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ORIGINAL ARTICLE

Transforming Orthopaedic Care with Interprofessional Education: Challenges, Strategies, and Outcomes

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Abstract

Introduction: Interprofessional education (IPE) is critical to improve teamwork and collaboration in orthopaedics, so ultimately improving patient care. This study is about the integration of IPE into orthopaedic practice, the challenges of implementation of IPE and, its impact on outcomes. **Methods:** A comprehensive review of the literature from 2005 to 2024 was conducted using PubMed, Google Scholar, and Scopus. Studies focusing on the role of IPE in patient care and teamwork were included. Non-peer-reviewed articles were excluded. **Results:** IPE improves clinical outcomes by improving communication, role clarity, and shared decision-making in orthopaedic teams. Effective strategies such as case-based learning and simulation training strengthen collaborative skills. Despite challenges such as time constraints and institutional resistance, customised training and curriculum integration provide viable solutions. **Conclusions:** Incorporating IPE into orthopaedic education is critical to promote teamwork and improve patient outcomes. Addressing challenges and fostering collaboration can drive innovation in orthopaedic care and enhance healthcare delivery around the world.

Keywords: Interprofessional Education, Orthopaedic, Collaborative Practice, Teaching Strategies, Healthcare

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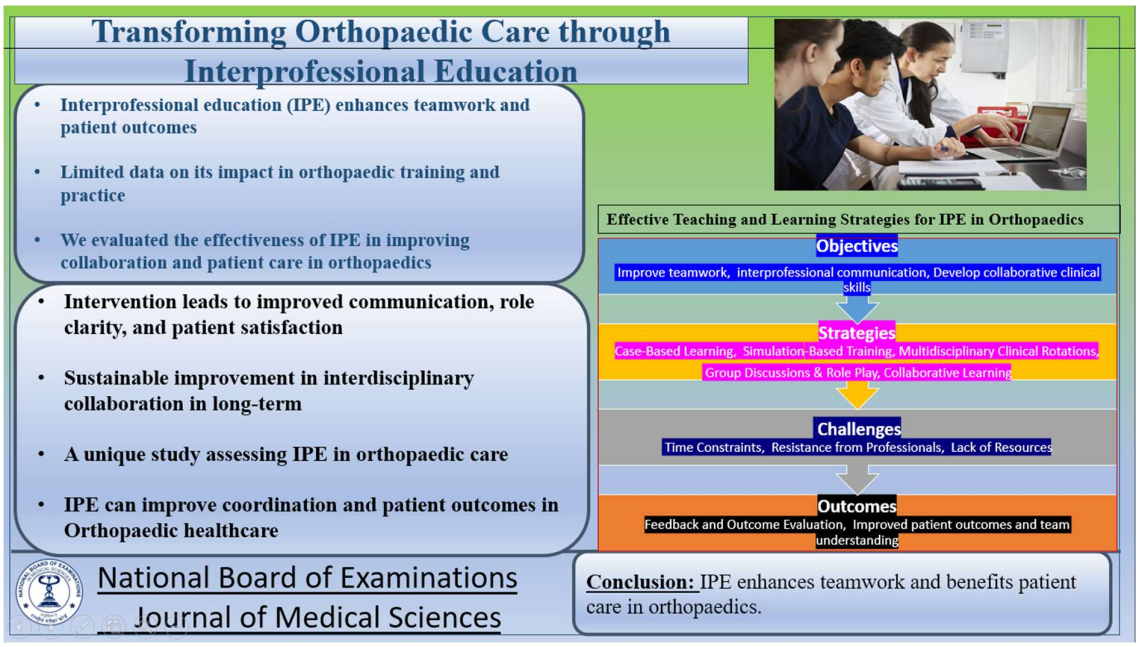
Graphical Abstract



Key Highlights

- Interprofessional Education (IPE) significantly improves clinical outcomes by fostering effective communication and collaboration among diverse healthcare professionals in Orthopaedics.
- The role of the core principles of the IPEC framework – ethics, roles, communication, and teamwork – in making interprofessional education (IPE) effective.
- Case-based learning, simulation-based training, and multidisciplinary clinical rotations are highlighted as key strategies that enhance teamwork and clinical skills among Orthopaedic professionals.
- The review identifies common barriers to IPE implementation, such as time constraints and institutional resistance, and proposes practical solutions to overcome these obstacles.
- Integrating IPE into residency programs can promote innovation in orthopaedic research and practice worldwide, leading to improved healthcare delivery.

1. Introduction

The World Health Organization (WHO) defines interprofessional education (IEP) as an experience in which "students from two or more disciplines learn from each other, from each other and from each other and facilitate each other to collaborate health outcomes" [1]. IEP improves patient care, by implementing multidisciplinary approach in orthopaedic care involving Orthopaedic surgeon, nurses, physician, physical therapists, anaesthesiologists, occupational therapists and other allied health professionals according to need of customised patient care [3]. The framework of interprofessional collaboration, focused on values, ethics, responsibilities, communication and teamwork [1,4]. Multidisciplinary interactions is crucial from preoperative planning, few important intraoperative decisions making as well as

during postoperative care and follow ups [5]. Therefore by strengthening team-based care and encouraging shared decision-making, interprofessional collaboration reduces medical errors, and improves outcome and satisfaction of patient [2,6]. IPE also prepares professionals to manage the dynamic clinical challenges by developing certain skills by other speciality of the teammates and resolve common conflict and confusion [7]. common Orthopaedic ailments which needs arthroplasty, arthroscopy and polytrauma or fracture management greatly benefit from these collaborative approaches [8,9]. This manuscript aims to review IPE delivery models in Orthopaedics, explores strategies to overcome obstacles in implementing, evaluating their impact on current and future patient care, and to know the the importance of shared learning of different disciplines.

2. Materials and Methods

- Search Strategy and Data Collection: A literature review was conducted using PubMed, Google Scholar and Scopus database to retrieve relevant articles published between 2005 to 2024. The keywords used in the search were “interdisciplinary education”, “orthopaedics”, “multidisciplinary teams”, “teamwork in health care”, “orthopaedic education”, “clinical collaboration” and “IPE in orthopaedics”.
- Inclusion and exclusion criteria: Studies focused on the integration of IPE in orthopaedics, its impact on patient care or its role in improving collaborative practice in the orthopaedic setting were included. Studies that did not involve IPE in healthcare or orthopaedic contexts or were not peer reviewed were excluded.
- Data synthesis: Data from those articles which were included, were analysed and classified according to themes, noting benefits of IPE, teaching and learning strategies, barriers to implementation and success. Studies bearing on the use of IPE in different subspecialities of orthopaedic specialties viz. trauma, geriatric orthopaedics, pediatric orthopaedics were retrieved, reviewed to assess their impact in the orthopaedic care.
- IPEC (Interprofessional Collaborative Education) framework analysis: It helps to explore the role of key IPE competencies of different studies: values and ethics, roles and responsibilities, processed interprofessional communication and teamwork, and [1,10] The integration of these core competencies in different education programs of orthopaedic speciality and their effect on professional collaboration were analysed.
- Review methodology: To summarize the findings of the literature, a narrative review methodology was done. It also identifies gaps in available literature, effectiveness of IPE strategies and their effect on patient care and on clinical practice. qualitative and quantitative data, educational assessments, and surveys on IPE effectiveness, including different types of articles, were assessed

3. Results and Discussion

3.1 Technology Integration

This section explores how telemedicine, AI-based tools, and simulation-based training are used in orthopaedics to improve teamwork and shared learning. How these technologies help health care professionals collaborate more effectively and improve patient care.

3.2 Comparison of IPE, Multidisciplinary, Interdisciplinary, and Transdisciplinary Approaches

Although IPE approaches, multidisciplinary, interdisciplinary, and intradisciplinary, all promote teamwork, they differ in how professionals engage and work with professionals of other speciality [11,12]. IPE focuses on collaborative learning to improve collaboration while multidisciplinary approach allow them to work separately so everyone solves their own problems [1]. In contrast, the Interdisciplinary approach combines expertise and perspectives to create integrated solutions [13]. The Transdisciplinary approach goes further by blending roles and expertise to address complex issues holistically [14]. Each approach has its merits and challenges, but they all aim to improve communication, understanding, and outcomes by leveraging the strengths of various professions (Table 1) [15,16].

Table 1. Comparison of IPE, Multidisciplinary, Interdisciplinary, and Transdisciplinary Approaches [11-18]

Aspect	Interprofessional Education (IPE)	Multidisciplinary Approach	Interdisciplinary Approach	Transdisciplinary Approach
Definition	Educating professionals from different disciplines to learn about, from, and with each other.	Professionals from different disciplines work on separate parts of a task or project without much interaction.	Professionals integrate their expertise and collaborate closely to develop shared solutions.	Professionals transcend disciplinary boundaries, working seamlessly to address complex, multifaceted problems.
Purpose	Foster collaboration, teamwork, and communication for better patient and professional outcomes.	Utilize individual expertise from each discipline to achieve a common goal.	Combine and synthesize knowledge for holistic problem-solving.	Create innovative solutions by blending disciplinary knowledge and roles, often leading to new perspectives and approaches.
Interaction	High: mutual learning and shared goals.	Minimal: limited interaction; each discipline works independently.	High: continuous communication and shared decision-making among team members.	Very high: roles and boundaries blur as professionals work together seamlessly.

Focus	Collaborative skills development and understanding roles.	Task completion within distinct disciplinary boundaries.	Integration of knowledge and collaborative problem-solving for comprehensive solutions.	Holistic, boundary-crossing approaches to solve complex, real-world problems.
Outcome	Improved teamwork and patient outcomes.	Achievement of discipline-specific tasks without full integration.	Innovation and holistic solutions with better outcomes through integrated efforts.	Groundbreaking solutions that transcend traditional boundaries and create new knowledge.
Example	Healthcare teams learning together to manage patient care collaboratively.	Cancer treatment teams where each specialist works independently on different aspects of treatment.	A team of surgeons, physiotherapists, and social workers jointly creating a rehabilitation plan.	A community health project where professionals from Healthcarehealthcare, engineering, and social sciences work together to solve health issues.

3.3. Core Objectives of Interprofessional Education (IPE) in Orthopaedics

The core objectives of IPE in Orthopaedics focus on enhancing teamwork, improving patient outcomes, and fostering respect across disciplines [1,7,19]. IPE ensures a holistic, patient-centered approach to orthopaedic care by promoting collaboration among healthcare providers (Table 2) [2,20].

Table 2. Core Objectives of IPE in Orthopaedics [1,2,7,15,16, 19,20,21]

Objective	Description	Strategies	Benefits	Core Competency Domains
Enhancing Collaborative Skills	Develops effective communication and teamwork among healthcare providers.	Cross-disciplinary training, role clarification	Improved decision-making, seamless care coordination	Roles & Responsibilities, Communication
Improving Patient Outcomes	Focuses on optimizing care to achieve better functional recovery.	Integrated care plans, shared patient management	Reduced complications, faster recovery	Team-Based Care, Values & Ethics
Building Mutual Respect Across Disciplines	Fosters understanding and respect for each healthcare professional's expertise.	Team-building exercises, mutual feedback	Enhanced collaboration, improved morale	Values & Ethics, Communication

In orthopaedic care, various healthcare professionals work collaboratively to ensure effective diagnosis, treatment, and rehabilitation for patients.[22] Each professional plays a unique and vital role, from diagnosis and surgery to post-operative care, rehabilitation, and psychosocial support.[23] Their coordinated efforts lead to better patient outcomes, improved recovery, and enhanced quality of life [24] (Table 3).

Table 3. Roles of Healthcare Professionals in Orthopaedic Care [22-30]

Healthcare Professional	Primary Responsibilities	Key Functions	Skills Required	Patient Interaction	Outcome Impact
Orthopaedic Surgeons	Diagnose and treat musculoskeletal issues. Perform surgeries.	Joint replacements, fracture repairs, treatment plans.	Surgical skills, musculoskeletal knowledge	Explain procedures, manage expectations.	Improves mobility, reduces pain.
Anaesthesiologists	Administer anesthesia, monitor vital signs during surgery. Manage post-operative pain.	Anesthesia management, post-operative care.	Expertise in anesthesia, risk assessment.	Ensure comfort during surgery, address concerns.	Reduces perioperative complications, ensures recovery.
Physiotherapists	Restore movement and function through exercises. Help with mobility and pain management.	Personalized rehabilitation programs, strength assessments.	Physical therapy knowledge, biomechanics expertise.	Guide rehabilitation, educate on injury prevention.	Speeds recovery, increases strength, prevents future injury.
Occupational Therapists	Help patients regain independence in daily activities. Adapt environments, provide assistive devices.	Assist with daily living activities, adaptive strategies.	Knowledge of daily living skills, ergonomic practices.	Help patients with tasks like dressing, cooking.	Enhances independence, reduces dependency.
Nurses	Monitor patients, manage pain, provide post-	Vital signs monitoring, medication administrati	Clinical care, patient education,	Offer reassurance, ensure recovery	Speeds recovery, reduces

	operative care, and educate on recovery.	on, wound care.	communication.	compliance.	complications.
Radiology Technicians	Perform imaging tests like X-rays and MRIs for diagnosis.	Diagnostic imaging for treatment planning.	Imaging technology expertise, attention to detail.	Ensure proper positioning for scans, explain the process.	Improves diagnostic accuracy, aids surgery planning.
Social Workers & Psychologists	Address emotional, social, and mental health aspects of injury or surgery. Provide counselling.	Emotional support, coping strategies, patient and family counselling.	Mental health expertise, counselling skills.	Provide one-on-one or family counselling.	Reduces anxiety, improves adherence to treatment plans.

IPE is vital in ensuring high-quality care in various Orthopaedic subfields [1,31]. By promoting collaboration between professionals from diverse disciplines, IPE enhances the patient experience and outcomes, particularly in complex care scenarios such as trauma, geriatric care, pediatric care, Orthopaedic oncology, and post-surgical rehabilitation [32]. Each area benefits from a multidimensional approach where team members work together to address all aspects of a patient's condition, from diagnosis and treatment to rehabilitation and psychosocial support.[17,33]

3.4 Applications of IPE in Orthopaedics

IPE in orthopaedics enhances patient care by fostering collaboration among healthcare professionals [1,34]. It ensures cohesive treatment strategies across trauma care, rehabilitation, geriatric management, pediatric orthopaedics, and oncology [35]. IPE integrates expertise to address complex patient needs, improve outcomes, and optimize recovery [32,35] (Table 4).

Table 4. Enhanced Applications of IPE in Orthopaedics [1,32,34-42]

Application Area	IPE Team Composition	Core Benefits	Notable Strategies
Trauma and Emergency Care	Trauma surgeons, anaesthesiologists, emergency personnel, radiologists, nurses	Faster interventions, reduced errors, enhanced survival rates	Hands-on clinical workshops, scenario-based training
Post-Surgical Rehabilitation	Orthopaedic surgeons, physiotherapists, occupational therapists, nurses	Optimized mobility, pain management, shorter hospital stays	Personalized rehab programs, interprofessional communication training

Geriatric Orthopaedics	Geriatricians, Orthopaedic surgeons, physiotherapists, social workers	Holistic care, improved quality of life, reduced complications	Integration of GERIATRIC 5Ms framework, multidisciplinary case reviews
Pediatric Orthopaedics	Paediatricians, Orthopaedic surgeons, physiotherapists, psychologists, social workers	Tailored care plans, developmental and emotional support, enhanced recovery	Anatomy demonstrations, collaborative functional assessments
Orthopaedic Oncology	Orthopaedic surgeons, oncologists, radiologists, physiotherapists, social workers	Comprehensive treatment, psychosocial support, long-term follow-up	Problem-based learning, community-based experiences
Educational Initiatives	Medical educators, clinical specialists, anatomists, physiotherapists	Improved collaboration and communication among students	Anatomy prosections, interprofessional workshops on MSK care
Research & Development	Healthcare researchers, Orthopaedic educators, medical students	Better preparedness for teamwork, improved patient outcomes	Interprofessional training wards, joint clinical studies
Cost Optimization	Administrators, Orthopaedic surgeons, financial officers	Reduced treatment costs, shorter recovery periods	Interdisciplinary budgeting sessions, implementation of cost-effective care pathways

GERIATRIC 5*M*s: Mind (Cognition and Mental Health), Mobility (Function and Physical Activity), Medications (Appropriate Prescriptions), Multicomplexity (Chronic Conditions), Matters Most (Aligning Care with Patient Goals).

3.5 Teaching and Learning Strategies for IPE in Orthopaedics

IPE in Orthopaedics is essential for promoting effective teamwork and enhancing patient care [1,7,43]. The first step is identifying learning objectives, such as improving teamwork, enhancing interprofessional communication, and developing collaborative clinical skills [44]. Once these objectives are set, the next step is to select teaching strategies, including case-based learning, simulation-based training, and multidisciplinary clinical rotations [45,46]. These strategies are then implemented through group discussions, role play, and collaborative learning platforms, fostering real-world clinical problem-solving [31,47]. Challenges like time constraints, resistance from professionals, and a lack of resources are addressed with practical solutions, including flexible scheduling, education on the value of IPE, and the use of technology [48,49]. Finally, outcomes are assessed through feedback mechanisms and evaluations, aiming for improved patient outcomes, enhanced understanding of team roles, and better preparedness for real-world clinical settings [7,50] (Figure 1).

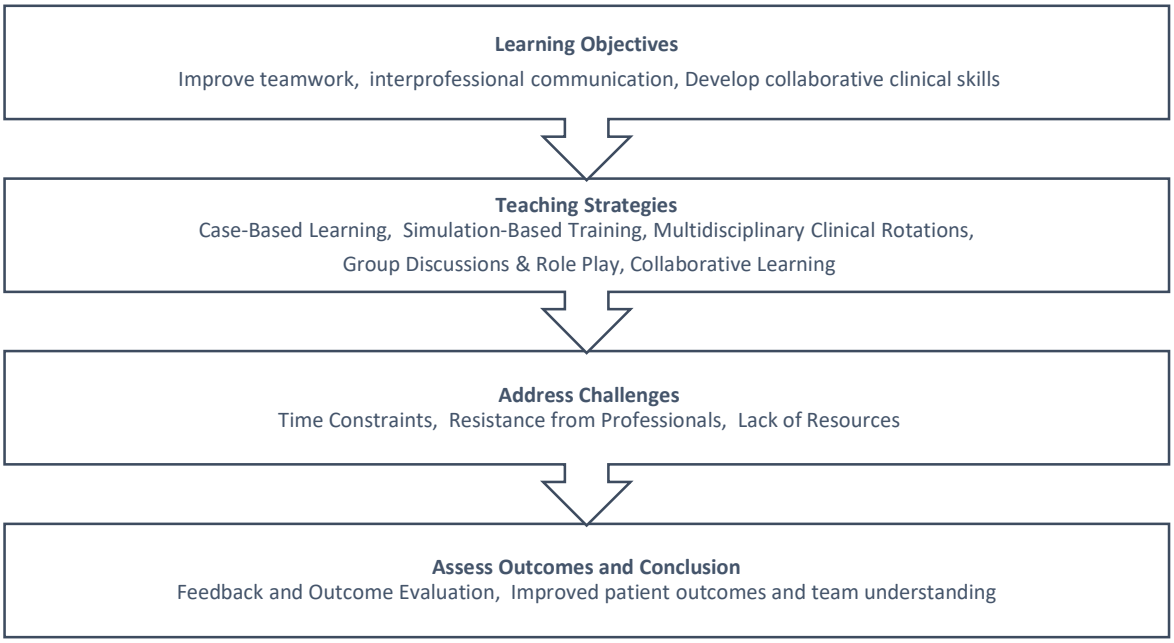


Figure 1. Effective Teaching and Learning Strategies for IPE in Orthopaedics [1,7,43-50]

These strategies facilitate the development of competencies required for effective interprofessional collaboration, improving overall patient outcomes in Orthopaedic care [32].

IPE in Healthcare focuses on fostering effective collaboration among various healthcare professionals to improve patient care. [1,7] By integrating different disciplines, IPE aims to enhance the quality of education and strengthen teamwork, enabling a holistic approach to patient treatment [31]. With the evolving healthcare needs, strategies like telemedicine, AI-driven planning tools, and simulation labs are essential to support the development of skills and competencies in collaborative practice [45,51] (Table 5).

Table 5: Strategies for Technology in IPE [45,51-55]

Strategy	Description	Impact on Orthopaedics
Telemedicine and Virtual Case Discussions	Use of digital communication tools to facilitate remote consultations and collaborative decision-making.	Enhances accessibility to expert consultations, enabling Orthopaedic surgeons to collaborate on complex cases, especially in rural or underserved areas. Facilitates learning across geographic boundaries, improving knowledge sharing and patient care.
AI-Driven Orthopaedic Planning Tools	Incorporating artificial intelligence into surgical planning and diagnostics to assist in decision-making.	AI tools can help orthopaedic surgeons predict surgical outcomes, plan complex surgeries, and improve treatment precision. This enables more personalized patient care and enhances learning about various treatment strategies.

Role of 3D Printing in IPE	Utilizing 3D printing technology for creating anatomical models, prosthetics, or surgical tools.	3D printing helps Orthopaedic surgeons, physical therapists, and other healthcare professionals visualize anatomical structures in greater detail, enhancing surgical planning, patient education, and rehabilitation.
Simulation Labs for Surgical Training	Virtual and physical simulation labs allow healthcare providers to practice surgeries and procedures in a controlled, risk-free environment.	Simulation-based training improves surgical skills by providing hands-on experience, reduces errors, and fosters teamwork. It supports interprofessional learning by allowing various healthcare providers, including surgeons, anaesthesiologists, and nurses, to practice together, improving collaborative care in real-world scenarios.

These strategies represent how technology is shaping the future of interprofessional education in Orthopaedics, enhancing the collaborative learning environment and improving patient outcomes.

3.6 Challenges and Controversies in Implementing IPE

While IPE in Orthopaedics aims to improve collaborative care and enhance patient outcomes, its implementation faces several challenges and controversial points [2,20]. These include issues such as the resistance to change within traditional educational systems, disparities in institutional support, and the effectiveness of IPE models [48,56]. There is also ongoing debate regarding how best to assess the outcomes of IPE and whether the expected benefits truly justify the resources invested in such programs [34]. Below is a comprehensive table outlining these challenges, possible causes, proposed solutions, and the impact on learning outcomes (Table 6).

Table 6. Challenges, Causes, Solutions, and Impact on Learning in Implementing IPE in Orthopaedics [1,2,7,19,57-63]

Challenge	Description	Possible Causes	Solutions	Impact on Learning
Resistance to Change	Reluctance to adopt new educational approaches.	Deeply ingrained traditional practices and a lack of understanding of IPE's benefits.	Implement pilot programs, showcase successful outcomes, and integrate IPE into curricula.	Facilitates a shift towards collaborative learning.
Logistical & Financial Barriers	Insufficient resources to support IPE initiatives.	Budget constraints, lack of shared spaces (e.g., simulation labs).	Allocate dedicated time, invest in shared facilities, seek external funding.	Enables smooth operation and sustainability of IPE programs.

Cultural Challenges	Differences in professional attitudes and perceptions.	Stereotypes, professional silos, resistance to new practices.	Promote team-building activities, clear role definitions, respect for diverse viewpoints.	Improves collaboration and respect across professions.
Curriculum Constraints	Overcrowded curricula and limited time.	Overloaded schedules, competing priorities.	Create interprofessional time slots, use online platforms for asynchronous learning.	Allows room for IPE integration in academic calendars.
Accreditation & Standards	Lack of clear IPE accreditation guidelines and standards.	Varying institutional policies and accreditation bodies.	Develop institutional policies, advocate for accreditation standards.	Ensures formal integration of IPE into educational standards.
Inadequate Faculty Preparation	Lack of faculty training for interprofessional teaching.	Traditional faculty training, lack of interprofessional expertise.	Offer faculty development programs focused on IPE teaching skills.	Enhances the quality of IPE instruction.
Measurement of Outcomes	Difficulty in assessing IPE effectiveness.	Lack of standardized metrics or outcomes.	Develop evaluation frameworks, collect feedback, assess student outcomes.	Provides data to refine and improve IPE programs.
Students' Resistance	Students' reluctance to engage in IPE.	Lack of familiarity with collaborative practice, perceived irrelevance.	Offer real-world case scenarios, foster peer learning, highlight IPE's career value.	Increases student engagement and participation.
Institutional Support	Lack of institutional backing for IPE.	Leadership not prioritizing IPE, competing institutional priorities.	Secure leadership support, ensure funding, embed IPE in institutional mission.	Encourages long-term institutional commitment to IPE.

3.7 Controversies in IPE Implementation

While many advocates of IPE argue for its efficacy in improving healthcare delivery, some critics question whether the outcomes justify the cost and resource allocation, especially in lower-resource settings [64]. Some stakeholders argue that integrating IPE into an already packed curriculum may dilute the focus on essential Orthopaedic skills. Others believe

it enhances clinical practice by fostering collaborative skills [1,7]. The lack of universally accepted, standardized measures for assessing IPE effectiveness remains contentious. There is a debate on how to quantify best improvements in patient care, team dynamics, and professional development [32]. The degree of support from academic institutions varies widely. While some institutions prioritize IPE, others remain hesitant, citing concerns over its long-term sustainability and alignment with other educational goals [65].

IPE can be integrated into educational programs by addressing these challenges and controversies through targeted solutions and ongoing dialogue, fostering collaborative practice and improving healthcare outcomes.

3.8 Evaluation and Accreditation of Interprofessional Education (IPE) in Orthopaedics

The evaluation and accreditation of IPE programs play a critical role in ensuring their effectiveness and sustainability within Orthopaedic education [1]. Accreditation bodies set clear goal to maintain high standards, to improve quality of team work and collaboration among healthcare professionals [1,66]. Evaluation of IPE programs means assessing at learning outcomes, Behavior changes, and improvements in patient care, aiming to better healthcare delivery [67]. Real clinical settings help measure the effectiveness of healthcare teams [68]. It also identify areas for improvement, and ensure that IPE remains relevant and effective [1,7,31]. This section discusses the metrics used to measure the success of IPE programs, the role of accreditation bodies in promoting these programs, and the tools employed to assess interprofessional collaboration, focusing on their specific application in Orthopaedic education [1,64]. The following table concisely overviews these key elements (Table 7).

Table 7. Key Elements in the Evaluation, Accreditation, and Assessment of IPE Programs in Orthopaedic Education [1,20,32,60.69-71]

Subsection	Key Points	Tools/Methods	Impact on Orthopaedic Education
Metrics for Success in IPE Programs	- **Learning Outcomes**: Assess knowledge and skills before and after IPE. - **Behavioural Change**: Monitor improvements in teamwork and communication. - **Patient Outcomes**: Track clinical improvements and patient satisfaction. - **Feedback**: Gather input from learners and faculty.	- Pre- and post-program assessments. - Competency frameworks (e.g., ICCAS). - Patient outcome tracking.	- Aligns education with real-world Orthopaedic practice. - Supports data-driven refinement of IPE.
Role of Accreditation	- **Standards**: Set quality criteria for IPE programs. -	- Accreditation standards. - Re-	- Ensures high-quality, sustainable

Bodies in Promoting IPE	**Recognition**: Ensure credibility and institutional support. - **Continuous Improvement**: Promote regular program updates. - **Multidisciplinary Involvement**: Encourage collaboration across professions.	accreditation processes.	IPE in Orthopaedics. - Promotes interprofessional engagement in education.
Tools for Assessing Interprofessional Collaboration	- **Competency Tools**: Evaluate communication and teamwork skills. - **Readiness Scales**: Measure attitudes towards collaboration. - **Team Performance Tools**: Assessing collaboration of healthcare professional in real time clinical setting. - **Patient-Centered Metrics**: Assess collaboration through patient outcomes.	- ICCAS, RIPLS, real-time observation tools. - Patient satisfaction surveys.	- Enhances collaboration within Orthopaedic teams. - Improves patient care through better team dynamics.

ICCAS: Interprofessional Collaborative Competency Attainment Survey, RIPLS: Readiness for Interprofessional Learning Scale

3.9 Global Perspectives on IPE in Orthopaedics

Inter professional education is an essential part of healthcare training in almost all part of the world. it helps professionals involved in orthopaedic care in various ways. it improves patient care not only in developed world but also in developing countries with limited resources [2]. Different models of IPE were described based on different healthcare needs and difference in availability of resources. These models have one thing in common that they all promotes collaboration among health care professionals of different speciality and a culture of shared responsibility [72]. IPE proven to have a positive impact on Orthopaedic education, which varies in different parts of world based institutional, administrative, system-level processes and available resources [73]. A few IPE models, explores initiatives in low-resource settings, and international collaboration to improve healthcare by means of improving patient care and Orthopaedic education [1].

3.9.1 IPE Models in Developed Countries

IPE in developed world with the adequate resources and takes full advantage of advanced infrastructure, modern technology, and multidisciplinary collaboration [1,73]. IPE in these settings are often quite clear with guidelines for student interaction, shared decision, role definition, and collaborative practice competencies [1,7,74]. Adequate resource models focus on improving clinical and communication skills among different medical subspeciality, nursing, physiotherapy, and other allied health students. It aims to improve patient

outcomes through teamwork. Various assessment tools were used by an institution to ensure quality patient care and education by means of collaborative practice in real-world Orthopaedic settings [1,7].

Mohammed (2021) explains about collaboration among different professionals improves both healthcare delivery as well as quality of education [1]. While describing importance of IPE framework, the importance of synergy between healthcare education and practice by regulatory and accreditation bodies in developed countries were explained. Which is crucial to ensure latest advancements in clinical care and teamwork by updating IPE programs time to time [7,76].

3.9.2 IPE Initiatives in Low-Resource Settings

Challenges in implementing traditional IPE models, includes limited resources in terms of educational materials, faculty, and clinical setting [48,57]. However, various IPE initiatives have emerged in such constrained situation and local need can that adapt modified IPE model keeping in mind about local healthcare need.[77] Innovative solutions such as telemedicine, online learning platforms, helps to reduce financial burden. Collaboration between local institutions also help to adopt IPE model satisfactorily with such limited resource settings. The focus on these IPE programs is basically on the essential competencies, such as patient based care, communication, and team coordination [2,78].

Khalili (2024) explains that collaborative partnerships are essential to develop effective IPE programs, helps in overcome institutional barriers in low-resource settings [63]. Thus improving interprofessional collaboration is essence of such IPE program to enhances the quality of Orthopaedic care in limited resource settings [79].

3.9.3 International Collaboration in Orthopaedic Education

Different institution collaboration beyond borders in terms of sharing Orthopaedic skills, education, resources, benefits both developed and low-resource settings equally [80]. These collaborations by means of exchange knowledge, developing training programs, and multicentric research initiatives aimed at improve quality of health care and competencies of specialist including Orthopaedic surgeon. These collaborations help to perform IPE program in more standard way in different settings. [1,34]

As health challenges are different in different parts of the world in different time zones, international collaboration in IPE also helps in sharing such problems which happens in one part of world and expected to be problem in other part. This allows healthcare professionals to learn together and learn from one another, to integrate such knowledge in clinical practices, research and future innovation. The exchange of clinical as well as surgical skills, mutual understanding integrate in the development of IPE programs and based on evolving health needs in Orthopaedics speciality [11].

3.10 IPE in Research and Innovation in Orthopaedics

Advanced research and innovation in Orthopaedics is better if collaboration between different speciality among health professionals to develop integrated approach, guidelines to follow, new management techniques, devices, and strategies [1,2]. Research focused on

integration of diverse perspectives of healthcare, taking care of local health needs lead to better healthcare, even with limited resources and helps to develop guidelines for other such health centers [2]. Innovations are essential, not only for research, but also to accelerate the development of personalized treatments and quality care at grassroot label and within reach of healthcare institution of developing countries [81]. Collaborative efforts helps particularly in developing new technologies, implants, orthotic and prosthetic devices, and conducting, multidisciplinary clinical trials [82].

3.10.1 Collaborative Research on Implants and Techniques

Orthopaedic implants design and newer innovation of implants is benefitted immensely from IPE [34]. 3D and 4D printing technologies have revolutionized the innovation of newer and better implants. Thus patient-specific implants and more precise implants according to different age, sexes and anatomical position are taken into consideration during the innovation [83]. Biomedical engineers, and material scientists in collaboration with Orthopaedic surgeons, are able to create creation more specific and durable implants that improve outcomes with much less complication due to implant and minimize recovery times [84]. Robotics, custom-made implants and rapid development of prototyping techniques, helps to orthopaedic surgeon in simplifying complex surgery to some extent [85].

3.10.2 Development of New Orthotic and Prosthetic Devices

IPE collaborative teams involving prosthetists, engineers, and rehabilitation experts in addition to Orthopaedic surgeon work together to develop newer and more efficient **Orthotic and Prosthetic Devices** for better, comfort, and patient satisfaction [87]. Addition of 3D printing, enable better customization of these devices according to individual patient needs [88]. 4D printing technology is still emerging and offers better adaptability of these devices with better response to environmental stimuli, and overall patient satisfaction [83].

3.10.3 Multidisciplinary Clinical Trials in Orthopaedics

Integration of IPE in designing as well as in execution of multidisciplinary clinical trials that evaluate interventions, surgical technique to rehabilitation are significant [82]. It involves collaboration between different specialities viz surgeons, physician physiotherapists, radiologists, and rehabilitation specialists [32]. This approach involves in preoperative, intraoperative as well as postoperative rehabilitation, which lead to more effective management protocols [89]. Thus IPE enhances the preparedness as well as effectiveness of clinical trials, to produce more reliable findings intern benefit different groups of patients [34].

3.11 Future Directions in IPE for Orthopaedics

IPE ensures teamwork, better health services and ensure collaboration of different medical speciality effectively in complex clinical settings [1,31]. The future of IPE needs to address emerging challenges in Orthopaedic care especially in rural set ups, during training program such as residency and fellowship programs, aiming to better healthcare, and knowledge sharing worldwide.[90]

3.11.1 Expanding IPE to Rural and Remote Care Settings

One of the most promising directions for IPE in Orthopaedics is its expansion into rural and remote care settings [91]. As the World Health Organization (WHO) emphasizes, work-based IPE has the potential to modify practices and improve patient care, particularly in underserved regions where resources are often limited [7]. By incorporating IPE into rural healthcare delivery, Orthopaedic teams can leverage collaborative skills and share expertise to overcome the shortage of specialists [34]. Integrating IPE into the existing healthcare frameworks rather than offering it as a separate course, as highlighted by the National Institutes of Health (NIH), ensures a more sustainable and viable approach [1,92]. This allows healthcare professionals in rural areas to enhance their competencies in collaborative care, improving patient outcomes even in resource-constrained environments [93].

3.11.2 Integrating IPE into Residency and Fellowship Programs

Integration of IPE during fellowships as well as residency is essential helps in for shaping future collaborative practice as well as to keep future Orthopaedic professional updated in clinical skills [1,7,34]. It also helps to understand the roles and contributions of different healthcare professionals [31]. Such integration promotes teamwork and patient specific care [94]. It also helps Orthopaedic trainees to better prepared for multidisciplinary work, even when there is scarcity of other speciality in the institution. Trainees will able to collaborate more effectively with other health professionals in their parent institution after completion of the course [1,19]. Thus, understanding the role as a team player also helps in better judgement in the clinical setting and improved outcomes in complex cases [15].

3.11.3 Role of IPE in Value-Based Orthopaedic Care

Value-based care is another aspect in shaping the future of IPE in orthopaedics. This approach prioritizes patient outcomes, cost-effectiveness, and satisfaction. Goals are best achieved through teamwork [21]. IPE helps healthcare providers collaborate to create efficient, patient-centered treatment plans and guidelines. By improving communication and coordination, it ensures high-quality care while making the best use of resources [1,2]. Research shows that integrating IPE into healthcare teams improves patient experiences and improves clinical outcomes, making it a vital part of modern orthopaedic care [79].

3.11.4 Global Networking and Knowledge Sharing

Global collaboration and knowledge sharing are essential to the future of IPE in orthopaedics. Working across borders helps improve healthcare around the world [1,34]. Through international collaboration, professionals can share research, clinical experience, and new treatment approaches [95]. This exchange of ideas and the latest advances in orthopaedic care are the key roles IPE plays. It bridges knowledge gaps and promotes shared learning across different healthcare systems [1,7]. Ultimately, a strong global network ensures that new techniques, treatments, and care models reach patients everywhere.

3.12 Limitations

This review has some limitations, which includes bias during literature search, as relying on specific databases and keywords may miss relevant studies in less accessible journals and publications of other language. Only published research is taken into consideration, but real-world experiences of clinical settings of developing world, which remain unpublished are not included. Differences in methodology across studies is another obstacle to draw broad conclusions. The review primarily considers healthcare professionals' perspectives, with less focus on patient experiences, which are essential for a full understanding of the impact of IPE. While implementation challenges are discussed, the institutional barriers of different healthcare settings may not be fully addressed. More research of current timeline is needed to evaluate how IPE strategies work in different orthopaedic environments.

Conclusion

IPE helps healthcare professionals in Orthopaedics speciality to work better needs working together. By improving communication, defining roles, and encouraging shared decision-making, IPE leads to improved patient outcomes. Practical teaching methods such as case-based learning and simulation training helps in building strong teamwork skills. While there are challenges to implement IPE, practical solutions can make it easier to adopt in clinical settings. Strengthening collaboration through IPE can transform orthopaedic education and practice, improving patient care worldwide.

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Conflict of Interest

None of the authors have any competing interests to disclose.

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Author's Contribution

JSB: Conceptualization, Data Analysis, Literature Search, Manuscript writing, editing and final approval; RV: Conceptualization, Data Curation and Analysis, Literature Search, Manuscript writing, editing and final approval; JM: Conceptualization, Manuscript editing, and final approval;

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