

## Musculoskeletal ultrasound guided manoeuvres – security profile

Mihaela C. Micu<sup>1</sup>, Violeta M. Vlad<sup>2</sup>, Sorana D. Bolboacă<sup>3</sup>, Mihaela Cârlig<sup>4</sup>, György I. Bodizs<sup>5</sup>, Alina G. Duțu<sup>6</sup>, Daniela Fodor<sup>7</sup>

<sup>1</sup>Rheumatology Division, Rehabilitation Clinical Hospital Cluj-Napoca, <sup>2</sup>Rheumatology Department, “Sfânta Maria” Hospital, Bucharest, <sup>3</sup>Department of Medical Informatics and Biostatistics, “Iuliu Hatieganu” University of Medicine and Pharmacy Cluj-Napoca, <sup>4</sup>University Medical and Surgical Center Interservisan, Cluj-Napoca, <sup>5</sup>Laboratory Unit, Rehabilitation Clinical Hospital Cluj-Napoca, <sup>6</sup>Biochemistry Department, “Iuliu Hatieganu” University of Medicine and Pharmacy Cluj-Napoca, <sup>7</sup>2<sup>nd</sup> Internal Medicine Department, “Iuliu Hatieganu” University of Medicine and Pharmacy Cluj-Napoca, Romania

### Abstract

**Background:** In daily rheumatology clinical practice, routine interventional musculoskeletal ultrasound (MSUS) guided maneuvers such as aspiration, intraarticular or periarticular drug injections require efficient cleaning and disinfection methods for both transducer and patient’s skin. **Aim:** To study the efficacy of probe and skin disinfection measures after using simple protocols, to identify the prevalence of septic and other drug related side effects after MSUS guided interventions and to quantify the total procedure time. **Material and methods:** Recruitment of consecutive patients with different joint/ periarticular MSUS guided interventions was made in 3 medical centers. Bacterial load was determined on the transducers footprint after dry cleaning with the removal of any gel trace and on patient’s skin after rigorous skin disinfection with either Bethadine or alcohol 70° and Bethadine. Non-sterile gel was used as an ultrasound transmission medium. The time spent for some of the invasive procedures was quantified. **Results:** Nine hundred and ninety eight MSUS guided interventional maneuvers were performed in 945 patients with inflammatory and degenerative musculoskeletal pathologies. *Staphylococcus epidermidis* was identified in 13.33% cases of the skin bacterial load analysis and in 37.50% cases of the footprint analysis. In two patients pathogenetic germs were detected on the skin. No septic post-procedural complications were reported. In 0.6% of the cohort other side effects occurred: aseptic osteonecrosis, skin depigmentation at injection site and iatrogenic microcrystalline reactions. The median time frame dedicated to the intervention was 6 minutes. **Conclusion:** Rigorous transducer dry cleaning and Bethadine/ Bethadine and alcohol 70° skin disinfection are efficacious methods. The risk for septic complications and other drug related side effects related to MSUS guided injections is very low in this context. A correct injection technique must accompany the previous requests. Rapid and safe interventional maneuvers reduce the risks and control the costs of the healthcare system.

**Keywords:** musculoskeletal ultrasound, interventional, disinfection, septic complications, side effects

### Introduction

Interventional musculoskeletal ultrasound (MSUS) guided manoeuvres refer to a large category of percuta-

neous invasive procedures the using ultrasound examination technique for needle guidance. In daily rheumatology clinical practice, several manoeuvres are more frequently performed such as aspiration or drug injection in joints, tendon sheaths and periarticular structures, or perineural anaesthetic blocks. More rarely, complex manoeuvres such as biopsies, foreign body extraction, or rotator cuff calcifications needling and aspiration techniques are done [1-5].

Over the last decade, MSUS guided manoeuvres have gained higher interest in clinical practice. Consistent published medical data assign higher drug deposition accuracy and higher efficacy in comparison to blind ma-

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Corresponding author: Micu Mihaela Cosmina

Rheumatology Division,

Clinical Rehabilitation Hospital,

46-50 Viilor street

400306, Cluj- Napoca, Romania

Phone: +40264207021, Fax: +40264453131

E-mail: mcmicu@yahoo.com

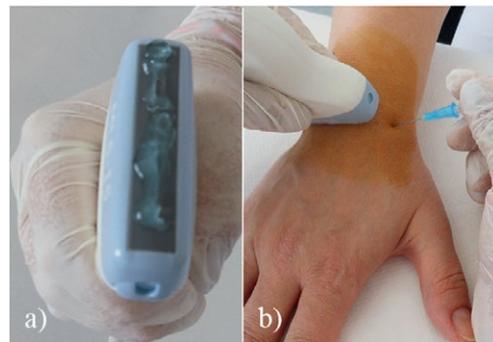
noeuvres along with better procedural and postprocedural pain and functional outcome [6-20]. All these advantages together with the possibility to perform interventional manoeuvres quickly and safely, immediately after the MSUS evaluation, in the same room and by the same physician, using a non-radiant imaging tool, generate an important economic impact on the healthcare system due to the direct and indirect cost savings [16,21].

Still, there is an ongoing debate concerning the security profile of MSUS guided manoeuvres when using simple transducer and skin disinfection protocols. Repetitive use of the same transducer in different anatomic areas or between different patients, the small distance between the transducer and injection site raises the question for the true risk of septic complications when performing these kinds of manoeuvres [22-26]. On the other hand, sophisticated disinfection protocols are time consuming and expensive and, at the end, may limit the number of performing physicians. Another important aspect is related to drug side effects: aseptic osteonecrosis of the injected joints, local skin depigmentation or iatrogenic microcrystalline synovitis/ tenosynovitis after corticosteroid drugs (CS) injection, etc., all these events being described as possible side effects in the literature [5,20,27-30].

Therefore, **the aims** of our study were to perform a prospective study with the focus on probe and skin disinfection efficacy after using simple protocols, to identify the prevalence of septic and other drug related side effects after MSUS guided interventional manoeuvres, and to estimate the total procedure duration.

### Material and method

Recruitment of consecutive patients with different joint/ periarticular pathologies was made in three medical centres: Rheumatology Division, Rehabilitation Clinical Hospital Cluj-Napoca, Rheumatology Department, "Sfânta Maria" Hospital, Bucharest, and 2nd Internal Medicine Department, "Iuliu Hatieganu" University of Medicine and Pharmacy Cluj-Napoca, Romania (randomly named *medical centre 1, 2, and 3*) between February 2013- January 2014. Clinical and MSUS evaluation was performed by 3 rheumatologists (MCM 7 years/ VV 10 years/DF 15 years of experience in MSUS), with Esaote MyLab 50/70 ultrasound machines, according to current guidelines and protocols for each anatomic region [31]. All MSUS guided interventional manoeuvres performed in this time frame were recorded. The decision for a certain interventional manoeuvre and timing related to other therapeutic modalities addressed to the patient was made by each performing physician for their own



**Fig 1.** a) Transducers footprint is covered by a small amount of non-sterile gel while preparing for injection; b) Transducer is placed on the disinfected skin; the total amount of gel remains between the footprint and skin. Security distance between the needle and transducer is kept.

group of patients. The patients signed a written consent, in agreement with the declaration of Helsinki, obligatory in our medical units, prior to any investigation or interventional manoeuvre. In addition, the consent specifies the possibility of clinical data use for scientific purposes. The local Ethics Committee approved the study.

The preparation for the performing physician included hand washing, gloves, mask and robe. No sterile cover for the probe was used, neither sterile gel. Non-sterile gel was placed strictly under the probes footprint (fig 1).

The standard preparation of the probe follows a protocol in which dry soft paper cleaning is performed before the first session, with the first patient, and after each examined anatomic area (in order to clean any trace of the remaining gel) and before performing the next examination or interventional manoeuvre in the same patient. Two bacterial loads were evaluated: first from the footprint surface after the cleaning protocol was applied and second from on the patient's skin after disinfection protocol was done

Examination of the transducers bacterial load was made by touching the footprint surface with a previously humidified (sterile saline solution) cotton swab. The cotton swab was kept for 10-15 minutes in 9 ml sterile saline peptone followed by insemination in two different culture mediums: blood agar and Bromothymol-blue lactose agar (AABTL). The culture technique underwent a standard protocol with incubation for 48 hours at 37°C. In cases where bacterial colonies were detected, the following supplementary tests were performed: chatalase test, gram stain, coagulase test, Chapman medium insemination, and Novobiocine test.

The second bacterial load determination was made from the patient's skin exactly before executing the cho-

sen interventional manoeuvre. After skin disinfection with alcohol 70° followed by Bethadine (*medical centre 2*) or only Bethadine (*medical centre 1 and 3*) a sterile saline serum humidified cotton swab touched an area of 4 cm<sup>2</sup> in the proximity of the transducers footprint. Afterwards, the invasive procedure was performed and at the end the transducer underwent dry cleaning again.

Evaluation of the time spent for performing the interventional manoeuvre was monitored in 87 patients with different pathologies. The time spent comprised the dry cleaning of the probe, hands wash and gloves on, disinfection of skin, placement of the probe in order to expose optimally the target lesion, insertion of the needle, aspiration, drug injection, needle retraction, disinfection and haemostasis if necessary.

Each patient was instructed to report in the first 48–72h after injection of the occurrence of systemic or local symptoms and signs of infection (redness, swelling, pain, fever, etc.) and to return for follow up after 3 weeks or at any moment if any suspicion of side effects related to the procedure were detected. No bed rest indications were made after the procedure, with the exception of a subset of patients with ongoing anticoagulant therapy.

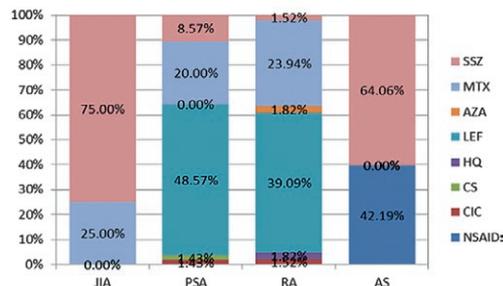
#### Statistic analyses

Data were analyzed according to the type of variables. Qualitative data were summarized as percentage and associated 95% confidence interval (provided in squared brackets along the manuscript), confidence interval computed using an exact approach [32]. Quantitative data were summarized as median and interquartile range (provided in round brackets along the manuscript) whenever data proved not to follow a normal distribution. Comparisons between two groups were done with Z test for proportions when qualitative data were of interest

or Mann-Whitney test for quantitative data proved not to follow a normal distribution. Statistical analysis was conducted with the Statistica (v.8) program at a significance level of 5%. Any  $p < 0.05$  was considered statistically significant. Graphical representations were done using Microsoft Excel.

#### Results

Enrolment of 945 consecutive patients totalizing 998 interventional MSUS guided manoeuvres was made. Demographic data, disease spectrum and activity scores for rheumatoid arthritis (RA) and ankylosing spondylitis (AS) are presented in Table I. A significantly higher proportion of investigated subjects were women (women: 66.46% [63.39–69.42]; men: 33.54% [30.58–36.61]; Z-statistics = -21.43,  $p < 0.0001$ ).

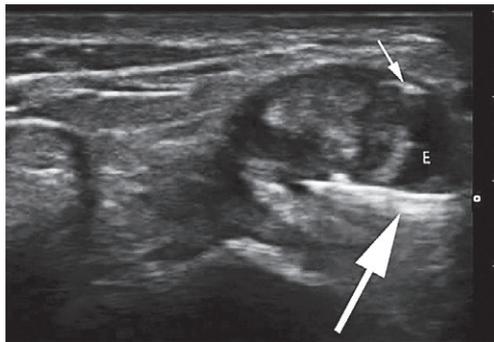


**Fig 2.** Distribution of different therapies in juvenile idiopathic arthritis (JIA), psoriatic arthritis (PSA), rheumatoid arthritis (RA), and ankylosing spondylitis (AS). SSZ- Salazophyrine, MTX- Metotrexate, AZA- azathioprine, LEF- Leflunomide, HQ- Hydroxyclochloroquine, CS- corticosteroids, CIC-cyclosporine, NSAIDs- nonsteroidal antiinflammatory drugs.

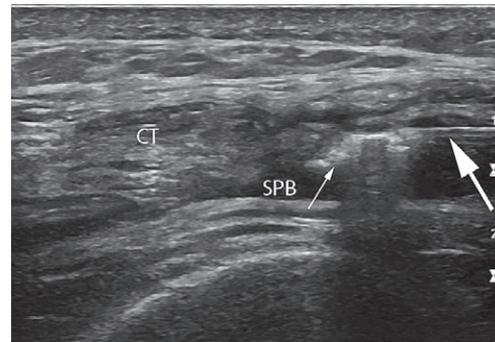
Table I. Characteristics of the patients group (number of the patients- 945)

Diagnosis	N	Age (years)	Disease onset (years)	Disease activity
JIA	4	10 (9.75–11.25)	3.5 (3–4)	n.a.
PSA	70	60 (55–66.75)	6 (5–8)	n.a.
Reactive arthritis	4	33.5 (31.75–37.25)	8 (7–8)	n.a.
Carpal tunnel syndrome	16	56 (54–65)	n.a.	n.a.
Degenerative lesions*	256	58.5 (61.0–67)	n.a.	n.a.
Gout	47	63 (54–69)	3.5 (1.5–4)	n.a.
OA	132	63 (54–69)	n.a.	n.a.
RA	330	63 (55–70)	5 (3.5–7)	4.03 (3.7–5.12)
AS	64	40 (31.25–48)	4 (3–6.5)	4.70 (3.99–6.2)
Trauma	22	20 (18–26)	n.a.	n.a.

Results are expressed in median (Q1–Q3) (lower and upper quartiles). Disease activity score in RA was expressed as DAS 28 (CRP). Disease activity score in AS was expressed as BASDAI. N- number of patients, \*-periarticular structures, JIA- juvenile idiopathic arthritis, PSA- psoriatic arthritis, OA- osteoarthritis, RA- rheumatoid arthritis, AS- ankylosing spondylitis.



**Fig 3.** Free hand technique injection with corticosteroids (CS) inside the tendon sheath at the level of the first extensors compartment. Needle is identified penetrating the tendon sheath (big white arrow), CS antigravitational accumulation after injection (small white arrow), E- effusion inside the tendon sheath.



**Fig 4.** Free hand technique injection with Hyaluronic acid prepare at knee level. The needle is visualized (big white arrow), the drug is identified as a hyperechoic mass (small white arrow), SPB- suprapatellar bursa, CT- quadriceps tendon.

Table II. Number, percentage, and type of injected areas

Injected area	CS	AO	HA	Total	95% CI	
					Lower Bound	Upper Bound
AC	3	0	1	0.40%	0.10	1.00
SASDB	276	0	0	27.65%	24.75	31.06
GH	3	0	0	0.30%	0.10	0.90
Elbow joint	16	0	4	2.00%	1.20	3.11
Elbow enthesis	102	0	0	10.22%	8.42	12.22
RC, IC	12	0	0	1.20%	0.50	2.60
CTS	19	0	0	1.90%	1.10	2.91
MCP	5	0	0	0.50%	0.20	1.20
DIP	1	0	0	0.10%	0.00	0.60
Knee joint	224	0	17	24.15%	21.54	26.95
Popliteal cyst	23	0	0	2.30%	1.50	3.41
CF	26	0	25	5.11%	3.81	6.61
PT	32	0	0	3.21%	2.20	4.51
TT	8	0	8	1.60%	0.90	2.61
Subtalar joints	2	0	0	0.20%	0.00	0.70
Plantar fascia	35	0	0	3.51%	2.40	4.81
Achille's bursa	11	0	0	1.10%	0.50	2.00
Olecranon bursa	16	0	0	1.60%	0.90	2.61
MTP	15	0	6	2.10%	1.30	3.21
Trauma	0	43	0	4.31%	3.11	5.71
Tenosynovitis	65	0	0	6.51%	5.01	8.22
Total	894	43	61	100%		

CS- corticosteroid;AO- Aspiration only; HA- hyaluronic acid; AC- acromio-clavicular joint; SASDB- subacromial subdeltoid bursa; GH- glenohumeral joint; RC- radiocarpal joint; IC- intercarpal joint; CTS- carpal tunnel syndrome; MCP- metacarpophalangeal joint; DIP- distal interphalangeal joint, CF- coxofemoral joint; PT- Peritrochanterian; TT- tibiotalar joint; MTP- metatarsophalangeal joint.

In the patients group, 468 subjects were diagnosed with RA, AS, psoriatic arthritis (PSA), and juvenile idiopathic arthritis (JIA). Out of this subset, 358 subjects received synthetic DMARD monotherapy (76.50% [72.44–80.13]) and 110 subjects received combined therapy with synthetic DMARDs or synthetic DMARD and biologic therapy (23.50% [21.50–28.54]). A significantly higher percentage of subjects was treated with monotherapy (Z-statistics = -25.48,  $p < 0.0001$ ) (fig 2). Inside the subgroup with chronic inflammatory diseases, only 8% of the patients (totalizing 38 patients) were in remission status at the time of recruitment.

Overall the local injected medication was represented by CS (Bethamethasone, 89.58% [87.47–91.38]), followed by viscosupplementation (Hyaluronic acids derivatives, HA) (6.11% [4.71–7.82]) (fig 3, fig 4); effusion evacuation was present in 4.31% [3.11–5.71] of the cases. Table II presents the percentage, type of injected anatomical areas and medication used.

Skin bacterial load determinations were performed randomly in 45 of analyzed subjects. The examinations were made as follows: in *medical centre 1*–24 determinations in 7 different days, different anatomical regions: knee, hands, shoulder, and ankle and in *medical centre 2*–21 determinations in 4 different days in following anatomic regions: knee, plantar fascia, shoulder, hand, and ankle. In 13.33% [4.49–26.62] of the cases bacterial growth was identified. Four subjects were detected with staphylococcus epidermidis, 1 case with bacillus cereus and 1 case with staphylococcus aureus (only in *medical centre 2*). No septic complications were reported after the interventional maneuvers in these 45 patients.

Transducers footprint bacterial load was determined in 16 cases (*medical centre 2*–10 determinations in 4 different days and *medical centre 1*–6 determinations in the same day). Six cases with staphylococcus epidermidis representing 37.50% [12.89–62.11] were detected, (only in *medical centre 1*). No septic complications were recorded post- interventional in these 16 patients.

Overall, out of 945 patients, in 99.40% [98.70–99.80] of the cases *no* post-interventional complications occurred. In 2 subjects which underwent coxofemoral joint CS injection, aseptic hip osteonecrosis was diagnosed 6 months later on MRI, in 2 subjects iatrogenic microcrystalline reaction after Achilles bursa CS injection was identified in the first 24 hours after injection (MSUS repeated) and in 1 subject skin depigmentation at injection site after CS occurred. One patient who received viscosupplementation drug deposition at the level of the lateral recess of the knee experienced an intense unexplained knee pain after 3 weeks (event announced by phone call). No patient presented post-procedural septic complications.

The median time frame dedicated to the intervention was of 6 minutes with an interquartile range from 5 to 7 minutes.

## Discussions

MSUS is a valuable tool for the physicians allowing real time visual assistance, helping them to perform quickly (immediately after the first consultation, at bedside sometimes), safely and precisely the interventional manoeuvres. The method is even more helpful in cases with anatomic variations – congenital or postsurgical – because it enables the physician to see the area of interest, to optimize the interventional manoeuvre per se, subsequently the patients outcome, and to minimize the risk of complications [21,33–40].

When inappropriate cleaning protocols are used, probe and ultrasound transmission gel used in daily practice can be a source of bacterial transmission among patients. By now, there is no consensus regarding these protocols for rheumatology settings. Reports of infectious diseases transmitted via probe or associated with the use of transmission gel occur more frequently in surgical healthcare settings, in patients with unhealed wounds, burns and those in intensive care units [24,25,41,42]. Some recent general guidelines which include the obligation of using sterile gel were proposed in order to minimize the infection risk [43]. Despite these protection measures, it has been shown that transmission gel can be contaminated (from manufacturer) leading to infections. Apparently, bacteriostatic components as parabens or methyl benzoate are not always a warranty for a high sterility standard as long as staphylococcus aureus, pseudomonas aeruginosa, and E. Coli could be identified in ‘sterile’ transmission gel [43–46].

In our daily practice, our protocol does not include the use of sterile gel. We consider that this measure is not necessary when probe and skin disinfection are properly done and security distance between needle and probe is kept during the entire interventional procedure.

In rheumatologic clinical practice patients have more rarely major skin problems such as extended wounds or other lesions with infection potential. Still, a higher risk for post-procedural infections could be linked to the patient’s immunosuppressive status due to chronic inflammatory disease and/or systemic medication. Indeed, multiple MSUS joint/periarticular evaluations/interventions in the same patient may enhance the iatrogenic infection risk [43]. In our study we show that no septic event occurred in any of the patients, independently of the underlying pathology, disease activity status, immunosuppressive therapeutic strategy or repetitive MSUS guided

interventions in the same patient. In fact, in the entire patients group, more than 50% were diagnosed with chronic inflammatory diseases out of which approximately 75% were treated with synthetic DMARD monotherapy and the rest with different drug combinations. Only 38 patients representing 8% of the subset were in remission status when data were registered. These results are in line with the study of Cervini et al that showed a very low incidence of serious septic events (14 cases) after different types of US guided interventions performed in over 13,000 patients with various pathologies [47].

It is well known that repetitive, aggressive (alcoholic solutions) disinfection of the probe produces irreversible damage translated into impaired ultrasound images [25,26]. Therefore, efficient but safe (non-alcoholic) probe cleaning and skin disinfection protocols together with a correct injection technique which implies a security distance of minimum 0.5 cm between the footprint and injection site are mandatory in avoiding septic side effects. Our objective was to ascertain whether the current protocol for probes cleaning and skin disinfection in our units is adequate to prevent cross contamination. Our data show that removal of any visible gel trace by using a simple dry cleaning method of the probe ensures a safe interventional procedure with no septic side effects, results confirmed also by other recent studies [22,42]. Indeed, rigorous skin disinfection with both described alternatives assures safe injection conditions. In our patients, the bacterial load was determined on the skin by checking an area of 4 square cm but in reality the needle tip touches an area of less than 1 mm<sup>2</sup> when penetrating the skin. Ubiquitous bacteria such as staphylococcus epidermidis may be present on patients' skin or on the transducers' footprint but does not represent a true risk factor for further infectious events as proved in our study.

In fact, in one of our centres, a higher incidence of staphylococcus epidermidis bacterial load was detected on the transducers footprint. A potential explanation for this finding could be that patients were evaluated with the same probe not only for musculoskeletal disorders but also for other different pathologies. The probe was placed in the same day on abdominal, pelvic, axillary or neck region skin and this could contribute to a higher incidence of staphylococcus epidermidis detection. Moreover, none of the 2 patients in which we identified pathogenetic bacterial skin load (bacillus cereus and staphylococcus aureus) developed infectious complications after the interventional manoeuvre. In this last example, two explanations could be valid: the needle penetrated in a sterile area inside those 4 cm<sup>2</sup> of skin or the skin bacterial load was too low to trigger an infectious event.

Apart from the infectious risk, current literature cite also other rare side effects due to the injected intra/par-articular drugs such as aseptic osteonecrosis after CS intra-articular injection, intraarticular granulomatous inflammation developed after viscosupplementation with HA, secondary iatrogenic crystalline synovitis, tendon ruptures, or more mild local effects as skin depigmentation, with higher prevalence in immunodepressed patients [28,29]. In our cohort, we reported 2 patients with possible aseptic hip osteonecrosis related to CS injection diagnosed 6 months later, 2 cases of iatrogenic microcrystalline bursitis and one case of local skin depigmentation, totalizing 0.05% of the interventional manoeuvres. A 100% link between the hip aseptic osteonecrosis and the intraarticular CS injection could not be demonstrated with certitude. The 2 patients were diagnosed with hip coxitis refractory to systemic NSAIDs that why CS and hip intra-articular CS injection was decided. No baseline MRI was performed, therefore primary aseptic osteonecrosis could not be ruled out based only on MSUS evaluation. Hip effusion may be part of this of the underlying pathology.

In clinical practice, MSUS guided injection technique has to show advantages over classic ones: better efficacy, a comparable or a better safety profile together with a similar or higher, if possible, procedure speed. MSUS guided invasive manoeuvres offer the possibility to see the target structure and surrounding tissues, to access millimetric spaces, to monitor the entire invasive procedure or to repeat the evaluation if necessary. But the unanswered question is: are these MSUS guided interventional manoeuvres feasible for clinical practice? This equation implies also the calculation of the absolute time spent for performing MSUS guided interventions [21,48]. Usually, less experienced doctors in performing MSUS guided manoeuvres are discouraged by complicated disinfection protocols, sophisticated equipment including sterile guiding systems, sterile gel, more time spent with the patient, and more costs. In our study we show that after MSUS target region evaluation, followed by a simple but efficient disinfection protocol, a reasonable timeframe totalizing maximum 7 minutes was necessary to accomplish the procedure. As far as we know, this is the first study which includes data regarding time evaluation when performing different MSUS interventional manoeuvres.

The main limit of our study is the low number of probe and skin bacterial load determinations in comparison to the total amount of interventional procedures (and sometimes data was collected in one single day). Another limit would be the absence of comparison with classic landmark guided injections.

In conclusion, MSUS guided manoeuvres are ideal for clinical practice because they are not only highly efficient but also safe, rapid, and cheap. The incidence for septic post-procedural events was zero in our study along with a very low risk for other types of complications.

The capacity to improve the patients' outcome, to reduce the procedural risk and to control the costs due to significant cost savings related to the increase use of invasive procedures in the outpatient clinic has in the end an important impact on health care resources.

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**Conflict of interest:** none

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