

Review

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# Telemedicine for sarcoma patient care

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**How to cite this article:** Schuetze SM. Telemedicine for sarcoma patient care. *J Cancer Metastasis Treat* 2022;8:41. <https://dx.doi.org/10.20517/2394-4722.2022.38>

**Received:** 18 Apr 2022 **First Decision:** 10 Aug 2022 **Revised:** 19 Aug 2022 **Accepted:** 16 Sep 2022 **Published:** 27 Sep 2022

**Academic Editors:** Lucio Miele, Alessandro De Vita **Copy Editor:** Fangling Lan **Production Editor:** Fangling Lan

## Abstract

Telemedicine is being incorporated into routine healthcare, including oncology. The integration of telemedicine with patient electronic medical records and the adoption of virtual provider-patient encounters was accelerated by the SARS-CoV2 worldwide pandemic. Although telemedicine has existed for more than 50 years, the impact of telemedicine on patient care and health outcomes is relatively understudied, and little research has been conducted on telehealth in the care of patients with sarcoma. This review discusses the potential applications of telemedicine to the care of patients with sarcoma and some of the data available on patient and provider preferences for telemedicine vs. in-person healthcare encounters. Some of the areas of care in which greater adoption of telemedicine may be beneficial to patients with sarcoma are also discussed.

**Keywords:** Sarcoma, telemedicine, telepathology, telehealth, virtual, multidisciplinary

## INTRODUCTION

Telemedicine refers to clinical care provided through the use of telecommunication technologies. In direct patient-related telemedical care, the patient is remote from the medical practitioner rather than in a physical face-to-face encounter in a medical office, clinic or hospital, and communication is made through audio-only or an audio-visual connection. This type of medical evaluation and management is often referred to as a virtual encounter. Telehealth, telehealthcare and e-health are often used interchangeably with telemedicine, although they may also include nonverbal communication through electronic medical record systems or other health communication electronic platforms. More broadly, telemedicine may also occur



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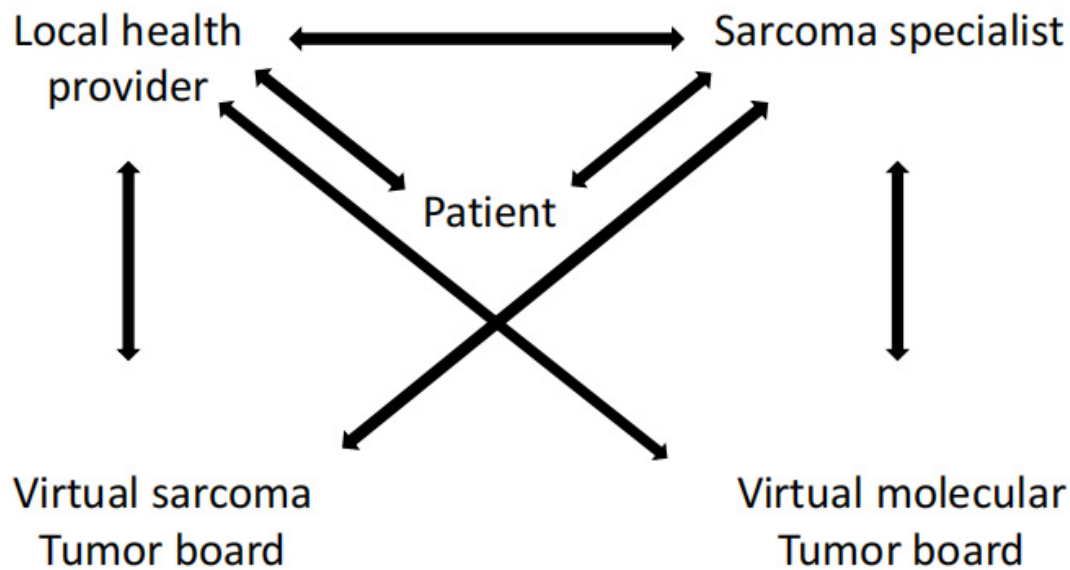


among providers in the care of patients, for example, telepathology used to aid in the diagnosis of disease, virtual multidisciplinary team tumor boards to develop complex disease treatment plans, and electronic consults between healthcare providers. The development of telemedicine has been attributed to the National Aeronautics and Space Administration for the evaluation and management of astronauts during missions in space<sup>[1]</sup>. Implementation in more routine terrestrial health care began in the 1970s as a demonstration project to extend opportunities for quality care to rural populations, populations underserved by specialists and under-resourced areas<sup>[2]</sup>. Physicians in Kansas developed a tele-oncology practice in the 1990s to bring oncology care to rural communities<sup>[3]</sup>. The implementation of telemedicine has been greatly facilitated by the development of the World Wide Web, improvement in computer connectivity and processing speeds, and development of electronic medical record platforms, video-capable platforms for communication, smartphones and healthcare computer applications. The field of telemedicine and telemedicine research is young. However, it is expanding rapidly following the disruption of healthcare delivery caused by the SARS-CoV2 pandemic, and it will likely assume a greater role in the delivery of healthcare around the world in the years ahead.

An overview of telemedicine is beyond the scope of this review; instead, this review is focused on the use of telemedicine to provide medical care for patients diagnosed with sarcoma, including the advantages and limitations of telemedicine. Telemedicine visits for sarcoma patients include, but are not limited to, specialty consultation/second opinion, new patient evaluation, chemotherapy management, symptom management, sarcoma surveillance evaluation and survivorship follow-up. Additionally, expert pathology review of suspected sarcoma cases through telecommunication platforms has been evaluated in international and under-resourced settings, tumor genomic databases for interinstitutional use have been developed, and virtual multidisciplinary tumor boards have been established within academic centers and institutions, nationally and internationally, to facilitate appropriate patient care. Some of the telehealth interactions which may be used to enhance sarcoma patient care are depicted in [Figure 1](#).

## TELEMEDICINE FOR SARCOMA DIAGNOSIS

The correct diagnosis of sarcoma and sarcoma sub-type is critical for the development of appropriate patient-specific oncology treatment plans for optimal outcomes. At high patient volume healthcare centers, sarcomas are usually diagnosed by pathologists with specialty fellowship training in soft tissue and bone pathology. In low patient volume healthcare settings, diagnosis may be provided by pathologists without advanced training in soft tissue and bone pathology. One study of sarcoma diagnosis based on a review of histopathology detected a 24% rate of discordance in diagnosis between community pathologists and an expert sarcoma reference pathology group, of which 66% of the discordant cases were felt to be clinically relevant due to impact on treatment recommendations<sup>[4]</sup>. Of the cases diagnosed by referring institutions as sarcoma, 13% were diagnosed as diseases other than sarcoma at the reference center. The discordance rate was greater for leiomyosarcoma, liposarcoma and rhabdomyosarcoma, whereas the discordance rate was low for angiosarcoma, Ewing sarcoma and gastrointestinal stromal tumor. Another study detected a discordance rate of 38%, and in 25% of the cases, the change in diagnosis affected treatment<sup>[5]</sup>. These studies highlight the importance of expert pathology review in the diagnosis of sarcoma. Telepathology and implementation of virtual microscopy or whole-slide imaging (e.g., Aperio digital pathology and whole-slide imaging) for the collection, storage and review of digital images of histopathology may expand opportunities for expert review of sarcoma cases in real-time beyond the traditional consultation service based on the review of glass microscopy slides. Remote review of pathology may be conducted on static images of histopathology acquired by a pathologist, dynamically through remote review of slides stationed in a microscope or from whole-slide imaging platforms in which the reviewing pathologist can examine different areas of the slide digitally and change magnification electronically.



**Figure 1.** Telehealth interactions to enhance patient care.

An evaluation of telepathology between 11 pathologists in nine European countries that was focused on sarcoma, prostate cancer and melanoma established that consultation based on a review of static digitized microscopy slides could be conducted but was hampered by the amount of time required to photograph and digitize representative fields of the tissue, variability in image quality and uncertainty about the diagnostic problem requiring consultation<sup>[6]</sup>. To my knowledge, the rate of concordance in diagnosis between the referring and consultant pathologists was not reported. Another evaluation of telepathology of static digitized samples acquired in Tanzania and analyzed in Germany demonstrated a low rate of concordance at 29% between diagnosis rendered by telepathology vs. conventional pathology in a cohort of malignant samples from children in which about 20% of the cases were sarcoma<sup>[7]</sup>. In 15% of the cases, a diagnosis of cancer was missed on telepathology compared to conventional review. Limitations of the study contributing to the high rate of discordance were the lack of immunohistochemistry and special stains and variability in the quality of tissue processing in Tanzania compared to Germany. Dynamic telepathology between a European and an under-resourced African country was evaluated and demonstrated a high concordance rate between pathologists, with the exception of soft tissue sarcoma<sup>[8]</sup>. Limitations cited in the manuscript were variability in the quality of tissue processing, lack of immunohistochemical stains and absence of clinical and molecular data.

Diagnosis of sarcoma sub-types is becoming more dependent on molecular diagnostics, which has a direct impact on cancer treatment. Next generation sequencing (NGS) for detection of gene mutations and fusions to aid in the diagnosis of sarcoma sub-types is expanding and has been assessed across a network-wide national collaborative effort using commercially available panels and formalin-fixed paraffin-embedded or frozen tumor tissue<sup>[9]</sup>. The investigators found that NGS performed well compared to reverse-transcription polymerase chain reaction and fluorescent in-situ hybridization and had the advantage of agnostic rather than a targeted approach to molecular evaluation. The feasibility of performing NGS to aid in the formulation of treatment recommendations for patients with locally-advanced or metastatic soft tissue sarcoma across a large sarcoma network is currently under study in the randomized phase II/III MULTISARC trial (NCT03784014)<sup>[10]</sup>. If the approach in MULTISARC is successful, the centralized performance of NGS with data input into a database accessible by local pathologists and the establishment of virtual molecular tumor boards could greatly assist in sarcoma diagnosis.

Digitization of whole microscope slides, including immunohistochemically stained slides (virtual microscopy) and annotation of case information with molecular data, when available, may greatly facilitate expert review of sarcoma cases by telepathology in the future and lead to reduced times between tissue biopsy and final diagnosis of the sarcoma. However, for telepathology to play a greater role in the diagnosis of sarcoma, access to equipment and expertise for the collection and processing of high-quality tissue samples, immunohistochemical stains and molecular diagnostics in rural and under-resourced areas will be needed.

## **VIRTUAL SARCOMA MULTIDISCIPLINARY TEAM TUMOR BOARDS**

Multidisciplinary review of patient data and development of treatment plans for patients diagnosed with sarcoma is necessary to deliver appropriate care and improve disease-related outcomes, and is recommended in the NCCN Soft Tissue Sarcoma and Bone Sarcoma treatment guidelines<sup>[11,12]</sup>. Multidisciplinary teams often include expertise in pathology, radiology, medical oncology, orthopaedic oncology, radiation oncology, surgical oncology, and thoracic surgery<sup>[13]</sup>. In certain circumstances, diagnosis of a disease is best reached after thorough discussion by providers with knowledge of the pathologic, radiologic and clinical features of the disease. Because of restrictions imposed on in-person conferences by many healthcare institutions during the onset of the SARS-CoV2 pandemic, many sarcoma tumor boards moved to virtual videoconference platforms. Survey data from one multidisciplinary team suggested a large majority (75%) of participants were satisfied with the virtual meeting and felt a similar level of care was provided compared to face-to-face meetings; however, only a small majority (55.6%) preferred virtual multidisciplinary tumor boards over in-person meetings<sup>[14]</sup>. Accessibility of images and slides, availability of expertise, time for discussion, concluding to an appropriate diagnosis and finalizing a treatment plan were rated very highly in the virtual format. Perhaps not surprising, participants were less satisfied with the depth of discussion and interaction with specialists. Virtual tumor boards have allowed the development of multi-institutional tumor boards to address rare diseases, expand a high level of expertise to a broader geographic area and bring together a broader group of experts to discuss difficult patient cases. For example, national multidisciplinary tumor boards exist for Ewing sarcoma in the United Kingdom and the United States<sup>[15]</sup>. Additionally, an international virtual tumor board, including institutions in the United States, Canada and Italy, coordinated by MD Anderson Cancer Center was developed to provide multidisciplinary input into the management of patients with complex primary and secondary cardiac sarcomas. Additional virtual sarcoma tumor boards are likely to be developed to bring together experts in the care of patients with ultra-rare sarcomas for which clear-cut treatment guidelines are not available. Such tumor boards will most likely improve patient care and could not be conducted in person for practical reasons.

## **TELEMEDICINE FOR SARCOMA CONSULTATION/SECOND OPINIONS**

Patient evaluation by physicians with expertise in evaluation and management of bone and soft tissue sarcoma and benign connective tissue tumors such as desmoid tumors, giant cell tumor of bone and diffuse pigmented villonodular synovitis/tenosynovial giant cell tumor (PVNS/TGCT) is critical to provide appropriate diagnostic and treatment recommendations. Because of the rarity of sarcoma relative to many other cancer types, most oncologists and surgeons have limited experience in the management of sarcomas. An additional level of complexity in sarcoma management is the large number of sarcoma sub-types with disparate clinical features, patterns of metastases and responses to chemotherapy<sup>[16]</sup>. Telemedicine may be used to link patients diagnosed with sarcoma to providers with sarcoma expertise to provide sarcoma-specific consultation or a second opinion regarding sarcoma evaluation and management. As discussed above, a review of tumor tissue by a pathologist with expertise in sarcoma is essential to confirm the diagnosis. Appropriate imaging of the site(s) of sarcoma involvement and potential areas of sarcoma metastases should be available digitally for review by the consultant, but imaging may need further

evaluation by a radiologist with experience in radiologic features of sarcoma if there are differences in interpretation of the radiology findings between the local radiologist and the sarcoma consultant. Virtual sarcoma consultations and second opinions may be helpful for patients who live a long distance from a medical center with sarcoma expertise, have limited means to afford travel, or are seeking reassurance that a treatment plan developed by local physicians is consistent with recommended guidelines. Some academic not-for-profit medical centers and for-profit medical centers offer virtual sarcoma second opinions between staff physicians and patients. However, the ability of nationally recognized experts in the management of sarcoma to offer virtual second opinions may be affected by institutional practices, variability in insurance reimbursement, state medical licensing board regulations and liability coverage, which generally do not affect in-person consultations, thus limiting the pool of sarcoma providers available for telemedicine visits. Additionally, physicians offering virtual second opinions may not be vetted by recognized national sarcoma organizations and patient-support groups. State medical boards usually require that patients receiving medical care, including consultation and follow-up evaluation, be physically present in the State licensing the practitioner at the time the service is provided, which prevents the ability to conduct telemedicine sarcoma visits across State lines. Some states have established rules on reciprocal licensing agreements which may facilitate telemedicine consultation and/or medical management across States with these agreements. Independent companies (e.g., Summus) may, for a fee, connect people with sarcoma or family members seeking advice from physician experts vetted by the company through virtual consultation. In these cases, persons seeking advice provide medical records and images to the company, which are then made available on a software platform for viewing by the physician expert prior to the virtual consultation. The physician expert may advise the consulter but generally does not provide medical treatment recommendations or plans because of regulations on the practice of medicine.

## TELEMEDICINE FOR NEW PATIENT EVALUATIONS

The initial evaluation of patients newly diagnosed with sarcoma may be less appropriate for a virtual clinical encounter, in particular for telemedicine conducted without 2-way video. The inability to palpate body parts affected by sarcoma and concurrent medical conditions, examine organ systems in detail and accurately assess patient performance status via telehealth could impact accurate assessment of the benefit-to-risk ratio of surgical intervention, radiation and/or chemotherapy, especially for patients requiring complex multidisciplinary sarcoma care. Other disadvantages of virtual new patient encounters are potential adverse impacts on the development of rapport and trust between the patient and the physicians, medical assistants and nurses involved in the patient's care. On the other hand, virtual new patient evaluations may be used to rapidly connect patients diagnosed with sarcoma to a center of sarcoma expertise and facilitate the ordering and performance of additional diagnostic tests that may be required before treatment options can be recommended. This can be followed by an in-person visit to establish rapport between the patient and the healthcare team. Ideally, an appropriate sarcoma treatment plan should be developed in conjunction with the patient after in-person evaluation and discussion of the options for treatment, risks of the medical procedures, benefit to the patient and potential outcomes. Telehealth between local providers and sarcoma specialists often occurs via telephone to discuss sarcoma patient evaluation and management. This type of telehealth communication which can include video should be encouraged to facilitate discussion of patient management according to national and international treatment guidelines and identification of available clinical trials which may provide the best option for treatment.

Few studies of the effect of telemedicine on the care of patients with sarcoma are available in the medical literature. Investigators in the Sarcoma Unit at the Royal Marsden Hospital (RMH), London, reported on survey results from patients and providers after the rapid implementation of telemedicine visits in the face of the SARS-CoV2 pandemic<sup>[17]</sup>. Two-hundred and eighty-three (75%) in-person appointments were



converted to telephone telemedicine appointments between March 23, 2020 and April 24, 2020, of which 19 were for new patient consultations. The percent of new patient consults converted to telemedicine visits (53%) was lower than for patients receiving oral chemotherapy (89%) or under active surveillance/follow-up (94%) but was higher than for patients receiving intravenous chemotherapy (37%). Reasons provided by the investigators for new patient consults that were conducted virtually included post-operative surveillance, second opinion/transfer of care, and referral for palliative radiation. A small minority (27%) of new patients requiring chemotherapy were seen by telemedicine visits. Most of the physicians responding to the survey reported that the lack of video-based assessment was a barrier to care. The preferences of patients who required a new patient visit for telehealth vs. in-person encounter was not reported. Patients and providers may become more comfortable in the future with new patient evaluations conducted via 2-way video telehealth with more widespread availability of wearable medical devices to provide vital patient objective data or use of local medical practitioners to provide an assessment of physical exam findings and performance status, but the impact on quality of care delivered and disease-specific outcomes will need to be examined.

### TELEMEDICINE FOR CHEMOTHERAPY MANAGEMENT

Oral chemotherapy is assuming a larger role in the management of sarcoma and benign connective tissue tumors including desmoid tumors and PVNS/TGCT. Monitoring of drug-related adverse effects and tumor response to therapy is often done by eliciting patient-reported symptoms, evaluation of blood cell counts and biochemical markers in blood and radiographic evaluation of tumors. These evaluations are suitable for telehealth visits, in which laboratory and radiology studies may be conducted prior to the patient-provider virtual visit. After the initial early treatment period with oral chemotherapies and adjustment in drug dose, if required, patients may remain on treatment long-term with managed adverse effects from chemotherapy. In survey data from the RMH Sarcoma Unit's evaluation of telemedicine, 89% of the patients on oral systemic therapy ( $N = 89$ ) had in-person visits converted to telephone visits. The mean patient-reported satisfaction score with telephone visits was higher than with in-person visits and common reasons provided by patients were reduced travel time, reduced travel expenses, and convenience. Of the providers completing the survey, 89% indicated telemedicine should become a routine part of care for patients on stable doses of oral chemotherapy. Additional advantages cited by the authors in the adoption of telemedicine into routine practice are reduced costs for healthcare systems, reduced carbon footprint of healthcare and improved patient access to care. The frequency of in-person relative to virtual encounters needs to be based on patient needs and symptoms, stability of the sarcoma under treatment and adverse effects from chemotherapy.

In another study conducted in Scotland during the SARS-CoV2 pandemic using similar questionnaires to the RMH team with sarcoma patients and providers, patients reported a high and similar mean rate of satisfaction with in-person visits<sup>[18]</sup>. However, the investigators reported more variability in the satisfaction scores for the telephone visits. Only 10% of the patients responding to the survey study were on active chemotherapy. The authors concluded that "there was a general consensus with the providers that telemedicine should play a role in the delivery of care to patients with sarcoma...who were on stable doses of oral anticancer medications", but details of patient survey results for the group of patients on oral chemotherapy, independent of the other responders, was not provided. Additional research is needed to see if the convenience to patients of telehealth visits for on-treatment evaluations on oral chemotherapy is more valued than other factors which require in-person contact. Research is also needed on the effect of telemedicine on healthcare savings, provider satisfaction and the environment.

For patients receiving intravenous chemotherapy, the convenience of telehealth visits and the impact on travel is negated by the need to travel to a medical facility for the administration of chemotherapy. In cases in which the patient-physician encounter occurs on a different day than chemotherapy administration or in a medical infusion setting distant from the physician's office, there may be a convenience benefit to the patient in providing telehealth visits. Intravenous chemotherapy for sarcoma (e.g., doxorubicin/ifosfamide, gemcitabine/docetaxel, doxorubicin/cisplatin/methotrexate, ifosfamide/etoposide) is often associated with more severe adverse effects than oral chemotherapy and more often requires a reduction in chemotherapy doses and management with supportive care medications. For these reasons, in-person evaluations are helpful and, in many cases, essential for patients receiving intravenous sarcoma chemotherapy.

Periodic evaluation of sarcoma response to chemotherapy is usually performed with radiology exams. In patients with metastatic sarcoma undergoing chemotherapy, radiology scans may identify an increasing burden of sarcoma due to the sarcoma's inherent or secondary resistance to the chemotherapy. This worsening burden of disease is usually perceived as "bad news" by patients. Medical teaching promotes that patients prefer to receive bad news in person in a quiet setting<sup>[19]</sup>. This allows time for the patient to process the implications of the radiology findings and ask questions, and for the provider to convey support and empathy for the patient. In-person meetings also allow the provider to review the radiology images with the patient for a visual representation of the sarcoma burden, which can be more impactful than an abstract radiology report. Forty-eight percent of patients surveyed in the RMH study preferred not to receive bad news by telephone, whereas only 20% would not want to hear any scan result by telephone. Most patient encounters that remained in-person in the RMH Sarcoma Unit during the study period were for patients receiving intravenous chemotherapy or with results indicating disease progression suggesting that providers prefer to deliver bad news to patients in person. In the Scottish study, 89% of patients indicated that they would not like to be delivered bad news by telephone and 41% would not want to be told of radiology results by telephone. In contrast, only 7.8% of patients would not want to be told of blood tests by telemedicine. Many patients now have access to the results of their blood tests and radiology reports in real-time through electronic medical record system applications on computers and smart phones. The impact of the real-time release of radiology reports indicating cancer progression on patient satisfaction, distress, anxiety, and emotional health deserves study.

## TELEMEDICINE FOR SYMPTOM MANAGEMENT

Patients with sarcoma frequently have symptoms related to cancer, including pain and fatigue, or the therapy for the sarcoma. Telephone or video encounters may be used to assist with the evaluation and management of cancer and treatment-related symptoms, except for symptoms requiring physical examination with auscultation, percussion, and/or palpation for evaluation. The use of wearable and home medical devices allows for recording vital signs, which can be used in assessing symptoms or complications from therapy. Data may be collected and transmitted passively without direct input from patients or actively by patients through smartphone or computer applications. Computer algorithms can alert providers if symptoms or vital data require urgent response or intervention. Telemedicine communication applications are under investigation in clinical research and have been associated with improved survival<sup>[20,21]</sup>. Avenues of active research are chemotherapy-related symptom monitoring, patient self-reporting of adverse events and quality of life. A randomized, controlled clinical trial of patient-reported symptoms via questionnaire, along with body temperature assessment, completed daily and entered in the Advanced Symptom Management System compared to usual medical practice was conducted to evaluate the effects of the digital intervention on symptom burden, supportive care needs and health-related quality of life measures in patients undergoing treatment with chemotherapy<sup>[22]</sup>. This multinational European trial enrolled 829 patients undergoing adjuvant or first-line chemotherapy for the treatment of cancer. Patients randomized to the

intervention reported lower symptom burden, distress, and physical and psychological symptoms compared to the control arm. More neutropenic events (125 vs. 71) were identified in the experimental compared to the control arm. However, the number of planned and unplanned hospitalizations and deaths were similar between groups. Another randomized trial using patient-reported symptoms through an automated symptom management eHealth system identified a significant reduction in moderate to severe symptoms compared to patients receiving usual care during chemotherapy<sup>[23]</sup>. Research suggests that physicians underreport adverse effects of chemotherapy compared to patients; therefore, future clinical trials may incorporate documentation of adverse effects and duration from patients through eHealth platforms<sup>[24]</sup>. The number of applications and systems incorporating management algorithms for patients to report cancer-related and treatment-related symptoms is rapidly expanding. Additional research is needed to determine if symptom monitoring and management through telemedicine improve the health, quality of life and survival of patients with sarcoma.

### TELEMEDICINE FOR SARCOMA SURVEILLANCE AND SURVIVORSHIP

Following curative therapy, patients with sarcoma remain at risk for distant and/or local recurrence of disease and require periodic evaluation for surveillance for sarcoma recurrence. The recommended frequency of evaluation is based on the risk of recurrence. Additionally, periodic evaluation of blood is often done to monitor for long-term complications related to treatment. Telemedicine may be useful in the long-term surveillance of sarcoma. Most patients in the RMH Sarcoma Unit with appointments converted to telehealth phone visits during the SARS-CoV2 pandemic study period were undergoing surveillance for sarcoma recurrence. Only 2 of 133 patients on active surveillance declined a telemedicine visit. A large majority of patients preferred some future appointments be conducted via telemedicine for the reasons discussed above. The patients who preferred in-person visits felt the face-to-face encounter would be more reassuring. Of the providers, 89% felt telemedicine should become part of regular practice for patients under surveillance for sarcoma recurrence. Similar results were seen in the study conducted in Scotland. Many patients on active surveillance will not have a recurrence of sarcoma; however, the majority of patients with high-risk gastrointestinal stromal tumor, high-grade osteosarcoma and large, high-grade soft tissue sarcoma will experience recurrence of sarcoma usually within five years of surgery. Patients may experience emotional distress and anxiety if bad news of sarcoma recurrence is delivered via telemedicine encounter or if an expected telemedicine encounter (for routine surveillance) is changed to an in-person visit to discuss the radiology findings (bad news). The latter will require flexibility in scheduling such that the patient is seen in person soon after the radiology results supporting sarcoma recurrence are available.

Patients surviving sarcoma require life-long care and risk chronic medical disease, secondary cancers and lower psychosocial functioning<sup>[25-28]</sup>. The adverse impact of prior therapy for sarcoma seems to be greater on patients who underwent treatment as adolescents or young adults than on older patients. Appropriate interventions may improve patient quality of life, physical and psychosocial function, and overall health. Relatively little is reported on the use of telehealth to improve the mental health, physical function and management of chronic disease in sarcoma. Telehealth could be used to connect sarcoma survivors to experts in the long-term management of physical and psychological consequences of sarcoma therapy and help local physicians provide appropriate medical care. The development of sophisticated wearable medical devices that measure physical activity and functioning, cardiovascular health, and metabolism, and mobile/interactive applications will allow for the integration of patient monitoring into sarcoma survivorship management plans to improve the long-term health of sarcoma survivors<sup>[29,30]</sup>. However, direct in-person interaction with physicians may be reassuring to patients, and provide an opportunity for physicians to convey encouragement and support for patients to lead healthier lifestyles.



## CONCLUSIONS

Advancements in communication technology, electronic medical record systems and computer applications have allowed for rapid expansion of telemedicine in the care of patients. Physician-patient interaction through virtual encounters has been facilitated by interconnections through the World Wide Web and was forced to the forefront by the SARS-CoV2 pandemic due to concerns for patient well-being and health, and increased risk of severe complications from COVID19 in patients with cancer. Telemedicine has the potential to improve the health of patients with sarcoma by allowing for a more rapid review of tumor tissue by experts in soft tissue and bone pathology, facilitating interaction and discussion among specialists in the treatment of sarcoma, and offering more patients in underserved areas without sarcoma centers of excellence access to sarcoma specialists. Telemedicine may also offer patients more convenience and seems suited for the evaluation of patients on stable doses of oral chemotherapy and in long-term follow-up after completion of curative therapy for sarcoma. More research is required to determine if telemedicine improves the health of patients receiving intravenous chemotherapy or participating in treatment clinical trials, as well as the long-term health of sarcoma survivors using wearable medical devices and interactive apps. The incorporation of telemedicine into some aspects of routine sarcoma patient care is ongoing, and telemedicine is likely to assume a greater role in the care of patients in the future.

## DECLARATIONS

### Authors' contributions

The author contributed solely to the article.

### Availability of data and materials

Not applicable.

### Financial support and sponsorship

Funding was provided by Jerry and Leslie Behar to establish the LMS360 project which supported this review.

### Conflicts of interest

The author declared that there are no conflicts of interest.

### Ethical approval and consent to participate

Not applicable.

### Consent for publication

Not applicable.

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## REFERENCES

1. Zundel KM. Telemedicine: history, applications, and impact on librarianship. *Bull Med Libr Assoc* 1996;84:71-9. [PubMed](#) [PMC](#)
2. Freiburger G, Holcomb M, Piper D. The STARPAHC collection: part of an archive of the history of telemedicine. *J Telemed Telecare* 2007;13:221-3. [DOI](#) [PubMed](#)
3. Doolittle GC, Allen A. Practising oncology via telemedicine. *J Telemed Telecare* 1997;3:63-70. [DOI](#) [PubMed](#)
4. Raut CP, George S, Hornick JL, et al. High rates of histopathologic discordance in sarcoma with implications for clinical care. *JCO* 2011;29:10065. [DOI](#)
5. Rupani A, Hallin M, Jones RL, Fisher C, Thway K. Diagnostic differences in expert second-opinion consultation cases at a tertiary sarcoma center. *Sarcoma* 2020;2020:9810170. [DOI](#) [PubMed](#) [PMC](#)

6. Tucker JH, Busch C, Spatz A, Wells C, Brugal G. An experimental inter-expert telepathology network using static imaging. *J Clin Pathol* 2001;54:752-7. DOI PubMed PMC
7. Voelker HU, Poetzl L, Strehl A, Mueller-Hermelink HK, Stuefe A, Stauch G. Telepathological evaluation of paediatric histological specimens in support of a hospital in Tanzania. *Afr Health Sci* 2020;20:1313-21. DOI PubMed PMC
8. Wamala D, Katamba A, Dworak O. Feasibility and diagnostic accuracy of Internet-based dynamic telepathology between Uganda and Germany. *J Telemed Telecare* 2011;17:222-5. DOI PubMed
9. Racanelli D, Brenca M, Baldazzi D, et al. Next-generation sequencing approaches for the identification of pathognomonic fusion transcripts in sarcomas: the experience of the Italian ACC sarcoma working group. *Front Oncol* 2020;10:489. DOI
10. Italiano A, Dinart D, Soubeyran I, Bellera C, Esperou H, Delmas C, et al. Molecular profiling of advanced soft-tissue sarcomas: the MULTISARC randomized trial. *BMC Cancer* 2021;21:1180. DOI PubMed PMC
11. Blay JY, Soibinet P, Penel N, et al. Improved survival using specialized multidisciplinary board in sarcoma patients. *Ann Oncol* 2017;28:2852-9. DOI PubMed PMC
12. von Mehren M, Kane JM, Bui MM, et al. NCCN guidelines insights: soft tissue sarcoma, version 1.2021. *J Natl Compr Canc Netw* 2020;18:1604-12. DOI PubMed
13. Siegel GW, Biermann JS, Chugh R, et al. The multidisciplinary management of bone and soft tissue sarcoma: an essential organizational framework. *J Multidiscip Healthc* 2015;8:109-15. DOI PubMed PMC
14. Rajasekaran RB, Whitwell D, Cosker TDA, Gibbons C, Carr A. Will virtual multidisciplinary team meetings become the norm for musculoskeletal oncology care following the COVID-19 pandemic? *BMC Musculoskelet Disord* 2021;22:18. DOI PubMed PMC
15. Bate J, Wingrove J, Donkin A, Taylor R, Whelan J. Patient perspectives on a national multidisciplinary team meeting for a rare cancer. *Eur J Cancer Care* 2019;28:e12971. DOI PubMed
16. WHO classification of tumours editorial board. Soft tissue and bone tumours. International Agency for Research on Cancer: Lyon, France. 2020. Available from: <https://publications.iarc.fr/588> [Last accessed on 27 Sep 2022].
17. Smrke A, Younger E, Wilson R, et al. Telemedicine during the COVID-19 pandemic: impact on care for rare cancers. *JCO Glob Oncol* 2020;6:1046-51. DOI PubMed PMC
18. McCabe HM, Smrke A, Cowie F, et al. What matters to US: impact of telemedicine during the pandemic in the care of patients with sarcoma across scotland. *JCO Glob Oncol* 2021;7:1067-73. DOI PubMed PMC
19. Parker PA, Baile WF, de Moor C, Lenzi R, Kudelka AP, Cohen L. Breaking bad news about cancer: patients' preferences for communication. *J Clin Oncol* 2001;19:2049-56. DOI PubMed
20. Harris J, Cheevers K, Armes J. The emerging role of digital health in monitoring and supporting people living with cancer and the consequences of its treatments. *Curr Opin Support Palliat Care* 2018;12:268-75. DOI PubMed
21. Denis F, Basch E, Septans AL, et al. Two-year survival comparing web-based symptom monitoring vs routine surveillance following treatment for lung cancer. *JAMA* 2019;321:306-7. DOI PubMed PMC
22. Maguire R, McCann L, Kotronoulas G, et al. Real time remote symptom monitoring during chemotherapy for cancer: European multicentre randomised controlled trial (eSMART). *BMJ* 2021;374:n1647. DOI PubMed PMC
23. Mooney KH, Beck SL, Wong B, et al. Automated home monitoring and management of patient-reported symptoms during chemotherapy: results of the symptom care at home RCT. *Cancer Med* 2017;6:537-46. DOI PubMed PMC
24. Galizia D, Milani A, Geuna E, et al. Self-evaluation of duration of adjuvant chemotherapy side effects in breast cancer patients: a prospective study. *Cancer Med* 2018;7:4339-44. DOI PubMed PMC
25. Youn P, Milano MT, Constine LS, Travis LB. Long-term cause-specific mortality in survivors of adolescent and young adult bone and soft tissue sarcoma: a population-based study of 28,844 patients. *Cancer* 2014;120:2334-42. DOI PubMed
26. Baker LH, Boonstra PS, Reinke DK, Antalis EJP, Zebrack BJ, Weinberg RL. Burden of chronic diseases among sarcoma survivors treated with anthracycline chemotherapy: results from an observational study. *J Cancer Metastasis Treat* 2020;6:24. DOI PubMed PMC
27. Tonning Olsson I, Brinkman TM, Wang M, et al. Neurocognitive and psychosocial outcomes in adult survivors of childhood soft-tissue sarcoma: a report from the St. Jude Lifetime Cohort. *Cancer* 2020;126:1576-84. DOI PubMed PMC
28. Drabbe C, Van der Graaf WTA, De Rooij BH, et al. The age-related impact of surviving sarcoma on health-related quality of life: data from the SURVSARC study. *ESMO Open* 2021;6:100047. DOI PubMed PMC
29. Roberts AL, Fisher A, Smith L, Heinrich M, Potts HWW. Digital health behaviour change interventions targeting physical activity and diet in cancer survivors: a systematic review and meta-analysis. *J Cancer Surviv* 2017;11:704-19. DOI PubMed PMC
30. Cox A, Lucas G, Marcu A, et al. Cancer survivors' experience with telehealth: a systematic review and thematic synthesis. *J Med Internet Res* 2017;19:e11. DOI PubMed PMC