances are distributed to meet demand, whether a hospital has nuclear medicine capacity and the radiopharmaceutical supply to use it,

whether dental services are integrated within hospitals, and whether health information systems are interoperable. Management practices that support staff development and team working have been associated with lower hospital mortality (West et al., 2002), demonstrating that administrative choices reach all the way to patient outcomes.

In a multidisciplinary context, health administration performs several integrating functions: designing care pathways that span professions and settings; establishing governance structures such as quality, patient-safety, and radiation-safety committees; allocating resources fairly across services; negotiating agreements between hospitals and EMS providers; ensuring regulatory compliance and accreditation; and using performance data to drive improvement. Administrators also shape organisational culture — whether professions are treated as equal partners or as peripheral support services.

4.2 Health Information Management: The Integrity of the Patient Record

Health information management professionals are responsible for the accuracy, completeness, confidentiality, and accessibility of patient health information. Their work includes managing electronic health record (EHR) content, clinical documentation improvement, clinical coding using classification systems such as ICD, data quality assurance, release of information, record retention, privacy and security, and the production of health statistics for management and research.

Accurate and accessible information is the connective tissue of multidisciplinary care. Reviews have shown that health information technology is associated predominantly with positive effects on quality, efficiency, and provider satisfaction (Buntin et al., 2011), while also identifying risks — such as poor usability, information overload, and workflow disruption — that must be managed (Menachemi & Collum, 2011). Electronic records can support care coordination, but only when information is structured, complete, and shared across settings (O'Malley et al., 2010). Coding accuracy also matters: inaccurate coding distorts quality indicators, reimbursement, and resource planning, and systematic reviews have documented substantial variation in discharge coding accuracy (Burns et al., 2012).

For the professions in this paper, HIM is pivotal: it ensures that the EMS patient care report reaches the emergency department record, that nuclear medicine reports and images are linked to the correct patient, that dental records are part of the integrated medical record rather than isolated in a separate system, and that administrators have reliable data for decision-making. Patient identification and record matching — avoiding duplicate or overlaid records — are fundamental safety functions of HIM.

4.3 Nuclear Medicine: Functional and Molecular Insight

Nuclear medicine uses small amounts of radioactive tracers to image physiological and molecular processes, and increasingly to deliver targeted therapy. Unlike anatomical imaging, which shows structure, nuclear medicine reveals function: blood flow to the heart muscle, metabolic activity of tumours, bone turnover, kidney function, thyroid activity, and the presence of specific molecular targets. Positron emission tomography combined with computed tomography (PET/CT) has transformed the staging and monitoring of many cancers; in the U.S. National Oncologic PET Registry, PET findings led referring physicians to change their intended management in a substantial proportion of patients (Hillner et al., 2008).

The field is now expanding rapidly into "theranostics", in which the same molecular target is used for both diagnosis and therapy. Radioligand therapies — such as lutetium-177–based treatments for neuroendocrine tumours, which improved progression-free survival in the NETTER-1 trial (Strosberg et al., 2017), and for prostate cancer — represent a new therapeutic modality that requires close collaboration between nuclear medicine physicians, oncologists, radiopharmacists, physicists, technologists, and nurses (Sgouros et al., 2020; Czernin et al., 2019).

Nuclear medicine's integration into the team occurs through participation in tumour boards and cardiology conferences, appropriate-use guidance for referring clinicians, timely communication of results, and rigorous radiation-protection practices based on the principles of justification, optimisation, and dose limitation (International Commission on Radiological Protection [ICRP], 2007). Its dependence on a reliable supply of short-lived radiopharmaceuticals, specialised equipment, and licensed staff makes administrative planning especially important.

4.4 Emergency Medical Services: The First Link in the Chain

Emergency medical services provide pre-hospital assessment, treatment, and transport for patients with acute illness and injury, as well as inter-facility transfers. For time-critical conditions — cardiac arrest, myocardial infarction, stroke, major trauma, sepsis, and respiratory failure — the minutes before hospital arrival often determine survival and disability. In out-of-hospital

cardiac arrest, survival is strongly associated with bystander cardiopulmonary resuscitation, early defibrillation, and rapid EMS response (Sasson et al., 2010).

EMS integration with hospital teams has a direct and measurable impact. Pre-hospital electrocardiograms with hospital pre-notification shorten the time to coronary reperfusion in ST-elevation myocardial infarction (Diercks et al., 2009), and EMS pre-notification of suspected stroke reduces in-hospital delays to imaging and treatment (Patel et al., 2011). Conversely, the handover from ambulance crew to emergency department staff is a recognised point of information loss; structured handover formats improve the completeness and reliability of information transfer (Bost et al., 2010).

EMS professionals also depend on other professions in this paper: on HIM for the integration of electronic patient care reports into the hospital record; on administrators for dispatch systems, vehicle distribution, protocols, and agreements with receiving hospitals; and on diagnostic services such as nuclear medicine and cardiology for the definitive care pathways into which they deliver patients.

4.5 Dentistry: Oral Health as Part of General Health

Oral diseases — including dental caries, periodontal disease, oral infections, and oral cancers — are among the most prevalent conditions worldwide and impose a large burden of pain, disability, and cost (Peres et al., 2019; WHO, 2022). Oral health is closely linked to general health. A consensus report of periodontal and diabetes experts concluded that there is a bidirectional relationship between periodontitis and diabetes, and that periodontal treatment is associated with improvements in glycaemic control (Sanz et al., 2018). Associations have also been reported between periodontal disease and cardiovascular disease, adverse pregnancy outcomes, and respiratory infections.

In the hospital setting, dentists contribute in several critical ways. Before chemotherapy, head-and-neck radiotherapy, organ transplantation, cardiac valve surgery, and treatment with antiresorptive medications, dental assessment and elimination of oral infection reduce the risk of serious complications, including medication-related osteonecrosis of the jaw (Ruggiero et al., 2022). In intensive care, structured oral hygiene programs reduce the incidence of ventilator-associated pneumonia (Hua et al., 2016). Oral and maxillofacial surgeons manage facial trauma, often arriving via EMS, alongside emergency and trauma teams. Dentists may also be the first to detect signs of systemic disease, such as oral manifestations of diabetes, nutritional deficiencies, or malignancy.

Despite these links, dentistry is frequently separated from medicine organisationally, educationally, and informationally — with separate records, facilities, and funding. Integrating dentistry into multidisciplinary pathways is therefore one of the most promising opportunities to improve outcomes for patients with chronic and complex conditions.

Table 3. Contributions of the Five Professions to Patient Outcomes

Profession	Core Contributions	Integration Points	Outcomes Influenced
Health Administration	Planning, resourcing, governance, culture	Care pathways; committees; inter-agency agreements	Access, efficiency, safety culture, mortality
Health Information Management	Record accuracy, coding, data quality, privacy	Integrated EHR; patient identification; health statistics	Continuity, safety, valid quality data
Nuclear Medicine	Functional imaging; theranostics; radiation safety	Tumour boards; cardiology conferences; result communication	Staging accuracy, treatment choice, survival
Emergency Medical Services	Pre-hospital care, triage, transport, pre-alert	Hospital pre-notification; structured handover	Survival, time-to-treatment, disability

Profession	Core Contributions	Integration Points	Outcomes Influenced
Dentistry	Oral disease prevention and treatment; pre-treatment clearance	Pre-chemotherapy/surgery assessment; ICU oral care; trauma	Infection, complications, chronic disease control

5. INTERDEPENDENCIES AND INTEGRATION MECHANISMS

5.1 How the Professions Depend on Each Other

The five professions are linked by a dense web of interdependencies. EMS depends on administrators for resources and on HIM for record integration; nuclear medicine depends on administrators for equipment and radiopharmaceutical supply and on HIM for linking results to the right patient; dentistry depends on HIM for integration into the medical record and on administrators for its inclusion in hospital services; HIM depends on accurate documentation by all clinical professions; and administrators depend on HIM for reliable data and on clinical professions for frontline insight. Recognising these interdependencies is the first step toward managing them.

Table 4. Key Interdependencies Between the Five Professions

From → To	What Is Exchanged	Risk if It Fails
EMS → Hospital teams	Pre-alert, structured handover, patient care report	Delayed treatment; lost information
EMS → HIM	Electronic patient care report for the hospital record	Incomplete record; duplicated assessments
Nuclear Medicine → Clinicians	Timely, actionable reports; critical findings	Delayed or inappropriate treatment
Dentistry → Medical teams	Oral clearance before high-risk treatments; ICU oral care	Infection; osteonecrosis; ventilator-associated pneumonia
All clinical professions → HIM	Complete, accurate documentation	Coding errors; unreliable quality data
HIM → All	Accessible, accurate, matched records and statistics	Wrong-patient errors; poor decisions
Administration → All	Resources, pathways, policies, governance	Unsafe conditions; fragmentation
All → Administration	Performance data, incident reports, frontline feedback	Systems disconnected from reality

5.2 Integration Mechanisms

Effective integration requires deliberate mechanisms, including:

- ◆ **Integrated clinical pathways** for time-critical conditions (STEMI, stroke, trauma, sepsis) linking EMS pre-alert, emergency department response, diagnostics, and definitive care.

- ◆ **Structured communication tools** such as SBAR and standardised ambulance handover formats, with closed-loop confirmation of critical information.
- ◆ **Multidisciplinary meetings and tumour boards** that include nuclear medicine and, where relevant, dentistry and oral surgery.
- ◆ **Integrated electronic records** that bring EMS reports, nuclear medicine images and reports, and dental records into a single, interoperable patient record.
- ◆ **Referral protocols** for pre-treatment dental assessment in oncology, cardiac surgery, and transplantation.
- ◆ **Governance committees** — for quality, patient safety, radiation safety, and health information — with membership from all relevant professions.
- ◆ **Joint training and simulation** — for example, mass-casualty exercises involving EMS, hospital teams, and administrators.

5.3 Transitions of Care

The most vulnerable points in the patient journey are transitions: from the scene to the ambulance, from the ambulance to the emergency department, from diagnosis to treatment, and from hospital to community. At each transition, information must move reliably between professions. The ambulance handover is a clear example: when it is unstructured, key details about the mechanism of injury, pre-hospital treatment, and vital-sign trends may be lost (Bost et al., 2010). Similarly, a nuclear medicine finding with management implications must reach the responsible clinician and be acted upon, and a dental clearance must be completed and documented before cancer treatment begins. HIM systems and administrative pathways together provide the infrastructure for safe transitions.

5.4 Interprofessional Education and Simulation

Professionals cannot be expected to collaborate seamlessly in practice if they have never learned together. Health administration, health informatics, nuclear medicine technology, emergency medical services, and dentistry are usually taught in separate faculties with little shared curriculum. Interprofessional education — in which students from two or more professions learn about, from, and with each other — builds mutual understanding of roles and develops shared communication skills (WHO, 2010). Simulation offers a powerful method for practising integration: mass-casualty exercises bring EMS crews, emergency departments, and administrators together; simulated handovers train paramedics and receiving staff; and case-based workshops can explore, for example, the dental and nuclear medicine considerations in a patient preparing for cancer therapy. Joint debriefing after real incidents extends this learning into everyday practice.

5.5 Shared Performance Indicators

What is measured shapes what teams prioritise. When each profession is assessed only on discipline-specific indicators — ambulance response time, coding turnaround, scan volume, dental appointments completed — the incentive to collaborate is weak. Shared indicators that reflect the patient journey make interdependence visible and create joint accountability. Table 5 provides examples of indicators that require more than one of the five professions to perform well.

Table 5. Examples of Shared Performance Indicators

Indicator	Professions Jointly Responsible	What It Reflects
First medical contact-to-reperfusion time (STEMI)	EMS, hospital teams, administration	Pre-hospital recognition, pre-alert, and pathway readiness
Completeness of ambulance handover documentation	EMS, HIM, emergency nursing	Reliability of information transfer at transition

Indicator	Professions Jointly Responsible	What It Reflects
Pre-treatment dental clearance completion rate	Dentistry, oncology/cardiology, administration	Integration of oral health into high-risk pathways
Time from nuclear medicine study to MDT decision	Nuclear medicine, oncology, HIM	Timeliness of diagnostic integration
Duplicate / mismatched record rate	HIM, EMS, registration, all clinicians	Patient-identification safety
Coding accuracy on audit	HIM, all documenting clinicians	Quality of documentation and data

6. IMPACT ON PATIENT OUTCOMES

6.1 Timeliness and Survival

The clearest evidence for integration comes from time-critical care. EMS pre-hospital electrocardiograms with hospital pre-notification are associated with shorter times to reperfusion in STEMI (Diercks et al., 2009), and EMS pre-notification for stroke reduces delays in in-hospital evaluation (Patel et al., 2011). In cardiac arrest, the integration of community response, dispatch, EMS, and hospital care forms a "chain of survival" in which each link affects outcome (Sasson et al., 2010). These benefits depend not only on EMS competence but on administrative pathways, communication systems, and hospital readiness.

6.2 Diagnostic Accuracy and Treatment Selection

Nuclear medicine contributes to outcomes by improving the accuracy of diagnosis and staging, which in turn guides treatment choice. PET findings frequently change intended management in oncology (Hillner et al., 2008), helping to avoid futile surgery or to identify disease that requires more intensive treatment. In theranostics, nuclear medicine moves from diagnosis to direct therapeutic benefit (Strosberg et al., 2017). These gains are realised only when results are discussed and integrated within multidisciplinary decision-making.

6.3 Safety and Prevention of Complications

Dental integration prevents complications in vulnerable patients: oral care protocols reduce ventilator-associated pneumonia (Hua et al., 2016), and pre-treatment dental assessment reduces the risk of osteonecrosis of the jaw and infection in patients receiving antiresorptive therapy, radiotherapy, or immunosuppression (Ruggiero et al., 2022). Periodontal treatment in diabetes is associated with improved glycaemic control (Sanz et al., 2018). HIM contributes to safety through accurate patient identification and record matching, which prevent wrong-patient errors, and nuclear medicine safety procedures protect patients and staff from unnecessary radiation exposure (ICRP, 2007).

6.4 Continuity, Efficiency, and Data-Driven Improvement

Accessible and complete health information supports continuity and reduces duplicated tests and procedures (Buntin et al., 2011; O'Malley et al., 2010). Accurate coding and reliable data underpin quality indicators, clinical audit, and resource planning, enabling administrators to target improvement where it is most needed. Management practices that support teamwork have been associated with lower mortality (West et al., 2002), reinforcing the role of administration as a determinant of outcomes rather than a purely supporting function.

6.5 Patients as Partners

Across all five professions, patients and families are partners in care. They provide the history on which paramedics act, consent to and prepare for nuclear medicine procedures, maintain daily oral hygiene, access their own records through patient portals, and give feedback that administrators use to improve services. Interprofessional collaboration that includes patients and families as team members is more likely to produce outcomes that matter to them (WHO, 2010).

Table 6. Summary of Evidence Linking Integration to Outcomes

Outcome Domain	Illustrative Evidence	Integrating Professions
STEMI reperfusion time	Pre-hospital ECG and pre-notification shorten time to reperfusion (Diercks et al., 2009)	EMS, hospital teams, administration
Stroke evaluation delays	EMS pre-notification reduces in-hospital delays (Patel et al., 2011)	EMS, emergency and imaging teams
Cancer management	PET changes intended management (Hillner et al., 2008); radioligand therapy improves progression-free survival (Strosberg et al., 2017)	Nuclear medicine, oncology
Ventilator-associated pneumonia	Oral hygiene care reduces VAP (Hua et al., 2016)	Dentistry, ICU nursing and medicine
Glycaemic control	Periodontal treatment associated with improved control (Sanz et al., 2018)	Dentistry, primary care, endocrinology
Quality and efficiency	Health IT associated predominantly with positive results (Buntin et al., 2011)	HIM, administration, all clinicians
Hospital mortality	Team-supportive management linked to lower mortality (West et al., 2002)	Administration

7. Illustrative Case: Integration Across the Continuum

The following composite case, constructed for illustration, demonstrates how the five professions contribute to a single patient's outcome.

A 58-year-old man with poorly controlled type 2 diabetes develops severe chest pain at home. His family calls the emergency number. **EMS** paramedics arrive within minutes, record a 12-lead electrocardiogram showing ST-elevation myocardial infarction, administer initial treatment according to protocol, and transmit the ECG to the receiving hospital, which activates its catheterisation laboratory before arrival. At the emergency department, the crew provides a structured handover, and the electronic patient care report is linked to his hospital record. He undergoes successful primary coronary intervention.

During his admission, **health information management** ensures that his pre-hospital, emergency, catheterisation, and ward documentation is integrated into a single record and accurately coded, enabling the cardiology team to see his full history, including a previously undiagnosed pattern of poor glycaemic control. Some weeks later, residual symptoms prompt **nuclear medicine** myocardial perfusion imaging, which identifies an area of reversible ischaemia in another coronary territory, leading the multidisciplinary heart team to plan further revascularisation.

Because he is to undergo further cardiac intervention and has poorly controlled diabetes, the care pathway includes a **dental** assessment, which identifies advanced periodontitis and an abscessed tooth. The dentist treats the infection and initiates periodontal therapy, coordinating with his endocrinologist. Over subsequent months, his glycaemic control improves alongside intensified medical management.

Throughout, **health administration** is present behind the scenes: the EMS–hospital STEMI agreement, the ECG transmission system, the round-the-clock catheterisation laboratory, the nuclear medicine service and its radiopharmaceutical supply, the referral pathway to hospital dentistry, and the dashboards that track door-to-balloon times all reflect administrative design. No single profession produced his recovery; it emerged from the alignment of five.

Integration means that what one profession learns about the patient becomes available to all, and that every hand-off strengthens rather than weakens the chain of care.

8. THE SAUDI ARABIAN CONTEXT

8.1 Vision 2030 and the Model of Care

The Health Sector Transformation Program under Vision 2030 aims to improve access, quality, and efficiency, and to reorganise services around patient needs (Health Sector Transformation Program, 2021). The Model of Care defines "systems of care" — including urgent care, planned procedures, chronic conditions, and women's and children's health — that require integration across professions and settings. The reorganisation of public services into regional health clusters, responsible for the health of defined populations, creates the organisational basis for integrating EMS, hospital diagnostics, dental services, and information systems within coherent pathways.

8.2 Emergency Medical Services

The Saudi Red Crescent Authority is the principal national provider of pre-hospital emergency medical services, operating ambulance stations, dispatch, and air ambulance services across the Kingdom, alongside hospital-based and private EMS providers. The Kingdom's large geography, extensive highway network, and the exceptional demands of mass gatherings during Hajj and Umrah make EMS integration with hospitals and administrative planning particularly important. University programs in emergency medical services have expanded the number of Saudi paramedics, strengthening the professional base for integration with hospital teams.

8.3 Health Information and Digital Platforms

Saudi Arabia has developed advanced national digital health infrastructure, including the Nphies platform for health-insurance and health-information exchange, the Seha Virtual Hospital for remote specialist services, the Wasfaty e-prescribing platform, and the Sehhaty patient application. These platforms create opportunities for EMS reports, diagnostic results, and dental records to be shared across facilities. Realising this potential depends on HIM professionals who ensure data quality, standardised coding, accurate patient identification, and adherence to national data protection requirements, including the Personal Data Protection Law.

8.4 Nuclear Medicine and Radiation Regulation

Nuclear medicine services in Saudi Arabia are concentrated in major tertiary and specialist centres, with growing capacity in PET/CT and radionuclide therapy. Local cyclotron and radiopharmaceutical production at leading specialist institutions supports service delivery. The Nuclear and Radiological Regulatory Commission oversees the licensing and safe use of radioactive materials and radiation-generating equipment, while SCFHS regulates the qualifications of nuclear medicine physicians and technologists. Expansion of nuclear medicine — particularly theranostics — will require careful administrative planning for equipment, isotope supply, shielding, licensed staff, and multidisciplinary oncology integration.

8.5 Dentistry and Oral Health

Oral diseases remain a significant public-health concern in Saudi Arabia, as in many countries, and dental services are provided through Ministry of Health primary care and hospital clinics, specialist centres, university dental hospitals, and a large private sector. The Model of Care and the emphasis on prevention offer an opportunity to integrate oral health into chronic disease management, maternal and child health, and hospital pathways for oncology, cardiac surgery, and intensive care.

8.6 Regulation, Accreditation, and Workforce

The Saudi Central Board for Accreditation of Healthcare Institutions (CBAHI) sets standards for leadership, information management, patient identification, communication, radiation safety, infection control, and quality improvement, all of which touch the professions examined here. The Saudi Commission for Health Specialties (SCFHS) classifies and registers all five professional groups and oversees their training and continuing professional development. The growth of Saudi graduates in

health administration, health informatics, nuclear medicine technology, emergency medical services, and dentistry is building a national workforce capable of sustained interprofessional collaboration.

Table 7. Saudi Institutions and Platforms Relevant to Integration

Institution / Platform	Relevant Profession(s)	Integration Opportunity
Model of Care & health clusters	All	Cross-professional pathways for defined populations
Saudi Red Crescent Authority	EMS	Pre-alert, transfer, and handover agreements with hospitals
Nphies, Seha Virtual Hospital, Sehhaty	HIM, all clinicians	Shared records, virtual consultation, patient access
Nuclear and Radiological Regulatory Commission	Nuclear medicine, administration	Licensing and radiation safety governance
CBAHI	All, especially administration and HIM	Standards for communication, information, and safety
SCFHS	All	Interprofessional training and CPD

8.7 Mass Gatherings: A Unique Test of Integration

Each year, the Kingdom hosts millions of pilgrims during Hajj and Umrah, creating one of the most demanding mass-gathering health environments in the world. Heat-related illness, cardiovascular events in older pilgrims, trauma, infectious disease risks, and exacerbations of chronic conditions occur in a confined geography over a short period. Effective response depends on precisely the integration described in this paper: EMS teams deployed across holy sites and coordinated by central command; hospitals and field facilities ready to receive patients; health information systems that capture encounters for surveillance and continuity; dental and other services available to pilgrims; and administrators who plan capacity, staffing, and logistics months in advance. The Saudi experience of mass-gathering medicine demonstrates that large-scale, multi-professional integration is achievable when goals, information, roles, governance, and measurement are aligned.

9. BARRIERS TO INTEGRATION

Several barriers limit the integration of these five professions into multidisciplinary care:

- ◆ **Professional invisibility:** HIM, administration, and to some extent EMS and dentistry are often regarded as support or separate services rather than core team members.
- ◆ **Organisational separation of dentistry:** distinct facilities, funding, records, and education separate oral health from medical care.
- ◆ **Information fragmentation:** EMS reports, dental records, and specialised imaging systems may not be fully interoperable with hospital records.
- ◆ **Unstructured handovers:** inconsistent ambulance-to-hospital handover processes lead to information loss.
- ◆ **Resource concentration:** nuclear medicine and specialist dental services are concentrated in major centres, creating access gaps.

- ◆ **Documentation and coding quality:** incomplete documentation undermines coding accuracy and the reliability of quality data.
- ◆ **Limited interprofessional education:** most professionals train in separate programs with little shared learning.
- ◆ **Weak shared measurement:** few indicators hold multiple professions jointly accountable for shared outcomes.

Table 8. Profession-Specific Barriers and Responses

Profession	Common Barrier	Suggested Response
Health Administration	Distance from frontline care; siloed budgeting	Leadership rounds; pathway-based budgeting; clinician involvement
Health Information Management	Seen as clerical; limited involvement in design	Involve HIM in EHR design, data governance, and quality committees
Nuclear Medicine	Limited availability; low referrer awareness	Regional networks; appropriate-use education; MDT participation
Emergency Medical Services	Variable handover; limited feedback on patient outcomes	Structured handover; outcome feedback loops to EMS crews
Dentistry	Organisational and informational separation	Hospital dental pathways; shared records; referral protocols

10. ETHICAL, LEGAL, AND SAFETY CONSIDERATIONS

Integration across professions raises ethical, legal, and safety considerations that must be managed deliberately so that closer collaboration does not come at the expense of patient rights or safety.

10.1 Privacy, Confidentiality, and Data Governance

Linking EMS, nuclear medicine, dental, and hospital records improves continuity but also increases the number of people and systems with access to sensitive information. HIM professionals play the central role in balancing access with protection: implementing role-based access, audit trails, consent management, and secure data exchange, and ensuring compliance with national data-protection requirements. Patients should be informed about how their information is shared within the care team, and secondary uses of data for research or management should follow approved governance processes.

10.2 Patient Identification and Record Integrity

Accurate patient identification is a foundational safety requirement. Errors are particularly likely at the interfaces examined in this paper: unidentified or unconscious patients transported by EMS, patients registered under temporary identities in emergency departments, and records created in separate dental or imaging systems. Duplicate or overlaid records can lead to wrong-patient results, inappropriate treatment, or radiation exposure. Standardised identification protocols, unique national identifiers, and active record-reconciliation by HIM professionals are essential safeguards.

10.3 Radiation Protection

Nuclear medicine procedures involve the administration of radioactive materials, and their safe use depends on the principles of justification, optimisation, and dose limitation (ICRP, 2007). Integration with referring clinicians helps ensure that studies are justified and that the most appropriate examination is selected. Administrative and regulatory oversight ensures licensed staff, calibrated equipment, safe handling and disposal of radioactive materials, and protocols for special situations such as

pregnancy, breastfeeding, and patients requiring care from other departments shortly after receiving radioactive therapy — where nursing, EMS, and dental teams may need specific guidance.

10.4 Consent and Decision-Making in Emergencies

EMS professionals frequently act in situations where patients cannot give informed consent. Clear protocols grounded in the principle of acting in the patient's best interests, together with accurate documentation of the patient's condition and the treatment provided, protect both patients and professionals. Accurate documentation is also medico-legally important across all five professions, again highlighting the role of HIM in maintaining complete and reliable records.

10.5 Equity of Access

Specialised services such as nuclear medicine and hospital dentistry are often concentrated in major cities, while EMS response times may be longer in remote areas. Integration should therefore include an equity perspective: regional networks, transfer agreements, telehealth, and mobile services can extend access to patients outside major centres. Administrators and planners should monitor outcomes by region and population group to identify and address inequities.

10.6 Workforce Wellbeing

EMS professionals face high stress, irregular hours, exposure to traumatic events, and physical risk; HIM professionals may experience pressure from documentation backlogs and system transitions; and dental and nuclear medicine staff face their own occupational hazards. The Quadruple Aim highlights that workforce wellbeing is integral to sustainable high-quality care (Bodenheimer & Sinsky, 2014). Supportive leadership, fair workloads, debriefing after critical incidents, and recognition of each profession's contribution to team outcomes all support wellbeing and retention.

11. THE ALIGN FRAMEWORK

To address these barriers, this paper proposes the **ALIGN Framework**, a practical model for integrating health administration, HIM, nuclear medicine, EMS, and dentistry into multidisciplinary care that improves patient outcomes.

Table 9. The ALIGN Framework for Multidisciplinary Integration

Pillar	Description	Key Actions	Indicators
A — Aligned patient-centred goals	All professions share explicit goals for the patient's journey	Pathway goals; patient and family involvement; shared care plans	Pathways with documented shared goals
L — Linked information flows	Information moves reliably across professions and settings	Integrated EHR including EMS, nuclear medicine, and dental records; patient-ID safeguards	Record linkage rate; duplicate-record rate
I — Integrated roles and pathways	Each profession's role is defined within shared pathways	STEMI/stroke/trauma pathways; pre-treatment dental clearance; MDT inclusion of nuclear medicine	Pathway compliance; dental clearance completion
G — Governance and leadership	Leadership and committees that include all professions	Multiprofessional quality, safety, radiation, and information governance	Committee representation; action completion
N — Navigating outcomes through measurement	Shared outcomes are measured and fed back	Joint dashboards; outcome feedback to EMS; coding quality audits	Time-to-treatment, complications, readmissions, data quality

11.1 How the Framework Operates

The ALIGN pillars reinforce one another. Aligned goals provide shared purpose; linked information ensures that every profession sees the same patient picture; integrated pathways define who does what and when; governance and leadership provide authority and resources; and measurement shows whether outcomes are improving and where to act next. Health administration and HIM serve as the backbone of the framework, while EMS, nuclear medicine, and dentistry provide the clinical contributions that the framework connects.

11.2 Implementation Phasing

- ◆ **Phase 1 — Foundation (0–6 months):** leadership commitment; mapping of patient pathways and information flows; inclusion of all five professions in relevant committees; baseline indicators.
- ◆ **Phase 2 — Integration (6–18 months):** structured EMS handover; integration of EMS, nuclear medicine, and dental records into the EHR; pre-treatment dental clearance protocols; nuclear medicine participation in tumour boards.
- ◆ **Phase 3 — Optimisation (18–36 months):** shared outcome dashboards across the health cluster; outcome feedback to EMS crews; coding-quality and data-governance programs; regional networks for nuclear medicine and specialist dentistry.

12. FUTURE DIRECTIONS

Several developments will reshape integration across these professions. Artificial intelligence is being applied to EMS dispatch and triage, to automated image analysis in nuclear medicine, to clinical coding and documentation, and to the analysis of dental radiographs. These tools can strengthen integration if they operate within interoperable systems and under clear governance. Telehealth is extending specialist input to remote areas, including tele-consultation for EMS crews, virtual review of nuclear medicine studies, and teledentistry. Theranostics will make nuclear medicine an increasingly central therapeutic partner in oncology.

Research priorities include evaluation of ambulance handover tools in Saudi emergency departments; studies of integrated medical–dental care for patients with diabetes and cardiovascular disease; assessment of data quality and coding accuracy in national platforms; and implementation studies of regional nuclear medicine networks. Value-based payment models that reward shared outcomes would further strengthen incentives for integration.

13. RECOMMENDATIONS

13.1 For Policymakers and Regulators

- ◆ Recognise HIM, EMS, nuclear medicine, and dentistry explicitly as members of multidisciplinary teams within the Model of Care.
- ◆ Mandate interoperability standards that include EMS, dental, and specialised imaging records.
- ◆ Develop national pre-treatment dental clearance guidance for high-risk medical treatments.

13.2 For Health Administrators

- ◆ Establish multiprofessional pathway and governance structures that include all five professions.
- ◆ Invest in structured EMS handover, ECG and data transmission, and outcome feedback to EMS.
- ◆ Plan nuclear medicine capacity and radiopharmaceutical supply at cluster and regional level.
- ◆ Integrate hospital dental services into oncology, cardiac, transplant, and intensive care pathways.

13.3 For Professionals

- ◆ HIM professionals: lead data governance, patient-identification safety, and documentation improvement.
- ◆ Nuclear medicine teams: participate in MDTs and educate referrers on appropriate use.
- ◆ EMS professionals: use structured handover and pre-notification consistently.

- ◆ Dentists: engage proactively with medical teams and document oral findings in shared records.

13.4 For Educators and Researchers

- ◆ Introduce shared interprofessional modules across administration, informatics, nuclear medicine, EMS, and dental programs.
- ◆ Evaluate integrated pathways using patient-outcome measures in the Saudi context.

14. CONCLUSION

This paper has argued that improving patient outcomes requires a broader conception of the healthcare team. Health administration designs and resources the system; health information management ensures that accurate information flows to every professional who needs it; nuclear medicine provides functional and molecular insight and increasingly delivers targeted therapy; emergency medical services form the first and often decisive link in the chain of survival; and dentistry protects oral health, which is closely bound to systemic health. Each profession contributes distinct expertise, and each depends on the others.

The evidence shows that integration across these professions improves timeliness, diagnostic accuracy, safety, continuity, and efficiency. Achieving it requires shared goals, linked information, integrated pathways, inclusive governance, and shared measurement — the pillars of the proposed ALIGN Framework.

For Saudi Arabia, the Vision 2030 transformation, the Model of Care, health clusters, advanced national digital platforms, and a growing national workforce in all five professions provide a strong foundation. By deliberately bringing these professions into multidisciplinary pathways, Saudi health institutions can ensure that no link in the chain of care is weak, and that every patient benefits from the full range of expertise the health system has to offer.

REFERENCES

- [1] Bodenheimer, T., & Sinsky, C. (2014). From triple to quadruple aim: Care of the patient requires care of the provider. *Annals of Family Medicine*, 12(6), 573–576.
- [2] Bost, N., Crilly, J., Wallis, M., Patterson, E., & Chaboyer, W. (2010). Clinical handover of patients arriving by ambulance to the emergency department: A literature review. *International Emergency Nursing*, 18(4), 210–220.
- [3] Buntin, M. B., Burke, M. F., Hoaglin, M. C., & Blumenthal, D. (2011). The benefits of health information technology: A review of the recent literature shows predominantly positive results. *Health Affairs*, 30(3), 464–471.
- [4] Burns, E. M., Rigby, E., Mamidanna, R., Bottle, A., Aylin, P., Ziprin, P., & Faiz, O. D. (2012). Systematic review of discharge coding accuracy. *Journal of Public Health*, 34(1), 138–148.
- [5] Carayon, P., Schoofs Hundt, A., Karsh, B. T., Gurses, A. P., Alvarado, C. J., Smith, M., & Flatley Brennan, P. (2006). Work system design for patient safety: The SEIPS model. *Quality and Safety in Health Care*, 15(Suppl 1), i50–i58.
- [6] Czernin, J., Sonni, I., Razmaria, A., & Calais, J. (2019). The future of nuclear medicine as an independent specialty. *Journal of Nuclear Medicine*, 60(Suppl 2), 3S–12S.
- [7] Diercks, D. B., Kontos, M. C., Chen, A. Y., Pollack, C. V., Wiviott, S. D., Rumsfeld, J. S., et al. (2009). Utilization and impact of pre-hospital electrocardiograms for patients with acute ST-segment elevation myocardial infarction. *Journal of the American College of Cardiology*, 53(2), 161–166.
- [8] Donabedian, A. (1988). The quality of care: How can it be assessed? *JAMA*, 260(12), 1743–1748.
- [9] Health Sector Transformation Program. (2021). *Health Sector Transformation Program delivery plan*. Vision 2030, Kingdom of Saudi Arabia.
- [10] Hillner, B. E., Siegel, B. A., Liu, D., Shields, A. F., Gareen, I. F., Hanna, L., et al. (2008). Impact of positron emission tomography/computed tomography and positron emission tomography (PET) alone on expected management of patients with cancer: Initial results from the National Oncologic PET Registry. *Journal of Clinical Oncology*, 26(13), 2155–2161.

- [11] Hua, F., Xie, H., Worthington, H. V., Furness, S., Zhang, Q., & Li, C. (2016). Oral hygiene care for critically ill patients to prevent ventilator-associated pneumonia. *Cochrane Database of Systematic Reviews*, (10), CD008367.
- [12] International Commission on Radiological Protection. (2007). The 2007 recommendations of the International Commission on Radiological Protection (ICRP Publication 103). *Annals of the ICRP*, 37(2–4).
- [13] Interprofessional Education Collaborative. (2016). *Core competencies for interprofessional collaborative practice: 2016 update*. Interprofessional Education Collaborative.
- [14] Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (Eds.). (2000). *To err is human: Building a safer health system*. National Academy Press.
- [15] Menachemi, N., & Collum, T. H. (2011). Benefits and drawbacks of electronic health record systems. *Risk Management and Healthcare Policy*, 4, 47–55.
- [16] O'Malley, A. S., Grossman, J. M., Cohen, G. R., Kemper, N. M., & Pham, H. H. (2010). Are electronic medical records helpful for care coordination? Experiences of physician practices. *Journal of General Internal Medicine*, 25(3), 177–185.
- [17] Patel, M. D., Rose, K. M., O'Brien, E. C., & Rosamond, W. D. (2011). Prehospital notification by emergency medical services reduces delays in stroke evaluation. *Stroke*, 42(8), 2263–2268.
- [18] Peres, M. A., Macpherson, L. M. D., Weyant, R. J., Daly, B., Venturelli, R., Mathur, M. R., et al. (2019). Oral diseases: A global public health challenge. *The Lancet*, 394(10194), 249–260.
- [19] Reason, J. (2000). Human error: Models and management. *BMJ*, 320(7237), 768–770.
- [20] Rosen, M. A., DiazGranados, D., Dietz, A. S., Benishek, L. E., Thompson, D., Pronovost, P. J., & Weaver, S. J. (2018). Teamwork in healthcare: Key discoveries enabling safer, high-quality care. *American Psychologist*, 73(4), 433–450.
- [21] Ruggiero, S. L., Dodson, T. B., Aghaloo, T., Carlson, E. R., Ward, B. B., & Kademani, D. (2022). American Association of Oral and Maxillofacial Surgeons' position paper on medication-related osteonecrosis of the jaws — 2022 update. *Journal of Oral and Maxillofacial Surgery*, 80(5), 920–943.
- [22] Salas, E., Sims, D. E., & Burke, C. S. (2005). Is there a "Big Five" in teamwork? *Small Group Research*, 36(5), 555–599.
- [23] Sanz, M., Ceriello, A., Buysschaert, M., Chapple, I., Demmer, R. T., Graziani, F., et al. (2018). Scientific evidence on the links between periodontal diseases and diabetes: Consensus report and guidelines of the joint workshop on periodontal diseases and diabetes by the International Diabetes Federation and the European Federation of Periodontology. *Journal of Clinical Periodontology*, 45(2), 138–149.
- [24] Sasson, C., Rogers, M. A. M., Dahl, J., & Kellermann, A. L. (2010). Predictors of survival from out-of-hospital cardiac arrest: A systematic review and meta-analysis. *Circulation: Cardiovascular Quality and Outcomes*, 3(1), 63–81.
- [25] Sgouros, G., Bodei, L., McDevitt, M. R., & Nedrow, J. R. (2020). Radiopharmaceutical therapy in cancer: Clinical advances and challenges. *Nature Reviews Drug Discovery*, 19(9), 589–608.
- [26] Strosberg, J., El-Haddad, G., Wolin, E., Hendifar, A., Yao, J., Chasen, B., et al. (2017). Phase 3 trial of 177Lu-Dotatate for midgut neuroendocrine tumors. *New England Journal of Medicine*, 376(2), 125–135.
- [27] West, M. A., Borrill, C., Dawson, J., Scully, J., Carter, M., Anelay, S., Patterson, M., & Waring, J. (2002). The link between the management of employees and patient mortality in acute hospitals. *The International Journal of Human Resource Management*, 13(8), 1299–1310.
- [28] World Health Organization. (2010). *Framework for action on interprofessional education and collaborative practice*. WHO.
- [29] World Health Organization. (2022). *Global oral health status report: Towards universal health coverage for oral health by 2030*. WHO.