Article

What Surgeons Want: Access to Online Surgical Education and Peer-to-Peer Counseling—A Qualitative Study

Astrid D. Häberle, DDS, MSc[1] ⦿, Riya Nath, BS[2],
Shelley N. Facente, MPH[3,4], Autumn E. Albers, BA[3,4],
and Sabine Girod, MD, DDS, PhD[2] ⦿

Abstract

Study Design: Mixed methods study including quantitative data analysis and qualitative analysis of semi-structured interviews.

Objectives: Utilizing information and communication technology can facilitate professional communication within health care on a global scale. This study aimed to identify the educational and peer-to-peer communication needs of cranio-maxillofacial (CMF) surgeons across the globe, determine preferred modes of communication, and assess technological and other barriers to online education and peer-to-peer communication.

Methods: We performed semi-structured videoconference interviews of 92 CMF surgeons from around the globe, with the largest number in the Asia/Pacific region, the Middle East, and Latin America. We triangulated quantitative summaries with qualitative themes to improve validity and enable a more comprehensive understanding of participant perspectives.

Results: The interviews revealed 3 main areas of technology use: *new surgical technology*, *technology that enables information exchange*, and *communication technology*. When asked about technology and communication platforms used in the course of their work, 33 participants (36%) mentioned PubMed or other journal-related sites; 25% recalled using YouTube as a resource; 23% described conducting internet searches using Google or other search engines; 21% used WhatsApp groups; and 11% used closed Facebook groups.

Conclusion: CMF surgeons embraced communication technologies that allowed them to quickly obtain knowledge especially on new surgical technology, discuss cases on demand, and maintain strong communication with their global peers.

Keywords

social media, technology, peer-to-peer communication, online education

Introduction

Injuries are a huge global socioeconomic burden; in 2017, they caused 4.5 million deaths, and head injuries were responsible for 6.9 million disabilities.[1,2] Unfortunately, low- and middle-income countries (LMICs) are particularly vulnerable to the impact of injuries due to shortfalls in infrastructure, supplies, and surgeons trained in advanced procedures.[3,4] This is particularly notable for injuries located within the head, face, and neck area, which require specific training for surgical treatment. Thus, comprehensive and sustainable solutions are needed to improve craniomaxillofacial (CMF) surgical patient care and medical training, especially in developed countries.

Some initiatives have focused on having surgeons or surgical residents from well-resourced countries briefly visit a developing country to offer services and training; however, these efforts have had limited success due to the broad

[1] Department of Health Research and Policy, Stanford University, Stanford, CA, USA
[2] SSPIRE, Department of Surgery, Stanford University, Stanford, CA, USA
[3] Facente Consulting, Richmond, CA, USA
[4] School of Public Health, University of California, Berkeley, CA, USA

Corresponding Author:
Sabine Girod, SSPIRE, Department of Surgery, 1070 Arastradero Rd. Stanford, CA 94305, USA.
Email: sgirod@stanford.edu

spectrum of surgical needs and challenging conditions of the visited areas.[5] Another approach is to develop local training programs and peer-to-peer consulting, by offering incentives to improve retention of trainees, as well as developing and implementing policies to address local training needs.[6] Some have proposed establishment of dyads between developed and developing countries for training and ongoing support of international and local staff.[7]

With recent changes in technology, online learning and social media communication offer a promising approach to shared learning environments and peer communication virtually and globally. Many studies have evaluated how new technologies and social media are currently being used, and how best to integrate such tools into medical education.[8,9] Other studies have assessed how peer-to-peer communication via social media and other apps have improved medical training and clinical performance.[10-14] A systematic review of 33 articles found that social media enhanced and facilitated peer communication and information sharing.[15] Studies also show that online technologies can help spread knowledge quickly, which gives users fast and easy access to cutting-edge information.[14,16]

The use of social media as a medical tool has been studied at different training levels and in a variety of medical fields, but the reliability and utility of the information received have yet to be determined.[12,17] Many studies report that health-care professionals use communication tools like Facebook, WhatsApp, and Twitter to efficiently communicate with other professionals and medical students.[11,13,18,19] Some researchers report that medical professionals who use social media are usually younger, less-experienced, and have a lower rank,[15,18] and are often passive users who tend to read more than participate.[20] Rolls et al found that the main reason for creating virtual communities was to share advanced knowledge and discuss professional problems.[20] A study by Elbuluk and colleagues explored the effect of establishing a messaging system compliant with HIPAA among orthopedic surgeons; the participants in this study felt that their surgical decisions were well supported, care of their patients was facilitated, and they experienced professional development and mutual learning.[21]

In order to apply limited resources strategically, it is necessary to understand the needs, communication preferences, and technical capabilities of surgeons in developed and resource-constrained countries. To date, no studies have gathered opinions from CMF surgeons about using online resources to further their education or facilitate peer-to-peer communication. Therefore, the current study aimed to (1) evaluate the perception of global CMF surgeons of the communication platform offerings, (2) assess the improvement needs of peer-to-peer communication, and (3) gather surgeons' perception of online education. Our findings form a basis for strategic recommendations for online education and peer consulting to support CMF surgical educational programs and practice globally.

Materials and Methods

We conducted a mixed-methods study to explore perceptions and preferences of CMF surgeons around the world regarding the use of technology and communications platforms to improve surgical skills. Between 2018 and 2019, we invited all CMF members of the AO Foundation (Switzerland) to participate in an interview on how to meet their educational needs. All surgeons who showed interest were contacted to arrange a phone call or videoconference. We ultimately interviewed 92 CMF surgeons via a 30-minute, one-on-one videoconference. Our study participants were comprised of clinicians from all around the world with specialties in oral and maxillofacial surgery, plastic surgery, ear–nose–throat surgery, head and neck surgery, ophthalmology, and neurosurgery. Each interview followed a semi-structured interview guide, designed using standard practices for qualitative interviews in medical research, specifically accounting for known biases in interviews.[22] We audio recorded the interviews after obtaining oral consent from the participants. We professionally transcribed the interviews verbatim, including translating to English whenever applicable. Translated interviews were checked for accuracy prior to analysis by bilingual team member.

All participants interviewed during 2019 were subsequently asked to participate in a brief, 19-question closed-ended survey about their experience with educational resources and were asked for suggestions on future materials. We designed this final survey to complement the qualitative interview findings. We administered the quantitative survey online in February 2019 using Qualtrics[XM] (SAP). Each question contained a 5-point Likert-type scale for the response choice. Of the 61 participants asked to complete the survey, an overwhelming majority completed the survey (59/61; 97%).

Two study team members who were not involved in the interviews (S.F., A.A.) qualitatively analyzed all 92 interview transcripts. We developed an initial codebook through an immersion and crystallization process, whereby researchers identify and describe meaningful themes and patterns in the data.[23] Each coder coded approximately half of the interviews while iteratively refining the codebook to reflect ideas derived from the transcripts; at this point, the coders jointly reviewed their refined codebooks and agreed on a final set of codes to use for complete interview analysis. Using the final codebook, S.F. and A.A. each recoded all 92 interviews and then discussed and resolved discrepancies by consensus. After completing the coding process, our study team analyzed the interviews to identify and summarize themes, key quotations, and the frequency of certain responses to questions, including conducting a subgroup analysis by age, experience level, and region whenever possible.

We analyzed the quantitative survey by calculating the mean, median, and mode of the Likert-type response

Table 1. Participant characteristics.

	Number	Percent
Total	92	100
Experience		
Resident	18	19.6
Attending/senior	72	78.3
Unknown	2	2.2
Age (n = 31)		
20s	3	9.7
30s	14	45.2
40s	7	22.6
50s	5	16.1
60s	1	3.2
70s	1	3.2
Region		
Africa	9	9.8
Asia/Pacific	22	23.9
Latin America	19	20.7
Middle East	22	23.9
Europe	12	13.0
North America	8	8.7

for each question, including conducting a subgroup analysis by region. We triangulated quantitative summaries with qualitative themes to improve validity and enable a more comprehensive understanding of participant perspectives.

This study has been approved by the Stanford University Institutional Review Board.

Results

The 92 interview participants had a range of clinical experience, from residents ($n = 17$) to junior and senior surgeons ($n = 72$), and practiced in a variety of clinical settings including private clinics, teaching hospitals, and other environments. Among participants for whom age data were available by decade ($n = 31$), ages ranged from 20s to 70s. Participants hailed from around the globe, with the largest portion practicing in the Asia/Pacific region ($n = 22$), the Middle East ($n = 22$), or Latin America ($n = 19$). Table 1 provides a summary of participant characteristics.

Role of Technology in the Professional Careers of Surgeons

The interviews revealed 3 main areas of technology influencing surgeons' careers globally today. The first was *new surgical technology*, such as virtual and three-dimensional planning and robotic surgery. Strong interest in learning about surgical technology was cited across regions. However, participants from LMICs or more junior surgeons noted limitations in access to new surgical technology. The second area was *technology—that enables information*, such as online videos, journals, and other content. Participants viewed this type of technology as essential for having the most up-to-date, evidence-based field information, especially in LMIC. The third area was *communication technology*, such as digital platforms to connect with surgeons and patients. This type of technology was also popular across regions, although connectivity challenges exist in lower resource settings.

Gadget Preferences

We asked 26 interviewees about their use of "gadgets" to access online surgical resources. Seventeen participants (65%) preferred using their smartphone, while 4 (15%) preferred using a laptop, and 5 (19%) said they used both phones and laptops equally. Among those who were not specifically asked about gadget preferences, the desire for a system that was compatible across platforms (mobile, tablet, desktop—but with most emphasis on mobile/tablet capabilities) was commonly cited. We observed regional trends in gadget preferences, with heavier laptop usage (combined or not) in Latin America, Africa, and Europe compared to Asia. Figure 1 (left) and (right) provides more information about gadget trends by region and age.

Commonly Used Technological Resources

When we asked participants about the technology and communication platforms they used in the course of their work, 33 participants (36%) mentioned PubMed or other journal-related sites; 23 (25%) recalled using YouTube as a resource; 21 (23%) described conducting internet searches using Google or other search engines; 19 (21%) used
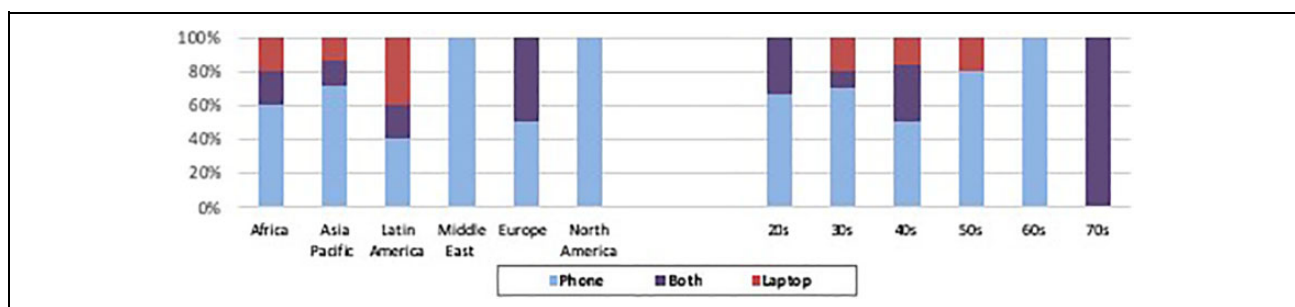

Figure 1. Gadget preference by region (left) and age (right), $n = 26$.

WhatsApp groups; and 10 (11%) used closed Facebook groups. The use of YouTube for surgical instruction or visual examples spread across all regions of the world; however, several more experienced participants described their concerns about "media literacy" of newer surgeons, for whom it may be difficult to judge the quality of technique or instruction.

Variations in Use of Technology

When considering differences by experience levels, junior surgeons reported benefiting more from detailed guidelines and specific surgical videos. By contrast, senior surgeons were more likely to use the resources to refresh their knowledge (particularly on unfamiliar cases), teach less-experienced surgeons, and stay abreast of their own continuing education. The survey data also revealed that online resources are especially important for junior surgeons; participants across all regions agreed that local courses, online courses, and peer-to-peer consulting would benefit their training programs (mean agreement level (AL): 4.6 of 5). When considering differences by region, US survey participants ($n = 3$, all experienced surgeons) were less likely to agree or strongly agree that they used online resources for professional insights (mean AL 3.3), compared to surgeons from outside of the United States (mean AL 4.6).

The participants from Africa, Latin America, the Middle East, and Asia—but not Europe or North America—commonly used WhatsApp for professional use. Less commonly mentioned variations of similar technology used by participants included Viber, Facebook Messenger, Apple iMessage, and IMO. Some participants (particularly those in Africa, Latin America, and Asia) described challenges accessing these types of resources due to poor connection speeds and/or limited English comprehension; for example, multiple participants from Latin America noted a lack of reliable WiFi, and multiple participants from Asia had difficulty connecting to webinars and videoconferences. Participants from these regions often desired more resources that are downloadable for offline use, including webinars, and more resources in Spanish or with subtitles in languages other than English. In contrast, surgeons in Europe and especially the United States noted a reduced need for online resources due to access to specialized systems for case conferencing, literature search, and surgical consultation designed or sponsored by high-resource universities.

Optimal Communication Strategies for Professional Use

Participants shared their thoughts on optimal communication strategies for CMF surgeons, as well as how they would utilize technology and communication in their professional capacity if they had a magic wand. Notably, participants of all ages and regions except Latin America requested more well-designed smartphone apps, instead of resources that require computers. Three other main areas of desired changes emerged, with many participants saying they would use the previously described optimal communication platforms:

1. Interactive case consultation: There was an overwhelming wish (reported by 82% of participants) for interactive, real-time case consultation. The concept of interactive, real-time case consultation took many forms, such as using WhatsApp or Instagram to share images/videos and obtain feedback; e-consult systems, where questions could be easily directed to specific experts; and real-time systems to access experts for consultation immediately, even during surgery. The forums would ideally be accessible across multiple platforms and especially on mobile devices. US surgeons were less likely to want online case discussions or peer-to-peer consulting (mean AL 3.7, compared to 4.8 among surgeons from other regions). However, US surgeons and many other providers interviewed—especially those who were most senior and/or lived in highly developed countries with access to advanced surgical resources—said they would be willing to volunteer their time to answer questions and mentor younger surgeons through this type of system. A system like this would likely require organization by specialty and by region/language, with time zone coordination of "on-call" consulting surgeons to ensure real-time access. It would need to be secure and closed, with viewers and feedback identified by name and credential; numerous participants also noted that a system like this would require thoughtful attention to security and legal/liability issues, particularly for US surgeons.

2. Opportunities to connect with surgeons internationally: Ultimately, the role of professional networks was paramount, with the vast majority of participants eager to connect with other surgeons in a safe, comfortable environment that would allow for a collective improvement in skills while building a supportive community. There were 3 categories in which participants encouraged increased structure and support for networking. First, *WhatsApp groups* were preferred by participants in all regions except North America and Europe, as it gives participants fast access to their colleagues via an encrypted platform; surgeons felt they could confidentially share information and receive a real-time response while working on a case. Second, participants requested *RSS feeds*, or the opportunity to set up customized notifications or emails regarding educational opportunities, new research, or other topics of interest. Anyone who was asked directly responded very favorably to the idea of having customized resources pushed to them rather than the

resources being passively available if participants had the time and forethought to search. Third, surgeons across regions and especially those outside of the United States and Europe were enthusiastic to participate in a *scientific and educational congress*, with more than 96% of survey participants ($n = 57$) agreeing or strongly agreeing that they would attend. For surgeons living in Asia, Africa, and the Middle East, it was particularly important to host the congress in a location close to home or to offer an online option to reduce travel costs and logistical challenges.

In general, senior surgeons or surgeons in medical settings where there were many colleagues working in the same field noted that they could directly contact these professional networks to ask questions and did not need to rely on other resources to answer case-related questions. In contrast, surgeons who were the only one from their field at their facility or those who were younger and less connected were more likely to rely on online resources to answer their questions and were more likely to cite the need for more opportunities to consult experts.

3. Improved online video resources: Beyond interactive case consultation opportunities, 30 participants (33%) said they desired more static and livestreaming surgical videos, including a searchable database of lectures and surgery videos. This strategy was described as an opportunity to replace the use of YouTube with similar but more professional resources, ideally with links to relevant publications. Participants repeatedly stressed the importance of a functionality to download videos for offline viewing in areas with poor internet connectivity. In addition to a surgical video platform, 36 people (39%) said they wanted more webinars and interactive-online trainings, which would offer them the opportunity to learn from people around the world without having to travel, which was often cost- or time-prohibitive. The wish for more videos was common among interviewees in their 20s and 30s. Regionally, surgeons from the United States were less likely to agree that a live surgery video platform (mean AL 3.7, compared to a mean AL of 4.7 among surgeons from other countries), or webinars (mean AL 3.7, compared to mean AL 4.7 among surgeons from other countries) would be important.

Discussion

Our findings—drawing from responses of 92 CMF surgeons from both developed and developing countries and across experience levels—suggest that surgeons are interested in new surgical technologies, technology-enabling information exchange, and communication technology. These 3 areas of technology can facilitate knowledge gain, in-depth case discussions, and communication between peers.

Participants agreed that online courses and peer-to-peer consulting would benefit their professional education. Consistent, another study found that apps improved knowledge and clinical security and helped solve problems.[24] A substantial minority of participants (23%) reported using YouTube as an information source. This could be a concern considering that previous studies have reported that YouTube is an inadequate source of information for medical content because of the variability in the quality of the content[17,25]; however, when carefully curated, YouTube has improved learning in other medical fields.[26-28] The interviews revealed that surgeons would like a reliable repository of online surgical videos for trainees, with improved surgical video content and a searchable database by topic. Surgeons also noted that they would like interactive case consultation and the opportunity to interact with international peers. This has been done in another specialty were physicians successfully interacted with international professionals to seek advice, share cases, and to share educational information.[29] Some participants suggested the creation of WhatsApp groups, but as mentioned in previous research, it would be important to find a channel that is HIPAA compliant and protects confidentiality and privacy.[30]

Surgeons in LMIC—particularly younger surgeons—tended to want more apps and interactive platforms that support direct contact with more experienced surgeons elsewhere in the world to discuss cases and techniques. Surgeons from these countries face greater barriers to accessing specialized content, primarily due to cost, but also due to accessibility (eg, the number of physical courses located in a given region), connectivity problems, and language barriers. Conversely, surgeons in more developed countries tended to ask for more downloadable content and surgery-planning tools. These surgeons also reported that they were willing to offer their expertise to others if the opportunity for mentorship existed.

Conclusion

Our study found that CMF surgeons are interested in easily accessible technologies that allow them to quickly obtain new knowledge, discuss cases, and maintain strong communication with their peers. These findings support a model of a shared virtual learning environment to enable peer communication across the globe. Future efforts could use these results to implement optimal strategies to link institutions from developing and developed countries to assist in learning and peer consulting and, ultimately, improve patient care and outcomes. More studies will be needed to evaluate the future impact of such platforms on surgical training and outcomes.

ORCID iD

Astrid D. Häberle, DDS, MSc ⬤ https://orcid.org/0000-0001-6414-540X

Sabine Girod, MD, DDS, PhD ⬤ https://orcid.org/0000-0002-6974-6076

References

1. GBD 2017 Causes of Death Collaborators GA, Abate D, Abate KH, et al. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the global burden of disease study 2017. *Lancet*. 2018;392(10159): 1736-1788. doi:10.1016/S0140-6736(18)32203-7

2. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators SL. Abate D, Abate KH, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the global burden of disease study 2017. *Lancet*. 2018;392(10159): 1789-1858. doi:10.1016/S0140-6736(18)32279-7

3. Contini S, Taqdeer A, Cherian M, et al. Emergency and essential surgical services in Afghanistan: still a missing challenge. *World J Surg*. 2010;34(3):473-479. doi:10.1007/s00268-010-0406-7

4. Van Buren NC, Groen RS, Kushner AL, et al. Untreated head and neck surgical disease in Sierra Leone: a cross-sectional, countrywide survey. *Otolaryngol Head Neck Surg*. 2014; 151(4):638-645. doi:10.1177/0194599814542587

5. Shrime MG, Sleemi A, Ravilla TD. Charitable platforms in global surgery: a systematic review of their effectiveness, cost-effectiveness, sustainability, and role training. *World J Surg*. 2015;39(1):10-20. doi:10.1007/s00268-014-2516-0

6. Gosselin RA, Gyamfi YA, Contini S. Challenges of meeting surgical needs in the developing world. *World J Surg*. 2011; 35(2):258-261. doi:10.1007/s00268-010-0863-z

7. Macpherson L, Collins M. Training responsibly to improve global surgical and anaesthesia capacity through institutional health partnerships: a case study. *Trop Doct*. 2017;47(1): 73-77. doi:10.1177/0049475516665999

8. Mobasheri MH, Johnston M, Syed UM, King D, Darzi A.The uses of smartphones and tablet devices in surgery: a systematic review of the literature. *Surgery*. 2015;158(5): 1352-1371. doi:10.1016/j.surg.2015.03.029

9. Rapp AK, Healy MG, Charlton ME, Keith JN, Rosenbaum ME, Kapadia MR. YouTube is the most frequently used educational video source for surgical preparation. *J Surg Educ*. 2016;73(6):1072-1076. doi:10.1016/J.JSURG.2016.04.024

10. Fehring KA, De Martino I, McLawhorn AS, Sculco PK. Social media: physicians-to-physicians education and communication. *Curr Rev Musculoskelet Med*. 2017;10(2): 275-277. doi:10.1007/s12178-017-9411-x

11. Hamm MP, Chisholm A, Shulhan J, et al. Social media use by health care professionals and trainees: a scoping review. *Acad Med*. 2013;88(9):1376-1383. doi:10.1097/ACM.0b013e31829eb91c

12. Sterling M, Leung P, Wright D, Bishop TF. The use of social media in graduate medical education: a systematic review. *Acad Med*. 2017;92(7):1043-1056. doi:10.1097/ACM.0000000000001617

13. Raiman L, Antbring R, Mahmood A. WhatsApp messenger as a tool to supplement medical education for medical students on clinical attachment. *BMC Med Educ*. 2017;17(1): 1-9. doi:10.1186/s12909-017-0855-x

14. Choo EK, Ranney ML, Chan TM, et al. Twitter as a tool for communication and knowledge exchange in academic medicine: a guide for skeptics and novices. *Med Teach*. 2015;37: 411-416. doi:10.3109/0142159X.2014.993371

15. Chan WSY, Leung AYM. Use of social network sites for communication among health professionals: systematic review. *J Med Internet Res*. 2018;20(3):1-12. doi:10.2196/jmir.8382

16. Leeuwenburg TJ, Parker C. Free open access medical education can help rural clinicians deliver "quality care, out there". *Rural Remote Health*. 2015;15(3):3185.

17. Sutherland S, Jalali A. Social media as an open-learning resource in medical education: current perspectives. *Adv Med Educ Pract*. 2017;8:369-375. doi:10.2147/amep.s112594

18. Morandeira Rivas A, Riquelme Gaona J, Álvarez Gallego M, Targarona Soler EM, Moreno Sanz C.Use of social networks by general surgeons. Results of the national survey of the Spanish association of surgeons. *Cir Esp*. 2019;97(1):11-19. doi:10.1016/j.ciresp.2018.07.001

19. Firdouse M, Devon K, Kayssi A, Goldfarb J, Rossos P, Cil TD. Using texting for clinical communication in surgery: a survey of academic staff surgeons. *Surg Innov*. 2018;25(3): 274-279. doi:10.1177/1553350618761980

20. Rolls K, Hansen M, Jackson D, Elliott D. How health care professionals use social media to create virtual communities: an integrative review. *J Med Internet Res*. 2016;18(6):e166. doi:10.2196/jmir.5312

21. Elbuluk AM, Ast MP, Stimac JD, Banka TR, Abdel MP, Vigdorchik JM. Peer-to-peer collaboration adds value for surgical colleagues. *HSS J*. 2018;14(3):294-298. doi:10.1007/s11420-018-9616-6

22. Britten N. Qualitative interviews in medical research. *BMJ*. 1995;311(6999):251-253. doi:10.1136/bmj.311.6999.251

23. Borkan J. *Doing Qualitative Research*. 2nd ed.(Crabtree B, Miller W, eds). Thousand Oaks, CA: SAGE; 1999.

24. Mendioroz J, Garcia Cuyas F, Vidal-Alaball J, et al. Social networking app use among primary health care professionals: web-based cross-sectional survey. *JMIR mHealth uHealth*. 2018;6(12):e11147. doi:10.2196/11147

25. Fischer J, Geurts J, Valderrabano V, Hügle T. Educational quality of YouTube videos on knee arthrocentesis. *J Clin Rheumatol*. 2013;19(7):373-376. doi:10.1097/RHU.0b013e3182a69fb2

26. Hughes JP, Quraishi MS. YouTube resources for the otolaryngology trainee. *J Laryngol Otol*. 2012;126(1):61-62. doi:10.1017/S0022215111002337

27. Jaffar AA.YouTube: an emerging tool in anatomy education. *Anat Sci Educ*. 2012;5(3):158-164. doi:10.1002/ase.1268

28. Nason GJ, Kelly P, Kelly ME, et al. YouTube as an educational tool regarding male urethral catheterization. *Scand J Urol*. 2015;49(2):189-192. doi:10.3109/21681805.2014.975837

29. Carmona S, Alayed N, Al-Ibrahim A, D'Souza R. Realizing the potential of real-time clinical collaboration in maternal–fetal and obstetric medicine through WhatsApp. *Obstet Med*. 2018;11(2):83-89. doi:10.1177/1753495X18754457

30. Mars M, Scott RE. WhatsApp in clinical practice: a literature review. *Stud Health Technol Inform*. 2016;231:82-90. Accessed May 31, 2019. http://www.ncbi.nlm.nih.gov/pubmed/27782019