

## RENE LAENNEC'S SYNDROME-BASED CLINICAL REASONING

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## ABSTRACT

The development of clinical reasoning, which is the basis of medical education, is of great importance in medical universities. One of the founders of modern structural clinical reasoning, based on the knowledge of pathological physiology, is the inventor of the stethoscope Rene Laennec (1781–1826). He described the pioneering experience of clinical reasoning in the pages of his treatise *A Treatise on the Diseases of the Chest and on Mediate Auscultation*, which is of lasting value, since every rookie physicians in his professional development goes through the path of Laennec. Laennec's practice is of great importance for novice physicians since Laennec's treatise contains a diagnostic analysis of the most common clinical cases. Each such analysis demonstrates the algorithm of clinical reasoning. The purpose of this study was to analyze the approaches of clinical reasoning by René Laennec, which made it possible to identify two basic principles. Laennec's diagnostic reasoning involved two principles: pathogenetic analysis of clinical manifestations and a syndrome-based approach to differential diagnosis. These principles help distinguish between diseases with similar symptoms and physical findings are used to demonstrate the practical application of syndrome-based differential diagnosis. These principles can be easily mastered by understanding the pathogenesis of clinical manifestations. Thanks to the pathogenetic basis, the principles of clinical reasoning of Rene Laennec are universal and applicable to the analysis of any signs of the disease: not only physical but also laboratory and instrumental.

**Keywords** Rene Laennec, physical diagnostics, clinical reasoning, differential diagnostics

## INTRODUCTION

Structured clinical reasoning, which is based on morphology and pathophysiology, is the cornerstone of modern medical education. Teaching structured clinical reasoning is fraught with great difficulty, since medical students see their task as remembering typical symptoms, rather than understanding their pathogenesis. A huge number of monographs are devoted to teaching clinical reasoning, but it is very symbolic that a review of one of it says: *'The subject matter of Clinical Thinking is very important and underresearched. It is not well understood by either clinicians or their teachers'*.<sup>1</sup> To understand the essence of a problem, it is always useful to know its origin. The history of structured clinical reasoning is associated with René-Théophile-Hyacinthe Laënnec (1781–1826), known throughout the world as a stethoscope inventor and the founder of the indirect auscultation method. At the same time, Rene Laennec made a huge contribution to the development of a new type of clinical reasoning for his time. Famous an Irish physician and medical educator Alfred Hudson (1808-1880) wrote about Laennec: *'What has been Laennec's influence on practice, on Clinical teaching, and on the public estimate of medicine? By his introduction of differential diagnosis – the essential pre-requisite of scientific therapeutics – the treatment of diseases of the chest,*

*previously directed to a name, a group of symptoms, or often to a single symptom supposed to be pathognomonic of a certain affection, has become differentiated'*.<sup>2</sup> Alfred Hudson specified that Laennec's differential diagnosis had a syndrome-based approach, which was absolutely revolutionary for European physicians. The basis of the diagnosis Laennec considered the study of the pathogenesis of a group of symptoms: *'And in like manner in dealing with causes: a group of symptoms may be caused by certain organic changes - it may be even probable that it is, we must first inquire into all the lesions of organs which occur in connection with such symptoms; in the second place, we must know if such lesions ever occur, or occur without the symptoms; and, again, if such symptoms can be attributed in any cases to other causes in the absence of such lesion'*.<sup>2</sup>

## Relevance

Laennec's treatise and the works of his followers reflect the experience of mastering structured clinical reasoning and a syndrome-based approach, which were based on morphology and pathophysiology. This experience has not lost its value, because even today medical students experience the same difficulties during their training in diagnostics as Laennec did in his time. Successful adoption of his experience would help students learn how to use their basic knowledge in the analysis of clinical manifestations; otherwise he will be forced to guess the diagnosis from single symptoms throughout his professional career. Using the experience of René Laennec by modern medical educators would increase the effectiveness of training. The purpose of this study is to determine the basic principles of diagnostic reasoning by René Laennec. The goal was achieved

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by means of Laennec's analysis treatise *De l'Auscultation Médiate, ou Traité du Diagnostic des Maladies des Poumons et du Coeur, Fondé Principalement sur ce Nouveau Moyen d'Exploration* 1819 (from French: *A Treatise on the Diseases of the Chest and on Mediate Auscultation*).<sup>3</sup> Laennec's treatise contains clinical examples of diagnostic analysis, which are very much needed by modern students.

### Diagnostic reasoning before the days of Rene Laennec

In the early 19th century, physicians used only the pathway from symptoms or disease pattern to diagnosis. Famous 18th-century a British physician Bartholomew Parr (1750–1810), author of *London Medical Dictionary* 1809 noted in his book: '*diagnostics means the signs of diseases by which they may be known and distinguished. They are of two kinds, viz. the adjunct, and pathognomonic: the first are common to several diseases, and serve only to point out the difference between diseases of the same species; the latter are those which always attend the disease, and distinguish it from all others*' (Parr, 1809, p. 551).<sup>4</sup> Nowadays, this approach to diagnosis is called *the traditional inductive diagnostic method*, which leaves certain diagnostic questions unanswered, especially when first confronted by a particular clinical pattern. This highlights the disadvantage of the inductive clinical reasoning.<sup>5</sup> Of course, with such a diagnostic approach, *pathognomonic symptoms* acquired particular importance. However, they did not seem reliable enough to practitioners, and therefore advice appeared in the medical literature to use *congeries of symptoms*: '*Pathognomonic, in Medicine, an epithet signifying that a symptom, or concurrence of symptoms, to which it is applied, is inseparable from, or exclusively characteristic of, a particular disease, and found in no other. There is, perhaps, no disease in which any single symptom can be strictly said to be pathognomonic; but the concise definitions of diseases given by the nosologists, should exhibit the congeries of symptoms which are pathognomonic. Thus the four symptoms, "fever, cough, dyspnea, and pain in the chest," which constitute Dr. Cullen's definition of pneumonia, are the pathognomonic symptoms of inflammation of the lungs*' (Rees, 1810, p. 521).<sup>6</sup>

It may be misleading that *congeries of symptoms* is a syndrome, but it is not. Ibn Sina (Avicenna, 980–1037) pioneered the idea of a syndrome in the diagnosis of diseases in his book *The Canon of Medicine* 1025 (Abu-Asab, 2013, p. 69).<sup>7</sup> Ibn Sina put the same meaning into the term syndrome as modern doctors: *a stable combinations of symptoms – mostly with morphological and pathophysiological backgrounds*.<sup>5</sup> European doctors in the 18th and early 19th centuries considered *congeries of symptoms* as a list of external signs of the disease, compiled based on empirical observations. It should be noted that the word *congeries* from Latin and from ancient Greek is translated as *accumulation, mass, heap, cluster*. The methods of diagnostic examination of that time did not allow judging the morphological and pathophysiological backgrounds of the disease. A distinguished Scottish physician John Forbes (1787 – 1861), in the preface to the English edition of Laennec's treatise, characterized the diagnostic approach of his predecessors as follows: '*Hitherto, unquestionably, the attention of nosologists has been too exclusively fixed on mere external symptoms without reference to the internal conditions of which these were the sign*'.<sup>8</sup> Thus, the diagnosis of pulmonary tuberculosis was made on the basis of an interview and visual examination, of the signs described in the second half of the second century AD. René Laennec noted in his treatise: '*Cough, dyspnoea, puriform*

*sputa, hectic fever, haemoptysis, emaciation, — the complete reunion of symptoms of which the frightful picture has been so faithfully delineated by Aretaeus*' (Laennec, 1821, p. 303).<sup>8</sup>

It is significant that the *pathognomonic congeries of symptoms* of inflammation of the lungs (*pneumonia*), which the famous Scottish physician William Cullen (1710 – 1790) cited in his treatise *Lectures on the Materia Medica* 1781, differs little from Aretaeus' *pathognomonic congeries of symptoms* of pulmonary tuberculosis. Laennec repeatedly noted in his treatise that *cough, dyspnoea, puriform sputa, hectic fever, haemoptysis, and emaciation* occur not only in pulmonary tuberculosis, but also in pulmonary catarrh, *pneumonia, pleurisy, sarcoma* in the lungs, *pulmonary hydatid cyst* (Laennec, 1827, p. 67, p. 74, p. 113, p. 376, p. 392).<sup>3</sup> Laennec remarked: '*No symptom mentioned above is specific to the disease. Cough is common in most lung diseases. Expectoration is not enough to differentiate pulmonary catarrh from pneumonia, pleurisy, or phthisis*' (Laennec, 1827, p. 67).<sup>3</sup>

Thus, early 19th century, the ineffectiveness of the standard classical descriptive-nosological approach to diagnosis, which implies an inductive route from symptoms or disease pattern to diagnosis, became apparent. Laennec and his famous teacher Professor Jean-Nicolas Corvisart (1755 - 1821) saw the development of diagnostics in the introduction of new physical research methods, as well as in the analysis of the pathophysiological basis of the symptoms of the disease. Corvisart (1755 - 1821) wrote in his treatise: '*the physician who does not unite physiology with anatomy will never become a firm and decisive practitioner, particularly in the treatment of the organic lesions*' (Corvisart, 1812, p. 184).<sup>9</sup>

### Principles of clinical reasoning by Rene Laennec

The first experience of using a stethoscope gave Laennec and his supporters the illusion of limitless diagnostic possibilities of the new method. John Forbes enthusiastically wrote in the preface of the treatise: '*He (Laennec) not only traces the progressive change of structure in the organ but connects every successive step of the change with external signs indicative of its existence. In short, he may be said to have realized the wish of the antient philosopher, and to have placed a window in the breast through which we can see the precise state of things within*' (Laennec, 1821, p. XIV).<sup>8</sup> However, it soon became clear that there were very few *pathognomonic* auscultatory phenomena. Some stethoscopic signs were present in completely different diseases. Therefore, Laennec began to pay special attention to differential diagnosis, the possibilities of which were greatly expanded thanks to indirect auscultation. An analysis of Laennec's differential diagnosis made it possible to identify two basic principles that later became the basis of modern structural clinical reasoning.

#### Principle No 1. Understanding the morphological and pathophysiological backgrounds of clinical manifestations.

Laennec inherited this diagnostic approach from Jean-Nicolas Corvisart. Analysis of the pathogenesis of stethoscopic and percussion signs allowed Laennec and use them as differential diagnostic criteria. The next Laennec's quote explains how normal auscultatory phenomena can become pathognomonic signs: '*When the lungs become condensed, the vesicular*

respiration may disappear, and the bronchial respiration can become a significant indication of several conditions. This happens because the air cannot penetrate the cells, making bronchial respiration the only option. It is usually louder and clearer, and in pneumonia cases, it can be the first indication of hepatization. (consolidation)' (Laennec, 1827, p. 32-33).<sup>8</sup> Laennec was not mistaken in using the term pathognomonic sign, since the appearance of bronchial breath sounds in the lung fields always attend lung consolidation (*hepatization*), and distinguish it from all other morbid changes in the lung (to paraphrase Bartholomew Parr' definition of *pathognomonic signs*). Nowadays the presence of a pathognomonic finding implies that the diagnosis is certain too. A *pathognomonic* finding allows immediate diagnosing since there are no other conditions in the differential (Leong, 2016, p. 205).<sup>10</sup>

The humid or moist crepitous rattle is another auscultatory phenomenon that Laennec considered the *pathognomonic sign* (differential diagnostic) of pneumonia. Laennec explained the pathogenesis of the stethoscopic phenomenon as follows: 'Moist crepitous rattle from the lungs resembles the sound of salt crepitation or blowing into a dried bladder. It is a notable sign of the first stage of peripneumonia, indicating a watery fluid and air mixture producing bubbles of extreme minuteness. It is easy to distinguish and disappears with hepatization, reappearing with inflammation resolution' (Laennec, 1827 p. 49-50).<sup>3</sup> Nowadays in common practice, terms such as *rales* or *crepitations* are still encountered, but the term *crackle* has become the main descriptor of discontinuous sounds, replacing both the French *râle* and the British *crepitation*. Currently, the only acceptable modifiers for crackles are *fine* and *coarse*. Laennec' the *moist crepitous rattle* or *fine crackles* have retained their importance as a differential diagnostic criterion for pneumonia to this day (Mangione, 2008, p. 419).<sup>11</sup> However, Laennec understood that single differential diagnostic criteria were not enough for an accurate diagnosis.

## Principle No 2. Syndrome-based approach

Laennec concluded that differential diagnosis is most effective when using stable combinations of symptoms, linking them to morphological and pathophysiological manifestations. Nowadays, such combinations of symptoms are called *syndrome* (Benenson, 2013, p. 99).<sup>5</sup> Laennec wrote: 'Percussion alone may provide limited indications. But when combined with mediate auscultation, it becomes valuable. By using these two methods together, we can identify signs of important diseases like pneumothorax, emphysema of the lungs, and unsoftened tubercles in the upper lobes.' (Laennec, 1821, p. 22).<sup>8</sup> It is clear from the quotation that Laennec calls *pathognomonic* a certain combination of percussion and auscultatory phenomena, while Laennec's predecessors used only single signs. In fact, Laennec used syndrome-based differential diagnosis. Differential diagnosis of this kind was so revolutionary new that Laennec could not create of a suitable name for it. In the 2nd edition of his treatise, Laennec singled out a section that he called 'Pathognomonic Signs'. From Laennec's explanations, it is obvious that he meant the differential diagnostic signs of the disease under the *pathognomonic signs*: 'Auscultation conjoined with percussion, furnishes us with several signs sufficient not merely to characterise the disease, but to point out its actual severity and to discriminate it from all others' (Laennec, 1827, p. 67).<sup>3</sup> Laennec' 'several signs sufficient to characterize the disease and to discriminate it from all others' – this is the

syndrome, that is, stable combinations of symptoms, linking them to morphological and pathophysiological manifestations.

'The contemporaneous employment of percussion and auscultation' was Laennec's favored basis for differential diagnosis. He noted: 'Both methods used together give clear diagnostic signs. Lack of sound on percussion always coincides with no respiration heard on the stethoscope' (Laennec, 1827, p. 31).<sup>3</sup> Laennec reasoned: the combination of the *dull sound* on percussion (the absence of the sound on percussion) with the absence of respiration (ascertained by the stethoscope) could be due to *lobar pneumonia* or *hydrothorax*. To differentiate these two diseases, Laennec using an assessment of the patient's voice transmission to the surface of the chest by palpation (*vocal fremitus*) and auscultation (*vocal resonance*).

Laennec wrote: 'The simple application of the hand would seem to furnish some signs of greater utility; for when a person in health speaks or sings, his voice excites in the whole walls of the thorax a sort of vibration, which is easily perceived on applying the hand to the chest. The phenomenon stops when lungs are diseased or removed from the chest wall due to fluid.' (Laennec, 1827, p. 10).<sup>3</sup> Laennec did not give any name to this method during his lifetime, later it was called *vocal fremitus* (*thoracic vocal fremitus* or *pectoral fremitus*, or *vocal tactile fremitus*) (Walshe, 1843, p. 15).<sup>12</sup> The assessment of *vocal tactile fremitus* is still used today (Mangione, 2008, p. 393; Laennec, 1821, p. 889).<sup>9,11</sup> *Hydrothorax* of any origin, 'when the lungs are removed from the parietes of the chest by an effused fluid', is characterized by the absence of the *vocal fremitus* (Mangione, 2008, p. 394; Walshe, 1843, p. 161).<sup>11,12</sup> The consolidation of the lung (for example, caused by *pneumonia*), on the contrary, is characterized by an increased *vocal fremitus* due to the fact that the consolidated tissue of lung conducts vibrations of the vocal cords to the surface of the chest better. (Laennec, 1827, p. 32-33; Mangione, 2008, p. 396; Mangione, 2008, p. 162).<sup>3,11</sup>

*Vocal resonance* is the auscultatory counterpart of *vocal fremitus*. *Vocal resonance* refers to the character of the patient's voice heard with the stethoscope over the posterior lung fields (Dennis, 2012, p. 156).<sup>14</sup> In Laennec's treatise and in modern textbooks, the following kinds of *vocal resonance* are indicated: *bronchophony* (Greek for 'sound of the bronchi'), *pectoriloquy* (Latin for 'the voice of the chest'), *aegophony* (Greek for 'the voice of the goat'). Localized *pectoriloquy*, *bronchophony* and *egophony* are seen in lung consolidation (Laennec, 1827, p. 35-47; Bickley, 2021, p. 905).<sup>3,13</sup> *Hydrothorax* is characterized by a local absence of *vocal resonance* (for example, a large pleural effusion) (Mangione, 2008, p. 440; Walshe, 1843, p. 71; Dennis, 2012, p. 156).<sup>11,12,14</sup> Thus, Laennec created a universal, easy to understand and reliable syndrome-based differential diagnosis. The example below gives an idea of the application of the syndrome-based approach to diagnosis.

## The lung consolidation syndrome

The above physical signs: localized increased *vocal fremitus*, the *dull sound* on percussion, and increased *vocal resonance*, taken solely, do not contribute much to the diagnosis. Laennec remarked on the *vocal fremitus*: 'This sign is, however, of inferior value, since a great many causes occasion varieties in the intensity of the vibration, or completely destroy it' (Laennec, 1827, p. 10).<sup>3</sup> The *dull sound* on percussion can also be caused by a wide variety of reasons: *hydrothorax* (Laennec, 1827, p. 41,

p. 437), *pneumonia* (Laennec, 1827, p. 58, p. 178), *oedema* of the lungs (Laennec, 1827, p. 176), pulmonary *haemorrhage* (Laennec, 1827, p. 190), *phthisis pulmonalis* (or pulmonary tuberculosis) (Laennec, 1827, p. 302) and others.<sup>3</sup> Increased *vocal resonance* is also not tied to any particular disease. Laennec believed that '*bronchophony can be caused by the simple induration of the substance of the lungs*' (Laennec, 1827, p. 45).<sup>3</sup> In turn, induration of lung tissue may be the result of *oedema* of the lungs (Laennec, 1827, p. 177), *pneumonia* (Laennec, 1827, p. 208), *phthisis pulmonalis* (Laennec, 1827, p. 335).<sup>3</sup> However, structural clinical reasoning, which is based on morphology and pathophysiology, leads us to the conclusion that the combination of these three physical features is indicative of the lung consolidation syndrome. The set can be supplemented with the appearance of *bronchial breath sounds* in the lung (Laennec, 1827, p. 32-33).<sup>3</sup>

Lung consolidation syndrome can be caused by various diseases, such as *oedema* of the lungs or *pneumonia*. In this final stage of diagnosis (from syndrome to disease), Laennec successfully used single signs to distinguish one disease from another. Laennec preferred signs that have an obvious pathophysiological basis. Thus, lung consolidation syndrome accompanied by the *moist crepitous rattles (fine crackles)* unmistakably indicated *pneumonia*. The stethoscopic phenomenon of the *oedema* of the lungs Laennec called the *subcrepitous moist rattle*. He pointed out their difference: *the bubbles usually seem to be somewhat larger and moister than in the rattle of peripneumony* (Laennec, 1827, p. 50).<sup>3</sup>

## Conclusion

Rene Laennec invented a syndrome-based differential diagnosis, fundamentally new for his time, based on stable combinations of symptoms, which are linked together by common pathogenesis. The path that Laennec overcame when creating a syndrome-based approach to diagnosis and structured clinical reasoning passes by every physician. Laennec's clinical reasoning, reflected in his treatise in the analysis of frequently occurring clinical syndromes, can significantly facilitate the teaching and learning of structured clinical reasoning in rookie physician.

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## CONFLICT OF INTEREST

The authors have no conflicting financial interests.

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