Original research article

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CHEst PHysical Examination integrated with UltraSound – Phase (CHEPHEUS1). A survey of Accademia di Ecografia Toracica (AdET)

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ABSTRACT

Background: Chest physical exam (CPE) is based on the four pillars of classical semiotics. However, CPE's sensitivity and specificity are low, and is affected by operators' skills. The aim of this work was to explore the contribution of chest ultrasound (US) to the traditional CPE.

Methods: For this purpose, a survey was submitted to US users. They were asked to rate the usefulness of classical semiotics and chest US in evaluating each item of CPE pillars. The study was conducted and described according to the STROBE checklist. The study used the freely available online survey cloud-web application (Google Forms, Google Ireland Ltd, Mountain View, CA, USA).

Results: The results showed a tendency to prefer chest US to palpation and percussion, suggesting a possible future approach based on inspection, auscultation and palpatory ultrasound evaluation.

Conclusion: The results of our survey introduce, for the first time, the role of ultrasound as a pillar of physical examination. Our project CHEPHEUS has the aim to study and propose a new way of performing the physical exam in the future.

Key words: chest ultrasound; diagnostics; physical examination; history of medicine; palpation; percussion.

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Authors' contributions: All authors equally contributed to conceptualization, methodology, validation, formal analysis and data curation for the study. All authors equally contributed in writing - original draft preparation and writing - review and editing of the manuscript. All authors have read and agreed to the published version of the manuscript

Ethics approval and consent to participate: Ethical committee approval was deemed unnecessary based on the General Authorization to Process Personal Data for Scientific Research Purposes (Authorization no. 9/2014).

Consent for publication: Not applicable.

Availability of data and material: Study data will be made available from the Corresponding author upon reasonable request.

Conflict of interest: DR Radovanovic reports fees for lecturing from Astra Zeneca, Berlin Chemie, Glaxo Smith Kline, Menarini, Roche, Sanofi. All the other authors have no relationships to disclose.

Funding: This research was not funded and did not receive any financial support.

Acknowledgments: We would like to thank all AdET members for their support and enthusiasm in learning, spreading and improving thoracic ultrasound.

Introduction

Inspection, palpation, percussion, and auscultation have been the cornerstone of clinical bedside medicine since its origins [1, 2]. The hands and senses inspect, palpate, and percuss to make a diagnosis, and these practices have been faithfully transmitted over generations.

Practice of clinical examination was revolutionized with the introduction of the stethoscope about 200 years ago. These basic methods of physical examination have served us well, but their efficacy has been held as self-evident.

Recent evidence supports the inclusion of imaging, along with inspection, palpation, percussion, and auscultation, as the fifth pillar of physical examination [3, 4].

The art of medical examination is being increasingly negatively impacted by the combination of limited resources, learning curves, increasing disease complexity, and the progressive propensity to defer diagnosis until the availability of supposedly better diagnostic methods (such as imaging). The most promising diagnostic tool that could improve accuracy of working diagnosis at the bedside is point-of-care ultrasound [5, 6] using relatively small handheld systems.

Our group "Accademia di Ecografia Toracica" (AdET) (in English "Chest Ultrasound Academy") is an Association of chest ultrasound users including doctors with different specializations, such as pulmonology, internal medicine, general practice, anesthesiology, pediatrics and emergency medicine. The core philosophy of AdET is the use of chest ultrasound not only as a self-contained diagnostic tool, but integrated with the clinical data and the physical exam. This study represents the first step to design a new concept of chest physical examination. With this premise, we aimed at investigating the potential impact of ultrasound on each pillar of chest physical examination (inspection, palpation, percussion, and auscultation) according to the opinion of chest ultrasound (US) users.

Methods

Clinicians enrolled in our Academy received an email-based survey to assess if chest ultrasound could perform better compared with the pillars of traditional semiotics or vice versa in different scenarios of chest physical examination. The mail contained a brief explanation of the study aims and an invitation to respond anonymously to a web-link 6-item multiple choice questionnaire. The link was active for at least 30 days. The survey was arbitrarily closed after a week of inactivity.

The data were reviewed retrospectively in accordance with the principles outlined in the 2008 revision of the Declaration of Helsinki. Ethical committee approval was deemed unnecessary based on the General Authorization to Process Personal Data for Scientific Research Purposes (Authorization no. 9/2014). This authorization specifies that ethical approval is not required for retrospective archival studies employing ID codes, as these codes prevent direct identification of the individuals. The confidentiality of the information collected was maintained in compliance with the GDPR (Regulation (EU) 2016/679) and Legislative Decree No. 101/2018.

Survey design

The survey was divided into two sections: the first included questions to classify the responders, the second was focused on the role of chest US in physical examination.

To design the survey, we had to consider the following issues:

1. Making the survey as simple as possible to improve the response rate and classify the responders, avoiding data fragmentation. The use of chest US during chest physical examination is a general medical act that requires no specialty. Respondents' sex, age, specialty and work setting was considered not useful and therefore not investigated.
2. Only users that reported employing the US mainly for qualitative purposes were included in the analysis. In fact, physicians using US as a guidance for chest invasive procedures would be less prone to perform a comprehensive qualitative US assessment. To this end, we chose to use a 0-100% scale to express the percentage of diagnostic chest US exams as compared to

interventional purpose (e.g. a physician performing 100 examinations, of which 30 US-guided procedures, should respond "70%").

3. Scoring the efficiency of chest US compared with the steps of chest physical examination. To this end, we developed a 5 point analogic scale for each pillar of the chest physical examination, with lower values reflecting a preference for classical semiotics and higher values a preference for US: 0 = only classic physical exam suitable for the item (semiotics only); 1 = classic physical exam better (mainly semiotics); 2 = classic physical exam and US equally useful (both useful); 3 = US better (mainly US); 4 = only US suitable for the item (only US).

Responders were asked to answer the following questions:

- US experience in years: 1) <2 years; 2) 2 to 5 years; 3) >5 years.
- Percentage of use of chest US for diagnostic purposes.
- Score (0 to 4) the usefulness of classic semiotics compared with chest US for each item of the physical examination (inspection, palpation, percussion, and auscultation) coupled with respective clinical signs (see point 3 above). The questions were focused on:
  - inspection of tumefactions, trauma/hematoma, chest symmetry, chest expandability, and features of intercostal spaces.
  - palpation of tactile fremitus (normal, reduced/absent, enhanced, respectively), painful points/areas, and density and mobility of tumefactions.
  - percussion for the assessment of normal pulmonary sound, dullness, hyperresonance and pulmonary bases' expansion.
  - auscultation to assess normal or reduced breathing sounds, wheezing/rhonchi, stridor, rales, crackles, respiratory silence, and bronchial flow.

The study was conducted and described according to the STROBE checklist.

The study used the freely available online survey cloud-web application (Google Forms, Google Ireland Ltd, Mountain View, CA, USA).

The questionnaire was firstly validated through the following procedure: 1) use of a structured Delphi method to achieve mutual agreement among panel experts to identify questions, and 2) validation phase on the first 25 responders to analyze applicability and generalizability. A reminder mail was sent two weeks after the first communication.

Statistical analysis

Categorical and ordinal variables were described in terms of frequencies and percentages. Continuous variables were reported as median (inter-quartile range) or mean (standard deviation) according to their distribution. Only answers from responders with ≥30% US-activity routinely conducted for diagnostic purposes were considered for the analysis. We evaluated if the distribution of answers was dependent on the US expertise of responders, expressed in years, by means of the chi-squared test. Finally, the distributions of answers among the three sub-groups of responders, stratified according to their expertise in chest US, were compared through the Mann–Whitney U test only for those items dependent on expertise. Statistical analysis was performed with Microsoft Excel (Microsoft Corporation 2021).

Results

One hundred and five clinicians responded to the survey, with a response rate of 10%. Fourteen responders (13.3%) used chest US for diagnostic purposes for less than 30% of their working time and were therefore excluded from the analysis. The final analysis included 91 answers. The distribution of experience with chest US was: 14 responders with ≤ 2 years (15.4% of total sample), 32 with 2-5 years (35.2%), 45 ≥ 5 years (49.4%).

In general, the most frequent answer from the responders was 2, indicating a perceived equal contribution of chest US to the single pillar of the classic

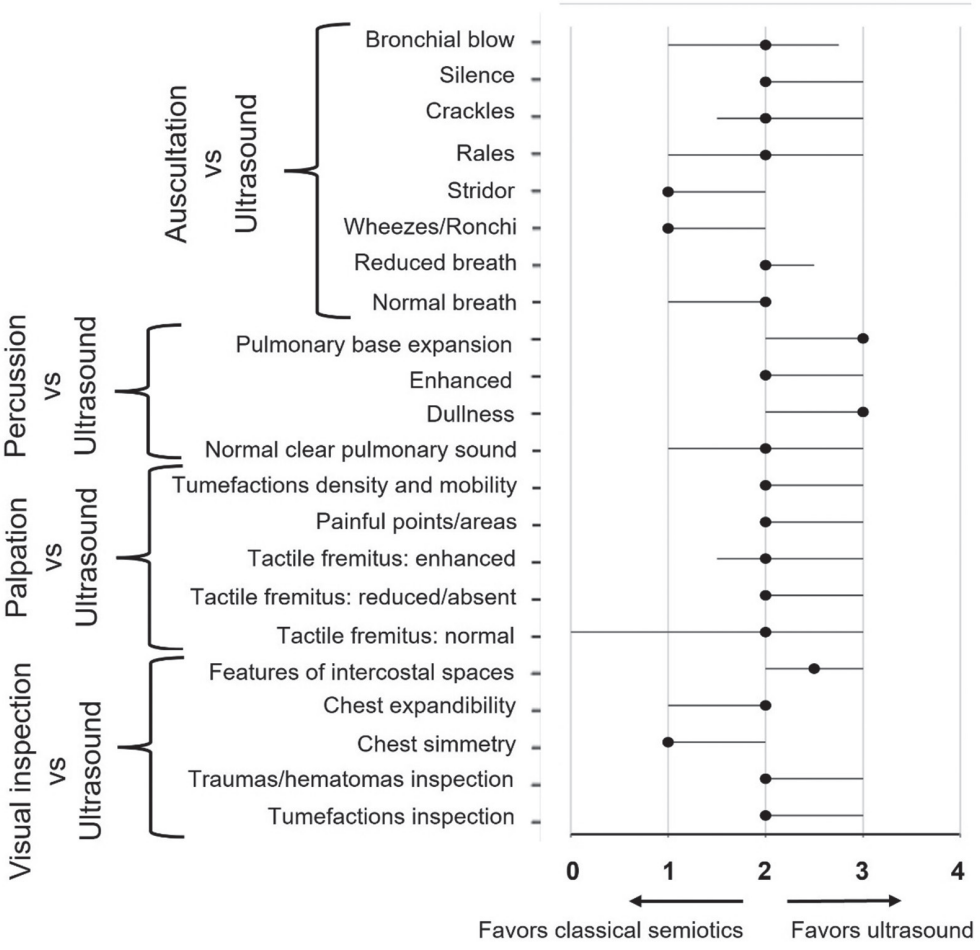

Figure 1. Pooled answers for each of the items explored by the survey. Data are presented as median (black dot) and inter quartile range (black lines). Values < 2 are in favor of physical examination, values > 2 are in favor of chest ultrasound. A value of 2 corresponds to: "both are useful".

clinical examination for each item explored. The scores for the main groups were: Visual Inspection vs Ultrasound: median 2 (IQR – 1-3); Palpation vs Ultrasound: median 2 (2-3); Percussion vs Ultrasound: median 2 (2-3); Auscultation vs Ultrasound: median 2 (1-2). Figure 1 shows the detailed results for each item explored by the survey, while Figure 2 reports the distribution of answers for the single items. We did not observe any significant correlation between answers and years of experience in US, except for only two items: the comparison between auscultation versus chest US in identifying stridor (p=0.002) and crackles (p=0.022). The role of US experience was further investigated comparing the three different experience groups for the items "stridor" and "crackles". Most skilled operators (>5 years of experience) reported that normal semiotics was more useful to define stridor, while operators with <2 years of experience indicated that chest US was more useful than classic semiotics in the characterization of crackles.

Discussion

Literature often refers to ultrasounds as "the new stethoscope" or "the fifth pillar of chest physical

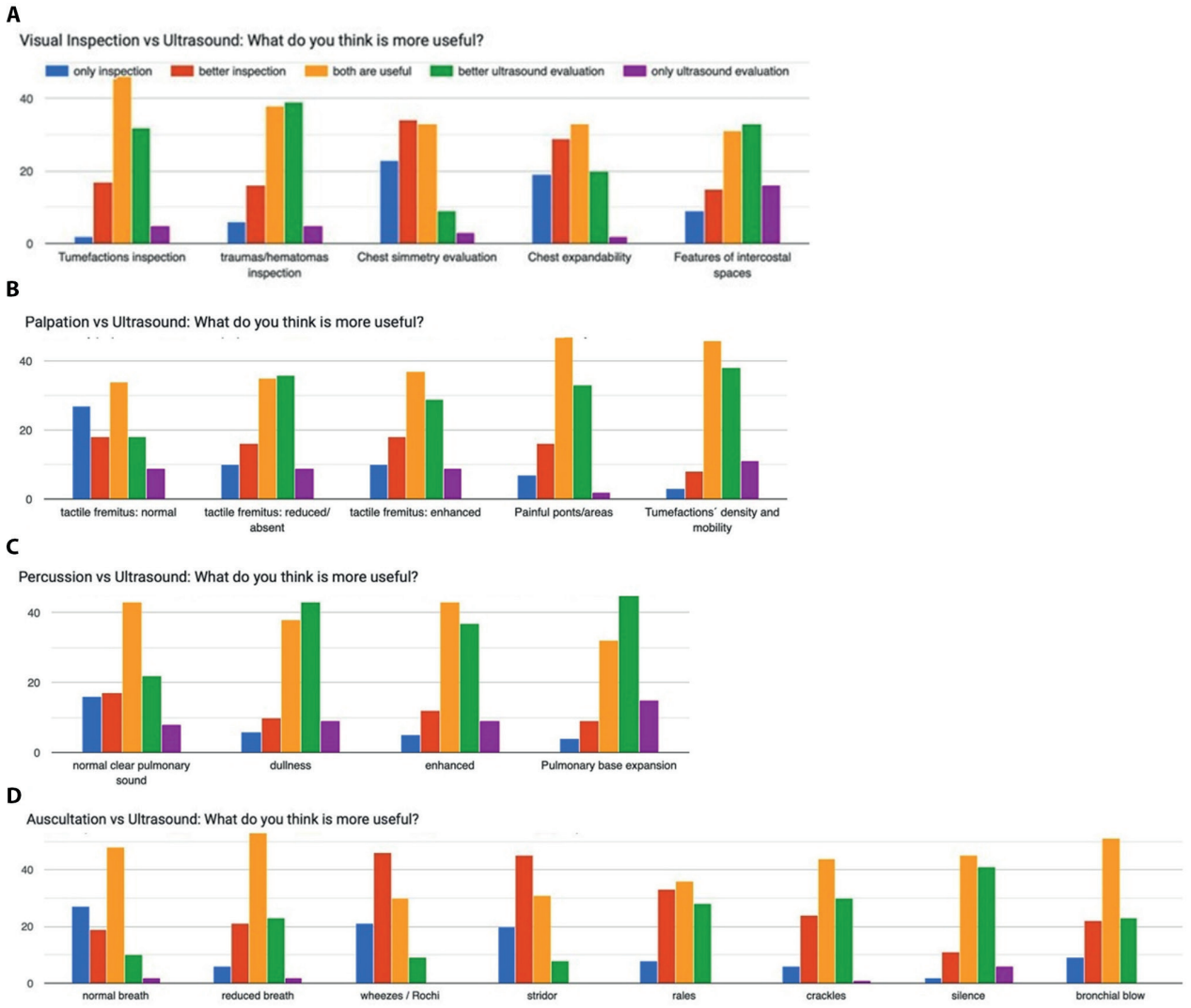

Figure 2. Response frequency for each step of the physical examination assessing preference for visual inspection (panel A), palpation (panel B), percussion (panel C) and auscultation (panel D) compared with ultrasound in different clinical situations when answering the question: "Visual inspection vs Ultrasound: What do you think is more useful?". Columns represent the number of respondents.

examination" [8-12]. The aim of this work was not to consider ultrasound as the fifth pillar of semiotics but rather to investigate the possibility to integrate, influence and even replace pillars of classic semiotics with ultrasound. Chest physical examination is based on the 4 pillars of medical semiotics: inspection, palpation, percussion and auscultation. However, the specificity and sensitivity of the signs collected by basic instruments such as hands, ears, eyes and stethoscope is generally low and, as other diagnostic tools, it could be affected by operator's expertise. In the last decades, the use of chest ultrasound has considerably increased, and portable ultrasound machines with satisfactory image quality have allowed physicians to use ultrasound bedside, daily and in different clinical contexts. Indeed, the results of our survey showed that respondents had

a tendency to prefer chest US to palpation and percussion, while classical semiotics was clearly preferred for auscultation, leaving inspection to both the classical and US approach.

To the best of our knowledge, this is the first survey to suggest a possible equal and complimentary contribution of both chest ultrasound and some of the classical pillars of semiotics for an optimal clinical evaluation of the patient. Respondents preferred US when exploring definite areas of the chest (*e.g.* in case of trauma, tumefaction, evaluation of intercostal spaces), while inspection was considered more suitable to assess chest symmetry and expandability. On the other hand, the identification and evaluation of bronchospasm and obstruction of central airways favor auscultation, while sounds indicating alterations of peripheral lung, such as crackles or absence of breath sounds, showed that the US assessment could provide additional important information, to exclude pleural effusion, hemidaphragmatic relaxation or atelectasis.

Study limitations

This study has limitations. Firstly, the sample size is small. In this pilot experience, the authors arbitrary defined a sample of at least 100 responders in one month due to the lack of previous studies on the same topic. Secondly, the study needs external validation of results in larger cohort of clinicians with different experience in chest US.

Conclusions

In conclusion, the results of our survey introduce, for the first time, the role of ultrasound as a pillar of physical examination. Our project CHEPHEUS has the aim to study and propose a new way of performing the physical exam in the future, assisted by the miniaturization and extreme portability of ultrasound machines and the progressive spread of knowledge about thoracic ultrasound.

Supported by the data of this survey, our vision for a new physical exam is the following:

1. Visual inspection
2. Auscultation
3. Palpatory ultrasound evaluation

Future studies are needed to prove the superiority of this new vision of the physical exam. In this view, a phase 2 validation study that compares traditional physical examination and ultrasound enriched physical examination is currently ongoing.

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Received for publication: 16 February 2025 - Accepted for publication: 17 April 2025

Licensee Mattioli 1885, Italy
Multidisciplinary Respiratory Medicine 2025; 20: 1020
doi: 10.5826/mrm.2025.1020