Commentary

Orthopedic Residency Programs: What are Our Current Goals? An International Society of Orthopedic Centers (ISOC) Delphi Consensus

HSS Journal®: The Musculoskeletal Journal of Hospital for Special Surgery
1–8

DOI: 10.1177/15563316251337359
journals.sagepub.com/home/hss
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Keywords
orthopedics, global health, residency training, medical education, curriculum

Received March 24, 2025. Accepted April 1, 2025.

Introduction

Orthopedic residency poses a challenge to current educational institutes, as the number of applicants is rising [7]. Orthopedic postgraduate education is a critical component of shaping surgeons who are technically proficient, possess a solid foundation in theoretical knowledge, are empathic, and apply ethics during patient care [7]. There remains considerable variability in the structure and content of orthopedic education, as well as in evaluation methods of residency programs worldwide, often driven by differences in healthcare systems and available resources that affect the quality of training [14].

Recent technological innovations, changing patient demographics, and a growing emphasis on competency-based rather than time-based training have created rapid evolution in medical education. The lack of universally accepted standards has led to disparities in the level of preparedness among orthopedic residents [18].

As healthcare becomes increasingly globalized, it is imperative to define the core components of orthopedic postgraduate programs. In response to these challenges, an international Delphi consensus process was performed to establish a set of recommendations for postgraduate orthopedic education with the aim of guiding the development of programs that are both rigorous and responsive to present challenges [14]. This commentary presents the resulting recommendations that serve as a dynamic blueprint for institutions worldwide, facilitating continuous improvement in training quality, fostering innovation, and enhancing patient outcomes.

Methods

A modified Delphi technique was used to gather, refine, and solidify expert opinions through anonymous survey rounds. An initial open-ended survey was sent to 10 selected experts in

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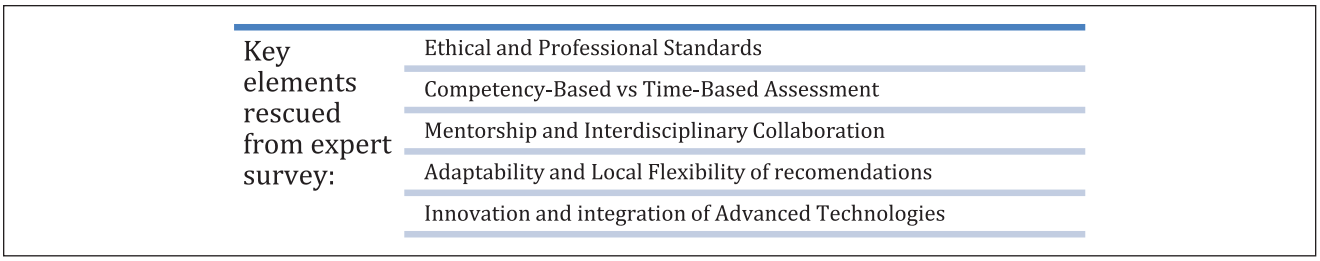

Fig. 1. Main domains rescued from open-ended expert survey.

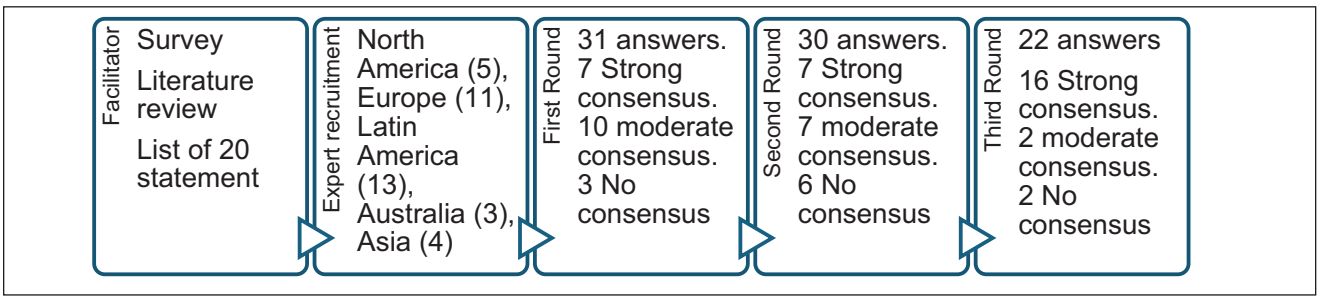

Fig. 2. Expert participation and the process of work.

orthopedic surgery residency to gather their concerns and identify relevant topics by the senior author. Their input guided a literature review, forming the basis for developing the initial survey for round 1 (Fig. 1), which consisted of 20 statements in English. The expert panel (Fig. 2) was formed based on a nominative process to recognize the relevant experts in the research topic because of their knowledge, experience, and/or membership in the International Society of Orthopedic Centers (ISOC). Each round was performed in anonymity.

In the first round, the survey was meant to capture a broad spectrum of opinions and to identify and classify the topics according to the level of consensus. This highlighted the levels of agreement among the experts as statements in the following rounds were modified according to the analysis of answers from each round. This round was performed online.

In the second round, in response to the feedback received during round 1, the survey items were refined to address emerging concerns. Ambiguous items were clarified, and a summary of the initial round's results was provided to the participants. Relevant discussion of each item was performed in the 11th ISOC conference hosted in Clinica Alemana de Santiago, Chile, between 13 and 16 November 2024. Experts were then asked to re-rate the revised statements, facilitating a convergence of opinions toward a common viewpoint. At the end, experts were presented with aggregated responses from rounds 1 and 2.

The third round, the final round, was carried out in an online manner. It was focused on resolving any remaining uncertainties and confirming the strength of consensus on each statement. This served as the basis for the recommendations presented in this manuscript.

A 5-point Likert scale was utilized ("strongly disagree" to "strongly agree"). Consensus was defined a priori as achieving at least 80% agreement (the combination of "agree" and "strongly agree" responses). Moderate consensus was between 60% and 80%, and below 60% was no consensus. The format of 20 statements was maintained irrespective of previous round answers; the committee and authors were allowed to vote, and no financial support was provided to voters.

Descriptive statistics were calculated for each statement. The intraclass correlation coefficient and Cohen's Kappa index were used to indicate stability between rounds. Statistical analysis was performed using STATA v18 (STATACORP, TEXAS, USA). ACcurate COnsensus Reporting Document (ACCORD) guidelines were followed.

Results

The consensus process was carried out from August 2024 to February 2025. Of the 20 statements evaluated by the working group (S1 through S20), 16 reached a strong consensus, 2 achieved moderate consensus, and 2 were below the threshold for consensus (Table 1). Two statements achieved unanimous (100%) support. Interclass correlation, results from the consensus third round, and supporting literature are shown in Supplemental Tables 1–3.

S1: Residency programs need to implement robust, objective metrics to evaluate competency, ensuring that early graduation does not compromise training quality. The introduction of competency-based models could allow faster progression for advanced residents while maintaining a minimum threshold for proficiency.

Table 1. List of final statements in descending order, per level of agreement.

Statement		% of agreement
Strong consensus		
S4	The curriculum of orthopedic postgraduate programs should incorporate ethical and professional standards to uphold the profession's integrity.	100
S7	Mentorship programs should include formal mentor training to ensure effective guidance. Systematic feedback from residents regarding the quality of mentorship can help maintain high standards and enable programs to adapt to evolving needs.	100
S5	OSCEs should be integrated into a broader assessment framework, supplemented by additional tools that standardize the evaluation of surgical skills. Their contribution to the overall assessment process should be balanced with other methods to ensure comprehensive evaluation.	95.45
S11	Programs should emphasize the importance of patient-centered care, ensuring residents develop skills in communication, empathy, and patient engagement.	95.45
S12	Residency programs should encourage the integration of advanced technologies, such as robotics and telemedicine, when feasible, with a focus on enhancing training.	95.45
S16	There is a conflict of interest between early specialization in orthopedic training, which results in shorter programs, and the importance of acquiring a broad range of orthopedic knowledge and practical skills to secure consultant positions later on.	95.45
S17	Surgical skill laboratories are strongly recommended as the gold standard for training; however, their universal application may depend on the available resources.	90.95
S1	Residency programs need to implement robust, objective metrics to evaluate competency, ensuring that early graduation does not compromise training quality. The introduction of competency-based models could allow faster progression for advanced residents while maintaining a minimum threshold for proficiency.	90.90
S6	Collaboration with other medical specialties is crucial for enhancing the training and overall competency of orthopedic residents. Rotations in specialties such as surgery, anesthesia, emergency medicine, and others are highly valuable.	90.90
S8	High-fidelity simulation training, including Virtual Reality and augmented reality, should be encouraged as key components of orthopedic residency programs.	90.90
S9	Increasing equitable funding for residency programs should be prioritized to enhance the quality of orthopedic education and training worldwide.	90.90
S13	Faculties and staff should foster a non-discriminatory environment that is open to all, ensuring merit-based opportunities while promoting inclusivity.	90.90
S20	Programs should establish quotas to ensure that residents have sufficient opportunities for hands-on surgical training.	90.90
S3	Orthopedic postgraduate programs should explore schedules that balance clinical demands with mental health needs, fostering a culture of sustainable training	86.36
S10	Programs should balance local adaptability with the need to prepare residents for global practice.	86.36
S19	Educators should gradually integrate validated Artificial Intelligence tools into residency programs, focusing on enhancing clinical decision-making.	86.36
Moderate consensus		
S15	Research and innovation stimulate residents' cultural growth and critical thinking. It should not be imposed but should be chosen in the area that is most stimulating for each resident.	72.73
S2	While 5 years may seem lengthy, this duration ensures adequate exposure to diverse cases, subspecialties, and surgical procedures. Shortening the duration risks insufficient preparation, particularly in areas that require high levels of surgical skill or advanced knowledge.	72.27
No consensus		
S18	Only after residents have demonstrated that they possess the necessary skills and knowledge to perform the surgery in simulators and laboratories should they return to the operating theatre, where they will be allowed to perform the procedures under the supervision of senior surgeons with continuous feedback.	59.09
S14	Orthopedic programs must be oriented early toward a subspecialty, allowing residents to choose their preferences from the beginning. In this way, general orthopedic programs should be abandoned.	22.73

OSCEs objective structured clinical examinations.

90.91%: High consensus.

Discussion: Traditional time-based models have been criticized for not accommodating individual learning differences [10]. Competency-based frameworks allow for accelerated progression when proficiency is achieved while safeguarding the minimum standards required for independent practice. It is expected that they will correlate more strongly with future clinical performance and can enhance both educational outcomes and patient care [10, 11]. Adequate assessment strategies and a minimum time for skill development should be considered.

S2: While 5 years may seem lengthy, this duration ensures adequate exposure to diverse cases, subspecialties, and surgical procedures. Shortening the duration risks insufficient preparation, particularly in areas that require high levels of surgical skill or advanced knowledge.

72.27%: Moderate consensus.

Discussion: A 5-year residency is frequently cited as providing the training needed to achieve the versatility in surgical techniques and clinical decision-making necessary for independent practice. Proponents of this model argue that compressed programs risk insufficient procedural volume and may not equip residents with the advanced competencies required. Moreover, complex surgical procedures often demand sustained mentorship and repetitive skill refinement, both of which can be compromised if training duration is shortened [23]. How long the minimum length should be for residents who perform better in competency-based training is still up for debate.

S3: Orthopedic postgraduate programs should explore schedules that balance clinical demands with mental health needs, fostering a culture of sustainable training.

86.37%: High consensus.

Discussion: While excessive workload has been linked to increased burnout and decreased well-being among residents, programs that integrate structured wellness initiatives and flexible scheduling have shown a decrease in burnout rates and overall performance improvement. Sustainable training models, with a maximum level of work-hours (70–80/per week), are associated with enhanced learning outcomes and long-term career satisfaction, making it each institution's job to consider, define, and enforce the upper limit [30]. This approach supports the well-being of residents and helps ensure a resilient workforce capable of high-quality medical attention.

S4: The curriculum of orthopedic postgraduate programs should incorporate ethical and professional standards to uphold the profession's integrity.

100%: Unanimous consensus.

Discussion: Strong ethical training guides decision-making and fosters trust between patients and physicians. Integrating ethics and professionalism early in training helps residents navigate complex clinical scenarios and diverse cultural contexts, as it has been linked with improved team collaboration in high-stakes clinical environments [29]. Proven strategies for developing professionalism include case-based learning, interactive discussions, and the use of OSCEs. These methods can specifically target skills such as acknowledging and learning from mistakes, effective communication across all levels, and overcoming interdisciplinary challenges inherent to team-based care.

S5: Objective Structured Clinical Examinations (OSCEs) should be integrated into a broader assessment framework, supplemented by additional tools that standardize the evaluation of surgical skills. Their contribution to the overall assessment process should be balanced with other methods to ensure a comprehensive evaluation.

95.45%: High consensus.

Discussion: OSCEs have long been recognized as a valuable component of medical assessments, evaluating clinical and communication skills, but they should not be the sole measure of a resident's abilities, particularly in surgical disciplines. Surgical skills require evaluation through multiple modalities to capture the full spectrum of technical and decision-making abilities [20].

S6: Collaboration with other medical specialties is crucial for enhancing the training and overall competency of orthopedic residents. Rotations in specialties such as surgery, anesthesia, emergency medicine, and others are highly valuable.

90.91%: High consensus.

Discussion: Interdisciplinary collaboration is widely recognized as a key element in the development of comprehensive clinical skills among residents, and it can broaden their clinical perspectives and enhance decision-making abilities in complex scenarios. Interdisciplinary experiences foster communication and teamwork skills that are essential for effective collaboration in modern healthcare settings [17]. These experiences and proper rotations should be considered and adjusted to satisfy the needs of local requirements, develop interdisciplinary relationships, and acquire skills best trained in different scenarios.

S7: Mentorship programs should include formal mentor training to ensure effective guidance. Systematic feedback from residents regarding the quality of mentorship can help maintain high standards and enable programs to adapt to evolving needs.

100%: Unanimous consensus.

Discussion: Effective mentorship depends on 2 key elements: formal mentor training and systematic feedback. Well-trained mentors are better equipped to provide clear guidance, facilitate professional development, and support the complex learning needs of residents [1]. Training the mentors improves their communication skills and their ability to set clearer expectations. Feedback from mentees serves as a critical tool for quality assurance; it enables programs to identify strengths and areas for improvement in mentorship practices [1,6]. Mentorship remains a dynamic, high-standard component of resident education.

S8: High-fidelity simulation training, including virtual reality and augmented reality, should be encouraged as key components of orthopedic residency programs.

91.91%: High consensus.

Discussion: High-fidelity simulation training has gained significant attention in surgical education by providing a safe, controlled, and reproducible environment for residents to practice complex procedures without risk to patients. Virtual reality training can improve technical skills, enhance spatial awareness, and accelerate the learning curve for surgical procedures. Simulation is associated with improved decision-making and procedural confidence, which are critical in high-stakes surgical environments [16].

S9: Increasing equitable funding for residency programs should be prioritized to enhance the quality of orthopedic education and training worldwide.

90.91%: High consensus.

Discussion: Disparities in funding can lead to significant differences in educational resources, access to advanced technologies, and opportunities for research and simulation training. Enhanced funding is associated with improved educational and patient-related outcomes and greater resident satisfaction. Equitable funding ensures that programs can provide training of comparable quality, contributing to a more uniformly skilled surgical workforce on a global scale [15].

S10: Programs should balance local adaptability with the need to prepare residents for global practice.

86.36%: High consensus.

Discussion: Training should be tailored to local needs, available resources, and cultural contexts to ensure immediate applicability, while still providing exposure to internationally recognized standards measured through objective assessment [27]. This balance fosters versatility, enabling residents to adapt to both resource-rich and resource-poor settings as well as a globalized healthcare environment. Incorporating international benchmarks into local curriculum elevates the quality of training and facilitates cross-border collaboration in research and clinical practice [27].

S11: Programs should emphasize the importance of patient-centered care, ensuring residents develop skills in communication, empathy, and patient engagement.

95.45%: High consensus.

Discussion: Residents who develop strong communication skills, empathy, and active patient engagement are more likely to achieve better clinical outcomes and higher patient satisfaction [4]. Training that prioritizes these skills, such as courses focusing on clear communication, patient involvement and recognizing emotions, improving individual patient interactions, and fostering a culture of collaboration and trust within healthcare teams, is essential and incorporating it into residency curriculum and has been linked to communication clarity and a more integral approach to treatment planning [9].

S12: Residency programs should encourage the integration of advanced technologies, such as robotics and telemedicine, when feasible, with a focus on enhancing training.

95.45%: High consensus.

Discussion: Integrating technologies to enhance surgical training and clinical decision-making is a valuable approach in modern education. Studies indicate that robotics can improve precision and reproducibility in complex surgical tasks, while telemedicine expands access to expert consultation and remote learning opportunities. Adequate technologies can help in technical skill development and encourage critical thinking and adaptability. The incorporation should be guided by resource availability and validated evidence, complementing traditional hands-on training [5].

S13: Faculties and staff should foster a non-discriminatory environment that is open to all, ensuring merit-based opportunities while promoting inclusivity.

90.91%: High consensus.

Discussion: When faculties and staff ensure that opportunities are available for anyone that meets predefined criteria, all residents can thrive, which is associated with improved academic performance, greater job satisfaction, and better patient care [12]. Inclusivity has been linked to the development of a more resilient workforce capable of meeting the challenges of a diverse patient population, enriching the educational experience [26].

S14: Orthopedic programs must be oriented early toward a subspecialty, allowing residents to choose their preferences from the beginning. In this way, general orthopedic programs should be abandoned.

22.72%: No consensus.

Discussion: Comprehensive general training provides residents with a solid foundation across all aspects of musculoskeletal care, ensuring that they develop versatile clinical judgment and robust technical skills before narrowing their focus. Worldwide medical training is mainly focused on this approach. Early sub-specialization can risk creating a narrow skill set, potentially leaving residents ill-prepared to manage clinical scenarios encountered in general practice or emergency [29]. Broad exposure during residency is needed to identify areas of interest and aptitude, guiding more focused training during the later years of education. Retaining a generalist phase fosters adaptability and helps acquire a comprehensive understanding of orthopedic principles, though the level of knowledge is not as easily approachable as it was in the past [13,24]. Defining the correct length of training before sub-specialization may be the new challenge.

S15: Research and innovation stimulate residents' cultural growth and critical thinking. It should not be imposed but should be chosen in the area that is most stimulating for each resident.

72.73%: Moderate consensus.

Discussion: Research and innovation are catalysts for developing critical thinking and helping increase medical knowledge. Exposure to research fosters analytical skills and encourages a questioning attitude, but forcing research requirements may lead to disengagement among residents whose interests lie elsewhere [2]. Allowing students to select research areas that align with their interests can enhance motivation and may lead to higher-quality output and provide a more meaningful educational experience [2]. This individualized approach respects the diversity of interests within residency and supports the development of tailored expertise.

S16: There is a conflict of interest between early specialization in orthopedic training, which results in shorter programs, and the importance of acquiring a broad range of orthopedic knowledge and practical skills to secure consultant positions later on.

95.45%: High consensus.

Discussion: Early specialization in orthopedic training can lead to shorter programs that foster focused technical skills, but evidence suggests this approach may not adequately prepare residents for independent practice. A survey of Ontario graduates revealed that only 62.8% felt ready to enter practice immediately after residency, with many relying on additional fellowships to bridge gaps. This may impose constraints that limit career flexibility [21].

S17: Surgical skill laboratories are strongly recommended as the gold standard for training; however, their universal application may depend on the available resources.

90.95%: High consensus.

Discussion: Simulation-based training can significantly enhance technical skills and procedural proficiency. This provides a safe environment to practice and refine their surgical techniques without risking patient safety, reducing learning curves, and improving operative performance through immediate feedback [8]. The significant financial investment and high costs associated with advanced equipment and ongoing operational expenses can limit widespread implementation, making cost–benefit analysis a critical component in justifying such expenditures.

S18: Only after residents have demonstrated that they possess the necessary skills and knowledge to perform the surgery in simulators and laboratories should they return to the operating theatre, where they will be allowed to perform the procedures under the supervision of senior surgeons with continuous feedback.

59.09%: No consensus.

Discussion: Simulation does not fully replicate the complexities and unpredictability of real-life operative conditions. Overreliance on simulation may affect clinical exposure, limiting intraoperative decisions, as the effectiveness of simulation training can vary based on the fidelity of the simulator and the available resources. The expertise of senior surgeons in evaluating readiness is indispensable; guidance during early operative experiences can provide insights that simulation metrics overlook, and objective metrics may be used to complement this assessment [3,22].

S19: Educators should gradually integrate validated Artificial Intelligence tools into residency programs, focusing on enhancing clinical decision-making.

86.36%: High consensus.

Discussion: Integrating validated AI tools into medical practice, including residency programs, can provide easier access to data-driven insights and evidence-based practices [28]. These tools can reduce diagnostic errors and improve treatment planning by synthesizing vast amounts of clinical data quickly, but it is not without fault, as specific tools may perform differently and are susceptible to mistakes. The integration of AI should be gradual with rigorous validation and comprehensive training, as the effectiveness of AI is dependent on the quality of data and the specific clinical context [25]. Other potential uses are in research, serving as a data processing tool, a guidance provider, statistical analysis support, search refinement, and a document synthesizer [28].

S20: Programs should establish quotas to ensure that residents have sufficient opportunities for hands-on surgical training.

90.90%: High consensus.

Discussion: It is the educational institution's responsibility to ensure that each resident can achieve a minimum number of procedures. Structured case quotas help to standardize training across different programs, reduce variability in operative exposure, and can serve as objective benchmarks for competency, ensuring that residents do not graduate without adequate practical experience. Rigid quotas might lead to an overemphasis on quantity over quality and not fully account for the complexity or educational value of each case [19]. Combining quota volume with surgical complexity, surgical planification and preparation, and competency assessments can better ensure that training is both quantitative and qualitative.

Discussion

Strengths: This is an international effort to standardize and elevate orthopedic residency training with a diverse panel of experts, ensuring that the consensus reflects a wide range of perspectives across different healthcare systems. The high level of agreement on many key recommendations provides a clear framework for educational institutions.

Limitations: The variability in training needs and resources among institutions may limit applicability. The inherent subjectivity of the Delphi method also remains a consideration when interpreting the consensus data.

Future Perspectives: We offer a blueprint for the evolution of orthopedic residency programs. Future research should focus on longitudinal studies that evaluate the impact

on resident competence and patient outcomes. Exploring adaptive curricular models and sustainable funding mechanisms may help training programs to remain both cutting-edge and contextually relevant. Future ISOC meetings will include follow-up surveys to evaluate modifications to the curriculum at these centers.

Conclusion

This consensus provides a framework for enhancing orthopedic residency programs. The recommendations emphasize 16 strong recommendations and 2 moderate recommendations. These statements can guide curriculum development, ensuring training aligns with contemporary clinical and educational demands. Continued research and adaptation will be essential to apply these guidelines and ensure they remain responsive to evolving clinical and educational demands globally.

Declaration of Conflicting Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Human/Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration.

Informed Consent

Informed consent was not required for this commentary.

Required Author Forms

Disclosure forms provided by the authors are available with the online version of this article as supplemental material.

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Supplemental Material

Supplemental material for this article is available online.

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