











Teaching the respiratory physical examination: what is history and what is needed?

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ABSTRACT

Medical semiology has been one of the most common techniques used in medical practice for centuries. Health science students around the globe learn these techniques through a systematized model as a fundamental skill for patient evaluation. However, though being widespread, little is known about semiology's true accuracy as a diagnostic maneuver. Knowing that, through a literature review, this paper evaluated the precision of the preconized procedures that are used as part of the exam of the respiratory system and the comparative description of its teaching in different medical schools around the world. As a result, disagreement between several papers was found, which can be justified by the poor quality of the studies and the different variables that were studied in each one. However, one thing is still clear: respiratory physical examination continues to be essential in medical practice, independently of the recent advances and availability of imaging exams. Teaching each step should consider available scientific evidence. The knowledge of the applicability and practical individualization of the respiratory examination can be a possible way for the current times without missing relevant information for developing clinical reasoning.

Keywords: Semiology, Physical exam, Medical education, Respiratory system.

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INTRODUCTION

Learning how to perform physical examination is undoubtedly a milestone in medical education. Identification of physical signs that translates the symptom reported by the patient or the underlying disease is the basis of semiology.

Descriptions of semiological techniques are part of history of medicine. Hippocrates (460-370 B.C.) described the importance of careful observation and direct auscultation of the chest, making medicine a rational activity¹. Leopold Auenbrugger, in 1761, described chest percussion bringing greater precision to location and understanding of pathophysiology. Rene Theophile Hyacinthe Laënnec, in 1816, created the stethoscope, an instrument improved over the years, which not only expanded our hearing and diagnostic capacity but has become one of the most known medical symbols¹⁻³.

Although some authors consider the complete physical examination of the chest (CE) as an essential part of the general physical examination⁴, others argue over its replacement by complementary tests, such as ultrasound⁵.

These antagonist opinions motivate us to look for the real validity of the semiological maneuvers taught and their applicability, in a completely different historical moment from when they were proposed. This article aimed to understand the contribution of each stage of the CE to the construction of clinical reasoning and, therefore, the accuracy of the various semiological maneuvers. We established as a secondary aim, the description of the medical education of the CE in other universities worldwide.

METHODS

A narrative review of the literature was performed using the National Library of Medicine search service, PubMed. The research was divided into themes referring to the steps of CE, which include chest inspection, palpation, percussion, and auscultation (lung sounds and voice resonance). The research period was between February 2020 and December 2021.

The search was performed by combining each subdivision from CE with expressions referring to diagnostic accuracy. Systematic reviews and bibliographic reviews that provided information

regarding the validity and reliability of the physical examination findings were analyzed, and the validity was studied through information from sensitivity, specificity, positive likelihood ratio (LR+), negative likelihood ratio (LR-), positive predictive value (PPV), and negative predictive value (NPV). Reliability was verified through agreement analysis. Articles that did not necessarily include all the parameters described above but that contributed to the understanding of the theme were also evaluated.

To answer how the semiology of the respiratory system is being taught, different standardizations of teaching in universities around the world were researched. This evaluation process was carried out from institutional videos published on digital platforms.

Inspection

Inspection of the respiratory system is a dynamic process that starts before the beginning of the physical examination. Alarm signs such as changes in speech, inability to speak more than short phrases, mental confusion, use of accessory muscles, flaring of nasal alae, and stridor should be quickly identified when approaching the patient⁶.

For a didactic discussion, the inspection was divided into two steps: static and dynamic.

Static inspection

The preferred position is observed in more than half of patients with decompensated heart failure; supine position is avoided by orthopnea⁷. When present, this sign is useful to diagnose heart failure, with a specificity of 82% (95%CI: 77-87%), PPV of 0.87 (95%CI: 0.84-0.91), and an LR+ of 2.05 (95%CI: 1.55-2.72). This sign is associated with disease severity and control, which explains the low sensitivity of 37% (95%CI: 34-40%)⁸.

Collateral circulation in the chest wall, a possible finding of the superior vena cava syndrome, may be present in patients with lung cancer and non-Hodgkin's lymphoma⁹. However, a study that analyzed 78 patients with superior vena cava syndrome concluded that only 38% of patients had dilated collateral veins in the chest wall. Other signs and symptoms were more frequently observed, such as face and neck edema (82%), ipsilateral upper limb edema (68%), dyspnea (66%), and cough (50%)¹⁰.

Spider angiomas, also known as telangiectasia, can be seen in systemic diseases such as liver cirrhosis, rheumatoid arthritis, or thyrotoxicosis. Multiple spider angiomas are characteristic of chronic liver disease with a specificity of 95% and a prevalence in cirrhosis of 33%¹¹.

Pectus excavatum is responsible for up to 90% of all chest deformities. It can cause symptoms such as pain, dyspnea, and self-image disorders¹². Pectus carinatum is often asymptomatic and not associated with long-term complications¹³.

Barrel chest describes an anteroposterior enlargement of the chest and is the most common sign seen in patients with advanced chronic obstructive pulmonary disease (COPD)¹⁴. A prospective study compared spirometric results with clinical evaluation in 98 patients with severe COPD and 102 controls without COPD. The presence of a barrel chest was favorable for the diagnosis of COPD with an LR+ 2.58 (95%CI: 1.45-4.57 and $p < 0.001$) and with a moderate agreement between observers (0.62 and $p < 0.0001$)¹⁴.

Dynamic Inspection

Respiratory rate (RR) is a vital sign and relevant parameter in several diagnostic and prognostic evaluation criteria, for example: scores for sepsis- Quick Sepsis-related Organ Failure Assessment (qSOFA) and scores for pneumonia severity-CURB-65^{15,16}.

One study investigated the accuracy and interprofessional agreement in the measurement of RR by health professionals and the potential consequence of incorrect measurement¹⁵. The accuracy and interobserver agreement were suboptimal. Overall, the intraclass correlation coefficient (ICC) was moderate, at 0.64 (95%CI: 0.39-0.94). In cases where the RR was high (> 20 rpm), the ICC was 0.29 (low agreement). The consequences for the diagnostic and prognostic scales were important since 4.5% to 7.1% of patients would receive a lower score, and 3.9% to 32.2% would receive a higher score¹⁵.

Some authors credit the false belief in the visual judgment of the patient's RR normality and the lack of adherence to the technique of counting during one minute of the RR, which results in the discrepancy of agreement between the observers of such an objective, relevant and simple parameter which is the RR^{6,15}.

A prospective study with 278 patients with pleural effusion found a perfect agreement for asymmetry in chest expansion, with a kappa of 0.85 (95%CI 0.73-0.96), a sensitivity of 74% (95%CI: 60-84), specificity of 91% (95%CI: 86-94%); LR+ of 8.14 (95%CI: 5.25-12.71) and LR- of 0.29 (95%CI: 0.18-0.43), proving to be a useful sign for clinical suspicion of pleural effusion¹⁷. In another study that evaluated 48 patients with pneumonia, the investigation of asymmetry in chest expansion showed a sensitivity of 4%; 100% specificity, and infinite LR+ and LR; pointing out that unhelpful for pneumonia diagnosis^{6,17,18}.

Hoover's sign, a paradoxical bilateral inspiratory movement of the rib cage, is more evident in lateral and lower portions of the thorax and can be found in 45% of COPD patients. Signal frequency increases with disease severity: 36% in moderate COPD, 43% in severe COPD, and 76% in very severe COPD and shows good interobserver agreement (kappa: 0.74)¹⁹.

There is no consensus in the scientific literature on the clinical relevance of signs of difficulty or respiratory effort, such as the use of accessory muscles, intercostal retraction, flaring of nasal alae, and phreno-labial breathing, for the diagnosis of respiratory diseases. Apart, none of these clinical signs presented good accuracy in determining disease or severity. However, it is concluded that a set of these signs may suggest clinical value by inferring severity^{6,20}.

Chest inspection can provide relevant information for the construction of diagnostic reasoning in certain diseases such as pleural effusion; however, the most clinically relevant maneuver is the RR counting, which should be performed routinely and with the correct technique.

Palpation

Vocal or tactile fremitus (VF) was analyzed in patients with dyspnea to evaluate pleural effusion and pneumonia. In cases of VF reduction, diagnosis of pleural effusion could be inferred with an LR+ of 5.7 and an LR- of 0.21. According to the authors, a decrease in VF would reinforce the hypothesis of pleural effusion by approximately 30-35% and, in cases of patients with dyspnea who have a normal or increased VF, the probability of pleural effusion diagnosis would reduce by approximately 30%, directing the diagnostic hypothesis to pneumonia²¹.

Another review suggests that VF may be helpful in cases where the pre-test probability of pleural effusion is low. In this sense, if there is no reduction/absence of VF, the probability of pleural effusion diagnosis is even lower, with an LR- of 0.21 (95%CI: 0.12-0.37)²². Reduced/absence of VF cannot affirm the presence of pleural effusion¹⁷, and the results of the assessment of agreement between health professionals are contradictory and do not allow conclusions^{17,23}.

VF could be useful when pleural effusion or pneumonia are the main clinical hypotheses. However, no evidence has been found that VF is useful as part of the routine physical respiratory examination in patients without suspected pulmonary disorders.

Percussion

The presence of dullness on chest percussion is an accurate sign of pneumonia, with LR+ of 5.7 and LR- of 0.9²¹. Sign presents high specificity of 94% (95%CI: 88-97%), but low sensitivity of 14% (95%CI: 10-19%), therefore, absence does not exclude pneumonia diagnosis, but presence favors it.²⁴

The presence of dullness also seems to be an accurate sign in pleural effusion cases, with an LR+ of 8.7 and an LR- of 0.31²¹. A meta-analysis that evaluated pleural effusion studies showed that dullness on chest percussion was the most accurate finding for this diagnosis, with combined results between studies having a sensitivity of 73% (95%CI: 61-82%), specificity of 91% (95%CI: 88-93%) and LR+ of 8.7 (95%CI 2.2-33.8%) and p<0.001²². The agreement among professionals was high (93%)¹⁷.

A review article about COPD sign's reported that loss of precordial dullness is related to diagnosis in patients with moderate COPD, with a sensitivity of 16%; specificity of 99%, and low interobserver agreement (kappa: 0.49); LR+ of 16 and LR- of 0.8 for COPD diagnosis, in patients with a history of smoking or self-reported COPD¹⁹.

No studies were found that evaluated the validity of vertebral column percussion.

Chest percussion seems to be a useful maneuver to evaluate patients with clinical suspicion of pleural effusion and pneumonia. Percussion of the precordium may be related to COPD severity. These data justify teaching chest percussion and applying it when necessary. Percussion also allows diagnosing conditions with hypersonority in emphysema and pneumothorax. The severity of pneumothorax can make it impossible to carry out complementary tests,

and chest percussion becomes important for the diagnostic and therapeutic definition.

Auscultation

The clinical utility of voice auscultation or vocal resonance (VR) is discussed. It can be useful to diagnosing pulmonary disorders, but it consumes a considerable time²⁵. In addition, most examiners do not perform this technique with frequency, and there is no agreement on whether the maneuver should be included as a routine step in CE²⁶. Reduced VR, despite having excellent interobserver correlation (kappa: 0.86; 95%CI: 0.74 - 0.97), was not confirmed to be associated with pleural effusion by a multivariate analysis model¹⁷.

Other voice auscultation disorders, such as bronchophony and egophony, may present slight variations, in terms of definition, from author to author. Classically, bronchophony indicates an increase in the sound intensity of the voice and can be found in areas of condensation of the lung parenchyma, as in pneumonia. Egophony is characterized by the presence of voice timbre alteration, becoming a more high-pitched, metallic, or nasal voice, and may occur in the upper limit of pleural effusions and, less frequently, in pulmonary condensations²⁷.

Different studies have shown that both bronchophony and egophony significantly increase the probability of diagnosing pneumonia, but the sensitivity is low (Table 1)²⁴. Despite the presence of bronchophony/egophony being associated with pneumonia (specificity up to 99%), they are rare signs, being found in a few patients^{24,28}. Another issue was that the interobserver agreement for these signs was low (kappa: -0.10 and kappa: 0.18)^{25,28}. Thus, in patients with suspected pneumonia, the presence of these signs in respiratory auscultation must be considered for clinical reasoning, but their absence does not exclude the diagnosis²⁹.

Auscultation of lung sounds

A meta-analysis showed low sensitivity and acceptable specificity regarding pulmonary auscultation for the diagnosis of acute diseases (pneumonias, obstructive pulmonary diseases, hemopneumothorax, and heart failure) with a combined overall sensitivity of 37% (95%CI: 30-47%) and combined overall specificity of 89% (95%CI: 85-92%); LR+ of: 3.2 (95% CI: 2.3-4.2), LR- of 0.72 (95%CI: 0.65-0.79)⁵.

In conclusion, pulmonary auscultation is a step of CE that must be performed in most diverse patients, given its high specificity to direct a diagnosis⁵.

Standardization of chest examination teaching around the world

Table 2 informs about CE teaching in different universities. It can be suggested that most institutions perform almost all the maneuvers recommended by the article reference institution (FMRP).

The vertebral column percussion maneuver has low support and was only taught by the reference institution of the present article. This observation and the fact that the maneuver is not found in the researched literature leads us to conclude that its execution has become obsolete.

Vocal fremitus and vocal resonance are not taught by all institutions, and there are even four institutions that perform only one of the two maneuvers. This can be explained by the fact that both reflect the same alterations, without differences in sensitivity and specificity^{17,22}, justifying the use of only one of them in the CE practice.

Regarding inspection, percussion, and pulmonary auscultation maneuvers, there is agreement among most institutions about the validity of the execution and its teaching.

Nowadays, time is synonymous with money, and beyond the popular dictation, the average time spent in a medical consultation is an indicator of quality used by the World Health Organization (WHO) and the International Network for the Rational Use of Drugs (INRUD)³⁸. Entering primary care physicians' offices, higher stress scores are identified in physicians characterized as slower³⁸. What would be the ideal time for a medical appointment that includes anamnesis and a complete physical examination? The answer would be obvious: time will be determined case-by-case, according to complexity, but reality does not agree with this statement.

A systematic review found that among 28.570.712 medical visits in 67 countries, the average duration of consultations in primary care ranged from 48 seconds in Bangladesh to 22.5 minutes in Sweden³⁸.

How does the lack of time imposed on medical care reflect the stages of CE execution? Perhaps, by shortening parts of the physical examination deemed not necessary by the doctor. A survey conducted via questionnaire evaluated 2684 responses from physicians around the world and found interesting data. Among the maneuvers considered most useful and frequently performed, 95% of the participants regarded pulmonary auscultation for wheezing as first place, and second place was pulmonary auscultation for crackles for 94.1%. The other

Table 1

Voice auscultation accuracy results.

Study	Sign	Diagnosis	Gold-standard	S	E	LR+	LR-
Kalantri et al. (2017) ¹⁷	Vocal resonance reduce	Pleural effusion	X-ray	76%	88%	6.3	0.3
Saldias et al. (2007) ²⁷	Bronchophony	Pneumonia	X-ray	4%	99%	4.0	1.0
Wipf et al (1999) ²⁸	Bronchophony	Pneumonia	X-ray	11 - 69%	61 - 96%	1.2 - 12.5	0.5 - 1.0
Wipf et al. (1999) ²⁸	Egophony	Pneumonia	X-ray	13 - 54%	61 - 98%	1.0 - 12.5	0.8 - 1.0
Gennis et al. (1989) ²⁰	Egophony	Pneumonia	X-ray	8%	97%	2.0	1.0
Diehr et al. (1984) ¹⁸	Egophony	Pneumonia	X-ray	4%	96%	---	1.0

Caption: Chest radiography; S: sensitivity; E: specificity; LR+: positive likelihood ratio; LR-: negative likelihood ratio; Bronchophony: increase in the sound intensity of the voice and Egophony: alteration in the timbre of the voice (higher or metallic).

Table 2

Comparison between teaching chest examination.

	Static Inspection	Dynamic Inspection	Palpation	Percussion	Vertebral column percussion	Vocal fremitus	Vocal resonance	Auscultation
FMRP (2020) ²⁷	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dundee (2015) ³⁰	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Warwick (2015) ³¹	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Warwick (2019) ³²	Yes	Yes	Yes	Yes	No	Yes	No	Yes
King's College (2020) ³³	Yes	Yes	Yes	Yes	No	Yes	No	Yes
Wake Forest (2018) ³⁴	Yes	Yes	Yes	Yes	No	Yes	No	Yes
Oxford (2015) ³⁵	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Stanford (2014) ³⁶	Yes	Yes	No	Yes	No	No	No	Yes
Leicester (2011) ³⁷	Yes	Yes	Yes	Yes	No	No	No	Yes

FMRP – Faculty of Medicine of Ribeirão Preto; ATS - American Thoracic Society. The color of the cell represents the frequency with which the breath exam steps are taught at different universities, green - always taught; yellow - taught directed to certain situations and red - not taught.

stages of the CE surveyed were considered useful and were frequently performed by the participants in 70.5% for chest percussion; 80% for auscultation for lung sound; 73.4% for differentiating between rales on lung auscultation; 30.2% for palpation of the trachea; 37.4% to investigate central cyanosis and 26% for lung expansion³⁹.

Supported by all information herein described, a more directed CE guide is essential. The imposition of performing all the CE steps, historically divided into inspection, palpation, percussion, and auscultation, is useless for patients with no respiratory complaints. On the other hand, the signs that endorse the diagnostic reasoning may not be found at all stages of the CE. This statement is translated by the results found in this review and confirmed by the impression of usefulness and frequency in which the semiological maneuvers were described in the study above³⁹.

It is a fact that alterations in lung sound more accurately indicate the possibility of alterations in palpation (VF, percussion) and voice auscultation.

And, from another perspective, it can be said that there is no significant change in palpation (VF, percussion) or voice auscultation when lung sounds are normal. Considering also that VF and voice auscultation are maneuvers that, when altered, express the same meaning, we propose the following steps for the CE (Figure 1):

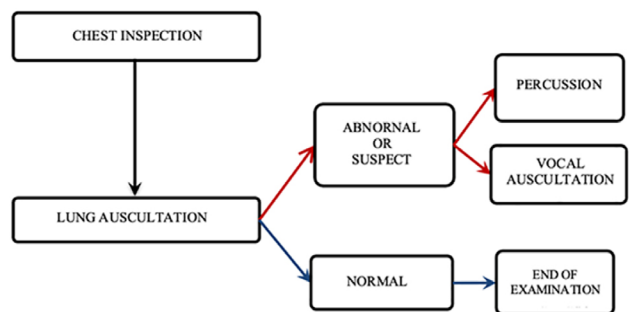


Figure 1: Script for the respiratory physical examination applied.

CONCLUSION

The present article provides evidence of the accuracy and reproducibility of the CE. Lung auscultation has high specificity, and maneuvers such as palpation and percussion are more important when the clinical hypotheses lead toward pleural effusion or pneumonia.

New studies seeking to improve understanding the accuracy of semiological signals and their reproducibility are necessary. This becomes evident when we look IN depth at the methodology of the reviewed studies, where the lack of comparison with gold standard exams for the diagnosis and the participation of only two or three examiners may compromise the interpretation of the results^{6,17}. Other studies dissociate the physical examination from the patient's clinical history²³, which makes sense not to induce a response, but makes the result unreal because when performing CE, the doctor looks for signs that corroborate the formulated clinical reasoning after the anamnesis.

We advocate for the continuity of teaching CE techniques by medical schools. It is an accessible, useful, and independent instrument from other resources. However, maneuvers that do not add information to clinical reasoning should be reviewed and perhaps abandoned. The CE guide must be more rational and adequate to current times, respecting the scientific evidence that we have.

Individualizing CE saves time and likely ensures that important steps are performed on all patients. Furthermore, in a pandemic period, when the contact time between professor, student, and patient is limited and must be optimized, the phases of the clinical examination that are scientifically endorsed must be prioritized.

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