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The clinical musculoskeletal ultrasonography: Egyptian guidelines for structured musculoskeletal ultrasound scanning and reporting

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Abstract

Background The aim of this work is to set up the standards for performing musculoskeletal ultrasound scans and reporting as an additional procedure in the rheumatology setting. We used two rounds of the Delphi approach to get the consensus on a musculoskeletal ultrasound reporting.

Results Fifteen expert panels had completed the two rounds of surveys. After the end of round two, eighteen recommendations distributed upon eight domains were released. The percentage of the agreement on the recommendations was 93.3 to 100 %. All eighteen key questions were answered at the end of the second round with agreement.

Conclusion A musculoskeletal ultrasound report template has been developed by this study, based on outcomes of a Delphi process, by an international participants' panel. All domains met the 80% voting threshold set in this work. The reporting template can be used for both clinical research as well as standard practice to provide guidance and standardize the musculoskeletal ultrasound reporting.

Keywords Egyptian guidelines, Musculoskeletal ultrasound scanning, MSUS, Reporting standard, MSUS template

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Background

Over the past 2 decades, ultrasound (US) has booked its place as the principal diagnostic tool in musculoskeletal medicine. The ability of US to portray both normal anatomy and pathology in musculoskeletal tissues has attracted the healthcare professionals managing musculoskeletal disorders, the rheumatologists, to utilize it as an extension of their clinical examination. Consequently, technical advances, portability of the US machines, and the economic cost have broadened its application in standard practice, beyond the diagnosis of inflammatory/degenerative joint disease and soft tissue pathologies to monitoring the status of the variable musculoskeletal components whether muscles, joints, cartilage or ligaments [1]. Furthermore, the facility of performing dynamic examination has paved the way for musculoskeletal ultrasonography to replace MRI imaging in several specific clinical settings [2]. The ultrasound enhances the care pathway provided to patients by facilitating one-stop clinical care, guiding interventions, increasing diagnostic accuracy, and improving the patients' experiences.

Integrating musculoskeletal ultrasound (MSUS) into the rheumatology practice raises the attention towards "Thinking of standards of practice". Several questions about training, competency, and accreditation have been raised. While US is often commended for its advantages over more resource-intensive imaging modalities, musculoskeletal US involves a high degree of operator dependence which can impact negatively on the quality of images attained [3]. This relates to issues of inter-observer and intra-observer reliability and the steep learning curve required to achieve a good level of competence in acquiring and interpreting the scans [4, 5]. The rapidly growing popularity of musculoskeletal US has witnessed the launch of several courses to educate interested healthcare professionals on its use. However, short courses that teach the basis of doing musculoskeletal US examinations are inadequate for trainees to become competent without additional hands-on experience. By not performing adequate scans or by misinterpreting US findings or both, inexperienced sonographers can do harm, particularly if they place too much reliance on their findings. Standardization of the training courses, techniques of image acquisition, and image interpretation methodology can minimize these negatives.

In concordance with the international interest in the musculoskeletal US, in Egypt, it has been embraced by many clinical rheumatologists and researchers in the field of rheumatology. Setting up the standards for musculoskeletal US is expected to facilitate and advance education of the healthcare professionals with a special interest in musculoskeletal and neuromuscular US. It will also help to establish the use of ultrasound as a diagnostic and monitoring modality of the musculoskeletal system. This work was carried out to set up the standards for performing musculoskeletal US scans and reporting as an additional procedure in the rheumatology setting. This is based on the synthesis of the best available literature and expert opinion evaluation.

Methods

Design

The consensus, evidence-based standards for musculoskeletal US were designed and developed based on the Clinical, Evidence-based, Guidelines (CEG) guideline development process protocol. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria guided the reporting of the systematic review [6].

Core team

The team consisted of three experts with established expertise in MSUS. The project's scope and initial PICO questions (PICO: Problem/Population, Intervention, Comparison, Outcome) were developed with support from the core team, which also supervised and organized the teamwork and decided which key questions to include in the guidelines. The core team pre-identified outcomes as crucial for the systematic literature review for each PICO question. Together with drafting the manuscript, the team nominated the expert panel and collected the responses from the experts.

Search strategy

The literature search was conducted using combinations of the following keywords: (1) "ultrasound" OR "ultrasonic" OR "ultrasonography" OR "sonography" OR "US" OR MSUS OR MSK US, (2) Standards OR guidelines OR Protocols, and (3) Rheumatology OR Musculoskeletal Medicine OR Joint OR Arthritis OR.

Key questions used to develop the standards

In order to begin this process, a list of prospective US musculoskeletal standards was created using expert opinions and literature. The primary focus of the standards, the scope of practice, the equipment, physician qualification, referrals, and the standards for musculoskeletal ultrasonography were determined by a set of structured key questions that identified the target audience.

The steps for gathering the evidence to address the clinical questions were as follows: formulation of the clinical questions, question structure, search for the evidence, critical evaluation and selection of the evidence, presentation of the findings, and recommendations.

Literature review team

Based on an extensive literature review and the specific research questions, a literature review was conducted. Three databases were searched: MEDLINE, Embase, and the Cochrane. Following the data abstraction, reviewing the published standards, the quality of evidence rating [7, 8], and the experts in charge of the literature assessment revised the standards and gave a thorough list of recommendations for the US musculoskeletal standards. The level of evidence was appraised using the Oxford Center for Evidence-Based Medicine (OCEMB) criteria (Table 1) [8]. The strength of the recommendation (SoR) was analyzed using the Grading of Recommendations.

Data sources and search strategies

The search strategy was planned to capture all studies discussing the musculoskeletal US. The following 3 databases are searched: MEDLINE, Embase, and the Cochrane Central Register of Controlled Trials (Central). To ensure that as many relevant studies as possible are identified, review authors are also encouraged to conduct additional searches by one or more of the following strategies: hand-searching those high-yield journals and conference proceedings that have not already been hand searched on behalf of the Cochrane Collaboration, reviewing reference lists of all papers and relevant reviews, contacting authors of relevant papers and authors of other reviews or experts in the subject area, and searching citation databases (e.g., Web of Science or Science Citation Index) and other relevant bibliographic databases. The publications were classified into 1 of 5 major categories derived from the key clinical questions including (1) quality standards, (2) operating standards, (3) reporting standards, (4) imaging standards, and (5) education and accreditation standards.

Literature searches on 10 May 2023 for PubMed and Cochrane Library databases, and on the 17th of May 2023 for Embase. The search was updated on June 22, 2023. Duplicate screening of literature search results was performed electronically. The abstraction process was divided into 3 stages: (1) title review, (2) review of the abstract, and (3) evaluation and abstraction of data from the manuscript.

Study selection

Applying inclusion and exclusion criteria to the literature retrieved using the search methodologies led to the selection of pertinent research.

Inclusion criteria: original research in humans evaluating musculoskeletal US standards in a setting reflective of rheumatologic practice for any of the pre-specified clinical scenarios.

Exclusion criteria

Review articles, letters, comments, editorials, case reports and case series with 6 subjects, or evaluations of emerging MSUS technologies such as 3-dimensional musculoskeletal US imaging, and arthroscopic musculoskeletal US. Also, articles about musculoskeletal US procedures performed outside of the routine rheumatology scope of practice (e.g., diagnosis of hip dysplasia) were also excluded.

Patient involvement

Patients were not involved in this research.

Ethical aspects

According to national regulations, written ethics approval from the experts participating in this work was deemed unnecessary; however, verbal informed consent was required from all participants in accordance with the Egyptian National Ethical Committee regulations. CEG initiative protocol was approved by the local ethical

Table 1 Levels of evidence

Level of evidence	
1	Systematic review of all relevant randomized clinical trials or n-of-1 trials
2	Randomized trial or observational study with dramatic effect
3	Non-randomized controlled cohort/follow-up study (observational)
4	Case series, case-control study, or historically controlled study
5	Mechanism-based reasoning (expert opinion, based on physiology, animal, or laboratory studies)
Grades of recommendation	
A	Consistent level 1 studies
B	Consistent level 2 or 3 studies, or extrapolations from level 1 studies
C	Level 4 studies or extrapolations from level 2 or 3 studies
D	Level 5 evidence or troubling, inconsistent, or inconclusive studies of any level

committee: ethical approval code: 34842/8/21, ethical board ** University.

Expert panel

This included a representative sample of consultant practitioners of musculoskeletal US in Egypt. They were a group of experienced informed professionals with a track record of ongoing practice, teaching, and research in the field of musculoskeletal US. The key clinical questions were refined with the assistance of the expert panel, and the questions were then written into standard statements and sent to the expert panel with the evidence report, who then voted on the standards.

Target audience

The standards were created to help rheumatologists and other healthcare practitioners who manage musculoskeletal illnesses. It also serves as a valuable resource for those in charge of ordering treatment for individuals with musculoskeletal disorders within the National Health Service.

Developing the clinical care standard framework

To ease the standardized identification of guideline components, a structured template has been developed based on the responses to the structured key questions and the literature research. The format in which recommendations and data will be provided and extracted for each guideline component has been established.

Delphi process

The Delphi procedure [9] is an organized approach that is frequently used to collect crucial data on a particular subject. It is predicated on the basic idea that group projections are typically more accurate than individual ones. In order to create forecasts with consensus from a group of experts in an organized, iterative manner, the Delphi method was developed. Its methodology is based on a number of "rounds" of questions sent to experts. The following phases are typically covered by the Delphi method: (1) a group of experts is put together. (2) The experts receive forecasting tasks and challenges. (3) Experts provide early predictions and explanations. These are gathered and summarized to offer comments. (4) The experts receive data, which they use to review their forecasts. Up until a suitable degree of agreement is obtained, this step may be repeated. (5) The expert forecasts are combined to create the final forecasts. The participants in this method are anonymous, and the feedback is carefully controlled [9–12].

Consensus process

There were two Delphi rounds in order to reach a consensus on the musculoskeletal US. The structured Delphi procedure ensures that the perspectives of all participants are considered. Online questionnaires were employed to complete the Delphi process. The initial phase of the computerized survey consisted of eighteen items.

Voting process

Live online voting took place in two rounds, with stringent time constraints for each round. Every member of the task force was invited to vote and informed in advance of the beginning and ending times of each round. Special access connections were provided, and anonymous votes were collected and processed. Regarding every statement, input on possible ambiguity, rewording, and undiscovered overlaps was gathered prior to voting. Only task force members were allowed to vote on the statements.

Rating

Every statement received a score ranging from 1 to 9, where 1 denoted "complete disagreement" and 9 represented "complete agreement." In general, the numbers 1–3, 4–6, and 7–9 stand for disagreement, uncertainty, and agreement, in that order. No statement required voting, and participants were urged not to vote if they thought a statement was outside their purview. "Uncertainty" in one's vote indicates "discomfort regarding the accuracy of the recommendation." Following each voting session, the scientific committee evaluated the comments that were added to all of the statements. Throughout each voting round, members were encouraged to voice their opinions, especially when there was a disagreement. As a result, the panel was able to determine when the statement was misunderstood and to remove the vote on it.

Definition of consensus

Prior to the data analysis, a consensus definition was established. In order to reach a consensus and become a recommendation in this guideline, at least 80% of participants are required to indicate agreement (scoring is 7–9: where a score of 7 or 8 means agree, while a score of 9 means strongly agreed) or disagreement (scores 1–3) [9–11]. A statement was retired if it obtained a mean vote of less than three or a "low" degree of agreement. Statements that scored in the (4–6) range of the uncertainty score were changed in light of the feedback. A recommendation was considered to have "high" levels

of agreement following the second voting round if all votes cast on it were inside the range of agreement (7–9) [11–13].

Chronogram of Delphi rounds

The first round lasted 6 days, from June 21 to June 26, 2023. The key questions were the focus of this round. Two weeks after the first round, on July 10, 2023, the second round began and ran for 6 days, until July 15, 2023.

Results

Literature research and evidence selection

By using a search strategy, we found 983 possibly pertinent studies throughout the research selection phase. After title and abstract screening, 915 articles were eliminated because of duplication or because they did not address the population or intervention of interest, failed to conform to the research design of interest, or did not include the desired outcome metrics. Therefore, for the entire article review, 68 documents that were pertinent were included. Sixty studies were excluded because the citations did not offer evidence that matched a PICO. Consequently, we selected 8 studies to create Fig. 1.

Expert panel characteristics

The expert panel (n=15) received the Delphi form, and they took part in both rounds. Respondents were drawn from different governorates and health centers across Egypt: ** University (6.7%), **University (20%), **University (13.4%), **University (13.4%), **University (6.7%), **University (6.7%), **University (6.7%), **University (13.4%), **University (6.7%), and UK (6.7%).

Delphi round 1

The response rate for round one was 100% (15/15). Consensus was reached on the inclusion of clinical standards

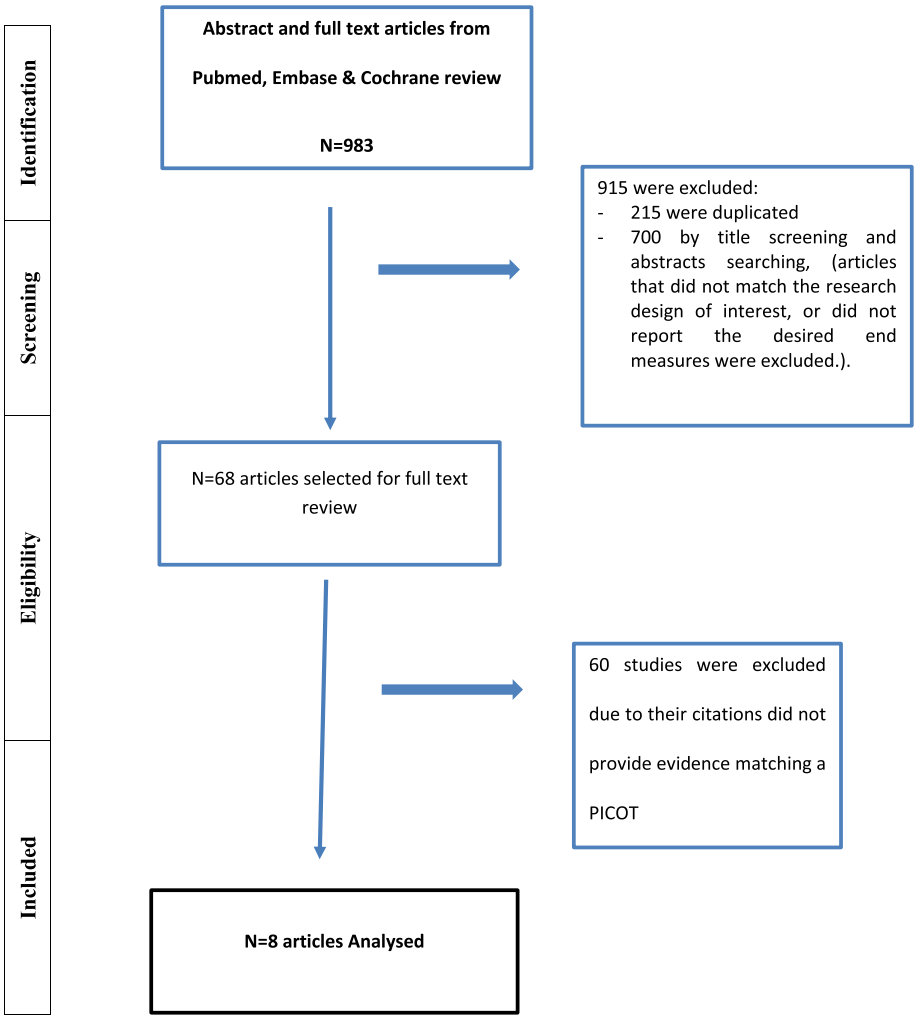

Fig. 1 The flow chart for the selection process of the study

on 94% of the items (i.e., ≥ 75% of respondents strongly agreed or agreed). There were 18 key questions distributed in 8 domains, and comments were made about how some of the recommendations were written. The criteria for the best image capture in the MSUS report and the qualifications for the physician who could write it received more comments (apart from minor editing suggestions). In the first round, there was no disparity of opinion. These questions, shown in Table 2, formed the basis of the systematic literature search and consequently the US standards.

Delphi round 2

The response rate for round 2 was 100% (15/15). A high-rank recommendation (ranks 7–9) was given to between 93.3 and 100% of respondents. Comments were more frequent for the optimum system quality for diagnostic musculoskeletal ultrasound machines. No statements were retired, and two statements were added in response to comments. There was agreement throughout all domains (i.e., 75% of respondents strongly agreed or agreed) on each domain.

Table 2 Key questions for MSUS reporting

Domain	Key question
1. US equipment	• What are the different types of musculoskeletal ultrasound (MSUS) equipment? • What is the Optimum system quality for diagnostic musculoskeletal ultrasound machines? • What are the advanced options in MSUS machines?
2. Physician qualification	• What are the standards for the physician competency for musculoskeletal ultrasound imaging (qualifications)?
3. MSKUS Referrals	• What are the criteria for musculoskeletal ultrasound requests?
4. Quality Standards for MSKUS imaging acquisition	• How to optimize the practitioner and patient safety especially during pandemics? • What are the requirements for the optimum MSUS examination? • What are the criteria for optimum image capture in the MSUS report? • How to ensure optimum Image storage and recording?
5. Image-guided MSK interventions	• How to keep control of the clinical decision making for US-guided musculoskeletal intervention?
6. MSK report standards	• What are the requirements for the physician who could write the MSUS report? • What are the Core set domains of the MSUS report?
7. Operating standards	• Will having a practitioner checklist for ultrasound examinations be of value in standard practice? • What are the clinical governance issues to consider in operating MSUS service? • How to ensure appropriate probe decontamination? • How to ensure high-quality standards for the procurement, use, and maintenance of US equipment? • How to ensure that patients are well informed about the nature and conduct of the musculoskeletal ultrasound examination so, they can give verbal consent?
8. Education and accreditation	• What is (are) the best approaches to ensure the quality of continuing professional development (CPD) of the MSKUS operator?

MSUS Musculoskeletal ultrasound, *US* Ultrasound, *CPD* Continuing professional development, *MSK* Musculoskeletal

Table 3 Overarching principals

Overarching principals
1. Ultrasound is an imaging modality which "creates" images by emitting ultrasound waves. These waves are reflected by the tissue they penetrate and the information of the reflected waves are shown in black and white.
2. Ultrasound examination allows both static and dynamic anatomical assessment of the visualized structures, and with Doppler information of perfusion may be obtained in the imaged areas.
3. MSUS can be used to diagnose musculoskeletal and neuromuscular different conditions using static and dynamic maneuvers, also MSUS can be used in interventional procedures.
4. The style of the report may vary subject to the local practice. It should be easily understandable, concise and without any obscurity. The common abbreviation only can be used in the MSUS report, while less common terms should be mentioned in full. The sonographer can ignore the irrelevant findings.
5. The significance of measurements and appearances should be explained. Template for specific type or region of ultrasound examination can be used and the completely normal report can be abbreviated.
6. The report should be completed and forwarded to the referrer in a timely fashion in accordance with national guidelines. The reporter is obliged to inform the referrer by using local alert mechanisms if there is a critical and urgent finding.

MSUS Musculoskeletal ultrasound

Recommendations for MSUS reporting

The overarching principles are summarized in Table 3.

At the end of the second round, a total of 18 statements distributed on eight domains were obtained.

Domain 1: US equipment

1. What are the different types of musculoskeletal ultrasound (MSUS) equipment?

   LOE: 5, GoR: D, mean±SD: 8.8+0.4, agreement percentage: 100%, LOA: high

Musculoskeletal ultrasound (MSUS) equipment

- Stationary equipment usually refers to larger, high-end, ultrasound systems. They have a superior imaging capacity but usually are best found in one location because of their size.
- Portable systems refer to compact systems approximately the size of a laptop computer. They usually have a single probe attached at one time. Hand-held pocket ultrasound systems have been developed. Portables are suitable for use across sites and can be easily transported from clinic to bedside. They may be carried using a rucksack but also may be attached to a stand, although this may reduce the system's portability.
- Mobile systems refer to midrange machines that are smaller and more mobile than stationary systems but usually retain a higher specification and image quality than portable systems at a lower price.
- Wireless probes are proving to be suitable, fast, and safe tools for MSUS examination, a handheld wireless ultrasound machine, able to connect to any iOS or Android device through a secure Wi-Fi.

2. What is the optimum system quality for a diagnostic musculoskeletal ultrasound machine?

   LOE: 5, GoR: D, mean±SD: 8.7+0.5, agreement percentage: 100%, LOA: high

Musculoskeletal ultrasound requirements

Musculoskeletal and neuromuscular ultrasound requires top-class equipment with the highest quality transducers and, if possible, full software options to improve image quality, i.e., resolution, contrast, and the best possible artifact removal.

The minimum requirements for diagnostic musculoskeletal ultrasound machine:

- A linear transducer with at least a frequency of 13 MHz with ultrasonic focusing at a depth of no more than 5 mm, at least 15.0 MHz transducer is needed for more superficial structures.
- A curvilinear (convex) transducer with a frequency of 2–6 MHz is required for examining deep structures such as hip joints and surrounding structures and also for obese patients.
- Doppler options: color, power, and tissue (microcirculation) options.
- Harmonic imaging: to provide images of better quality than conventional ultrasound technique.
- Spatial compound imaging combines multiple lines of sight to form a single composite image at real-time frame rates. This causes a reduction of angle-dependent artifacts.

3. What are the advanced options in MSUS machines?

   LOE: 4, GoR: C, mean±SD: 8.8+0.4, agreement percentage: 100%, LOA: high

   Advanced options in MSUS machine

   - Transducers with a high frequency of 20.0 MHz or higher, for superficial structures optimum visualization to show finer anatomic detail of the extremities
   - Superb microvascular imaging (SMI) or microvascular flow imaging (MVI/MV-flow by allowing more sensitive detection of increased vascularity in tendons, joint capsules, and peripheral nerves, and also for vasculitis.
   - Ultrasound elastography (EUS) is a method to assess the mechanical properties of tissue, by applying stress and detecting tissue displacement using ultrasound for early diagnosis to both guide and monitor therapy.
   - On-vision needle tip tracking (NTT) is a new technology consisting of a needle with an ultrasound sensor close to the needle tip and a console for computerized signal processing. this significantly reduced the procedure time and the number of hand movements for ultrasound-guided injection

Domain 2: Physician qualification

1. What are the standards for the physician competency for musculoskeletal ultrasound imaging (qualifications)?

   LOE: 5, GoR: D, mean±SD: 8.2+1.6, agreement percentage: 93.3%, LOA: high

Requirements for qualified musculoskeletal ultrasound reporter

- Basic competency

Achieved through a number of available basic introductory courses, usually over a minimum of 2 days.

– The physician who could perform the MSUS examination should be as follows:

  - Be a physician with a medical degree and physician license
  - Documented training in at least the basic MSUS techniques
  - Has detailed knowledge of musculoskeletal anatomy
  - Get a course or training in the field of musculoskeletal diagnosis in a documented professional center with documented competencies in musculoskeletal ultrasound.

Mentorship level

Those wishing to train and mentor other musculoskeletal sonographers should fulfill the following:

Consultant MSKUS radiologist

OR

Trainer certificate

OR

- Three years of clinical MSKUS experience
- Regular commitment to MSK US (minimum of 1 clinic per week where US is routinely used)
- Undertake a minimum of 400 scans per year (irrespective of whether full/part-time job plan)

Domain 3: MSUS referrals

1. What are the criteria for musculoskeletal ultrasound requests?

   LOE: 5, GoR: D, mean±SD: 8.3+1.2, agreement percentage: 93.3%, LOA: high

– There should be a clear working diagnosis and/or clinical question on the request.
– Findings of clinical examination in relation to the request and possible diagnosis
– A specific tendon or group of tendons (such as the rotator cuff) should be included in the request to ensure that the ultrasound scan and report are useful. Requests that will be returned to the referrer include the site of pain and probable cause of injury.
– Cases in need of vital/urgent treatment who should be referred directly to the specialist/secondary care (e.g., suspected thumb/finger collateral ligament injuries)
– Ultrasound may be indicated to rule out other pathologies. Scan only if there is clinical concern about alternative pathologies

Domain 4: Quality standards for MSUS imaging acquisition

1. How to optimize the practitioner and patient safety especially during pandemics?

   LOE: 4, GoR: C, mean±SD: 8.7+0.6, agreement percentage: 100%, LOA: high

Role of the patients:

- Patients are advised to avoid arriving very early or late for appointments because many ultrasonography clinics have relatively small waiting areas. Instead, strive to be on time.
- Attending appointments alone where asking relatives to wait outside
- Wear a mask while on hospital premises.

Role of the staff member:

- Follow the local protocols for hand hygiene
- Disposable PPE should be used frequently
- Risk evaluations should be carried out with respect to the capacity of the ultrasound room and the staff's ability to maintain social distance.

2. What are the requirements for the optimum MSUS examination?

   LOE: 5, GoR: D, mean±SD: 8.9+0.3, agreement percentage: 100%, LOA: high

Requirements for optimum MSUS examination

- Expert sonographer
- Optimum equipment selection
- Proper transducer selection
- Optimizing gray-scale and Doppler settings of the machine
- Usage of an appropriate amount of gel as transducers must be in direct contact with the patient's skin without an air gap
- Image orientation throughout scanning to optimize the left side of the image is cephalad in the longitudinal scan and the patient's right in the transverse scan
- Optimum patient and probe positioning
- Examine the structures on both longitudinal and transverse scans, using both gray-scale and Doppler modes
- The images should be stored on the ultrasound unit with a possibility of external backup.

3. What are the criteria for optimum image capture in the MSUS report?

   LOE: 3, GoR: C, mean±SD: 8.9+0.3, agreement percentage: 100%, LOA: high

Image capture

Ultrasound images are an important medical document. The abnormal finding should be illustrated as accurately and in two perpendicular planes as feasible, including measurements and vascularity. Common bone landmarks, site markers, and image labeling should be used for better orientation.

Images should be captured and labeled with a minimum dataset that includes name, ID (e.g., hospital number or National Health Service number), date of birth, gender, and postal code. Data entry is time-consuming but most of the machines now enable recording patient's data before doing the US examination and therefore should be seen on every picture. Patient demographics should be readily available when the ultrasound scanner is connected to PACS. In this case, the hospital's main radiology system is used to capture, store, and make images available for evaluation.

4. How to ensure optimum image storage and recording?

   LOE: 5, GoR: D, mean±SD: 8.4+0.7, agreement percentage: 100%, LOA: high

   Images are locally archived and, if printing is an option, printed and stapled to the patient's notes when the departmental scanner is not linked to PACS. The scanner's internal memory drive enables the storage of several videos and images that can be beneficial for treatment monitoring.

   The photos should not be transferred to external memory drives unless an encrypted system has been employed for patient confidentiality concerns. When transferring images from the scanner's local memory disk, this could be a challenge. To enable data transfer for uses like teaching, cooperation between the ultrasound manufacturer representative and hospital IT may be necessary. Some scanners have software that enables the blinding of patient information during image transfer.

Domain 5: Image-guided MSK interventions

1. How to keep control of the clinical decision making for US-guided musculoskeletal intervention?

   LOE: 5, GoR: D, mean±SD: 8.9+0.5, agreement percentage: 100%, LOA: high

The indications for referral for ultrasound guidance of a procedure for patients with MSK pathologies:

- Management of localized pathology, e.g., Baker's cyst
- To obtain samples of joint aspirate for diagnostic purposes
- For relief of pain from localized inflammation of the joint or soft tissue
- To aid mobilization
- To assist with rehabilitation and improve function

Making the decision of using imaging to direct therapeutic injections to their intended targets is a complex

one that depends on a number of variables, including clinical need, local finance, and the availability of imaging services. Therefore, rather than relying on national guidance like this document, it is still the responsibility of the individual clinician, service or clinical pathway lead to outline the requirements for performing guided or blind injections.

Domain 6: MSK report standards

1. What are the requirements for the physician who could write the MSUS report?

   LOE: 5, GoR: D, mean±SD: 8.9+0.3, agreement percentage: 100%, LOA: high

The ultrasound report is part of the medical record and is a legal document. The individual performing or verifying the scan is responsible for its accuracy. To be eligible to report musculoskeletal ultrasound, the characteristics of the physician who could write the MSUS report should possess certain qualities and meet specific requirements.

- Education and training

To be eligible to report musculoskeletal ultrasound, the individual must have completed a formal education in medical sonography or a related field. Additionally, they must have received specialized training in musculoskeletal ultrasound, which includes hands-on experience and supervised clinical practice.

- Technical skills

The person who would be eligible to report musculoskeletal ultrasound should possess excellent technical skills, including the ability to operate and maintain ultrasound equipment. They should also have a strong understanding of anatomy and physiology, as well as the ability to interpret and analyze ultrasound images accurately.

- Communication skills

Effective communication skills are essential for the person who would be eligible to report musculoskeletal ultrasound. They should be able to communicate clearly and effectively with patients, physicians, and other healthcare professionals, as well as document their findings accurately and comprehensively.

- Professionalism and ethics

The person who would be eligible to report a musculoskeletal ultrasound should exhibit professionalism and ethical behavior at all times. This includes maintaining patient confidentiality, adhering to professional standards and guidelines, and practicing within their scope of practice.

- Continuing education

To stay current with advances in technology and best practices, the person who would be eligible to report musculoskeletal ultrasound must engage in continuing education. This includes attending conferences, workshops, and seminars, as well as reading relevant literature and participating in online learning activities.

Quality improvement: The person who is performing the ultrasound examination should only practice what they are skilled in performing. To maintain high standards of practice, systematic review of procedures, learning audits, and participation in interdisciplinary team meetings should be used.

2 What are the core set domains of the MSUS report?

LOE: 5, GoR: D, mean±SD: 8.8+0.6, agreement percentage: 100%, LOA: high

Core set domains of MSUS report

– The MSUS report should be an answer to the question asked by the referring physician
– The report should be concise

Core set domains of MSUS report:

- **Data of examination and examining physician**
  - Name and affiliation of the examining physician
  - Date and place of the examination
- **Patient's demographics**
  - Full name, age, gender, and ID number of the patient

- **Data of referring physician**
  - Name, title, and the department of the referring physician
- **Reason for referral**

  - The clinical question that has led to the MSUS examination
  - A short summary of the case history and clinical data

- **Name of the region/regions examined**
- **Technique and procedural description (when required)**
- **Description of all the elements of the examined region**

  - "All evaluated structures, regardless of whether pathological or not, should be listed in the description."
    - B-mode
  - Doppler/contrast examination

- **Mention the previous imaging if available and compare it with the present findings**
- **Answer to the clinical question/conclusion**
- **Recommendation for future treatment or diagnostics, if relevant**

Domain 7: Operating standards

1. Will having a practitioner checklist for ultrasound examinations be of value in standard practice?

   LOE: 5, GoR: D, mean±SD: 8.9+0.4, agreement percentage: 100%, LOA: high

The importance of practitioner checklist:

- Check that the examination is justified
- Check available notes and referral documentation
- Address the clinical question.
- Confirm the correct modality
- Provide clear information and instructions to all involved
- Select the correct pre-set for the examination, adjusting imaging parameters as necessary
- Select appropriate transducer
- Prepare equipment as necessary
- Start with as low a power setting as possible
- Add image annotation and comments as appropriate to stored images
- Report the examination
- Inform patient of results appropriate to findings, situation, and local guidelines
- Inform the referrer of any urgent or significant findings

2. What are the clinical governance issues to consider in operating MSK US service?

   LOE: 5, GoR: D, mean±SD: 8.9+1.0, agreement percentage: 93.3%, LOA: high

   - Safety
   - Quality assurance
   - Infection control
   - Medico-legal aspects of ultrasound practice
   - Professional indemnity
   - Use of chaperones
   - Handling patient expectations

3. How to ensure appropriate probe decontamination?

   LOE: 5, GoR: D, mean±SD: 8.7+0.6, agreement percentage: 100%, LOA: high

   Decontamination is a general term used for all aspects of transducer cleaning, it is the sequence of processes including cleaning and microbiocidal actions that make a reusable medical instrument safe for reuse.

   To ensure appropriate probe decontamination, use five steps to decontamination:

   1. Remove the transducer cover, gel/visible soiled material from the transducer
   2. Visually inspect the transducer, cable, and machine. Report any signs of damage and remove the affected piece of equipment
   3. Determine the level of decontamination required and refer to the manufacturer's guidance on cleaning products or devices which can be used
   4. Follow decontamination process
   5. Record actions where required

4. How to ensure high-quality standards for the procurement, use, and maintenance of US equipment?

LOE: 5, GoR: D, mean±SD: 8.8+0.4, agreement percentage: 100%, LOA: high

Procurement management must seek out vendors who are best suited to their business and its unique requirements.

The US machine to be procured must meet the quality standards and expected abilities.

Regular maintenance contracts are to be agreed upon and made available and maintain the standards of machines.

5. How to ensure that patients are well informed about the nature and conduct of the musculoskeletal ultrasound examination so, they can give verbal consent?

LOE: 5, GoR: D, mean±SD: 8.6+0.6, agreement percentage: 100%, LOA: high

The concept of informed consent relies on the concept that a doctor has a responsibility to provide information to a patient so that the patient can make an informed decision about his or her own management or treatment.

Prior to an ultrasound exam, written patient consent is not legally required to be sought. To ensure that patients can offer verbal consent, it is best practice to ensure that they are thoroughly informed about the nature and process of the examination.

It is preferable that this information be given in written form, given before they arrive, however, and reviewed by the person conducting the scan when they attend.

Written consent will be required for some interventional ultrasound procedures if the procedure is expected to be relatively invasive or require sedation

Comparative claims with other practitioners should not be made in respect of the superiority of skills, equipment, and/or facilities. The term "specialist" should be restricted to those who have a defined specialist skill.

Domain 8: Education and accreditation

1. What is (are) the best approaches to ensure the quality of continuing professional development (CPD) of the MSKUS operator?

LOE: 5, GoR: D, mean±SD: 8.6+1.1, agreement percentage: 93.3%, LOA: high

- Audit, learning events, and learning meetings
- Continuing professional development (CPD)
- Align their services to the quality standards of imaging
- Keep a simple record of the impact or outcome of the event on their practice: Logbook
- Research studies

A musculoskeletal ultrasound report template is presented in Supplementary 1.

Discussion

Considering the significant big number of musculoskeletal US indications and the rapidly growing number of healthcare professionals providing medical care for musculoskeletal disorders, the demand for a consensual position among musculoskeletal US experts has become evident. This document is the result of collaboration between the leads of musculoskeletal and neuromuscular US in the different Egyptian universities. The national document provides a position statement representing the agreed consensus of experts in Egypt.

Some concerns have been raised regarding the potential risks arising from practices run by independent sonographers. Professional reporting and interventions carried out in US-guided or complex cases that require specific imaging techniques are also other challenges that need tackling to ensure efficiency and no harm. This work provided standards for point-of-care musculoskeletal ultrasound in Egypt. Similar efforts have been carried out to standardize the musculoskeletal US assessment and reporting [14, 15]. EULAR has organized several US courses and published guidelines for performing these courses at different levels (basic, intermediate, and advanced levels) [16]. The minimum training prerequisites for rheumatologists doing musculoskeletal US scanning were also issued, together with establishing [17] and implementing [18] a 3-level competency assessment (COMPASS). Furthermore, recommendations have been developed for teaching the teachers' courses [19]. The standards included in this work are in agreement with those included in the EULAR as well as the British Society of Skeletal Radiologists (BSSR) position statement [20]. However, these standards are set up for healthcare professionals dealing with musculoskeletal and neuromuscular medicine, and rheumatologists and should not be generalized to settings different from the rheumatologic examination, e.g., those that might take place in the radiology department.

Frequently, there is overlap between the terms "Standards", "Guidelines" and "Protocols" which may cause confusion. Standard is "A required or agreed level of quality or attainment. A standard is a means to guarantee the highest possible level of care or service delivery. Standards increase the probability that an ultrasound examination will be conducted safely and successfully are clear about what must be done to comply, are supported by evidence, and are effectively quantified. On the other hand, the guideline is "A general rule, principle or piece of advice. Based on the best current research, guidelines offer recommendations on how ultrasound examinations should be carried out. They support ultrasound professionals in their work but do not take the place of their knowledge and skills". On another front, protocol is "An agreement, preferably based on research, between practitioners to ensure the delivery of high-quality, standardized ultrasound examinations" [21]. This work provided key standards for musculoskeletal US practice based on a review of the published current standards for the delivery of musculoskeletal US and included statements on US equipment, physician qualification, referrals, imaging acquisition, image-guided interventions, report standards, and operating standards as well as education and accreditation.

The standards provided in this work endorsed the implementation of musculoskeletal and neuromuscular US as a component of the day-to-day rheumatology practice. The rheumatologist-administered US can potentially lessen the time to definitive diagnosis, facilitate patient education, and speed up management decisions. It can also be a key in reducing the number of patients lost to follow-up [22]. Furthermore, it helps reduce the utilization of other expensive imaging tools, e.g., MRI. The WHO has estimated that 90% of all imaging requirements in resource-limited countries can be provided by basic X-ray and ultrasound services [23–25]. It is expected that advanced US technology, such as hand-held, high-resolution devices plugged into smartphones and tablets as well as the integration of machine learning and easy-to-use interfaces, will facilitate the development of ultra-portable US machines which in turn will continue to minimize the time to diagnosis [26].

The literature base of musculoskeletal US is quite broad, but mainly includes observational outcomes, with few studies assessing the patient outcomes or implementing randomized-controlled setup for potential biases. This may explain the low level of evidence in some statements. Therefore, these standards present a framework for practice and do not dictate the care of a specific patient. Consequently, such standards are not intended, to establish a legal standard of care. The standards are meant to promote desirable or favorable outcomes, but do not secure any specific outcome. These standards are subject to regular revision as warranted by the evolution of technology, medical knowledge, and practice.

Conclusion

A musculoskeletal ultrasound report template has been developed by this study, based on outcomes of a Delphi process, by an international participants' panel. All domains met the 80% voting threshold set in this work. The reporting template can be used for both clinical research as well as standard practice to provide guidance and standardize the MSUS reporting.

Abbreviations

BSSR	British Society of Skeletal Radiologists
CEBM	Center for Evidence-Based Medicine
CEG	The Clinical, Evidence-based, Guidelines
CPD	Continuing professional development
EULAR	European Alliance of Associations for Rheumatology
EUS	Ultrasound elastography
GoR	Grade of recommendation
LOA	Level of agreement
LOE	Level of evidence
MSK	Musculoskeletal
MSUS	Musculoskeletal ultrasound
NTT	Needle tip tracking
PICO	Population–Intervention–Comparator–Outcome
PPE	Personal protective equipment
SMI	Superb microvascular imaging
US	Ultrasound

Supplementary Information

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Additional file 1. US report template.

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Authors' contributions

Conceptualization and design, Yasser El Miedany and Mohammed Hassan Abu-Zaid; Acquisition of data, Yasser El Miedany and Mohammed Hassan Abu-Zaid; Formal analysis, Maha El Gaafary; Investigation, Radwa ELkhouly and Waleed Hassan; Methodology, all authors; Writing—original draft, Yasser El Miedany, and Mohammed Hassan Abu-Zaid; Final approval of the version to be submitted, all authors.

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Availability of data and materials

The data will be available upon reasonable request.

Declarations

Ethics approval and consent to participate

This study was performed in accordance with the Helsinki Declaration. This was a multistep process that followed the "Clinical, Evidence-based, Guidelines" (CEG) initiative protocol (ethical approval code: 34842/8/21, ethical board Tanta University).

Consent for publication
Not applicable.

Competing interests
The authors declare that the corresponding author is the associate editor in the Egyptian Rheumatology and Rehabilitation, Mona Mansour is the editor-in-chief of ERAR, Mohammed Mortada, Yasser El Miedany, Waleed Haasn, Nouran Abaza, Hanan Abozaid, Radwa Elkhouly, Safaa Mahran, and Basant Elnady are from the editorial board of the journal. Other authors declare that they have no competing interests.

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