The Stethoscope: Historical Considerations

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It is now more than 200 hundred years since René Laennec invented the stethoscope [1–6], a device that became the unofficial badge of office for doctors for the best part of two centuries. Hailed as one of the great additions to the physician's non-invasive diagnostic armamentarium, there is no doubt that it has had a huge impact on clinical practice for much of this time. Laennec's classic textbook, *A Treatise on Mediate Auscultation and Diseases of the Lungs and Heart* first published 1819 [1], provided entirely novel and profound insights into both pulmonary and cardiac disease. In this he describes the events that lead to the invention of the stethoscope just 3 years earlier and his insights into the significance of the clinical findings he was able to elicit both with 'mediate auscultation' via the stethoscope and using the recently described technique of percussion, which he helped popularise. He was also able to use his skills in the field of morbid anatomy to inform his interpretation of the clinical signs he elicited when examining his many patients. Thus he helped play a central role in developing a rational scientific foundation for examination of the chest that continues to underpin routine clinical practice to this day.

2.1 The Significance of Laennec and the Stethoscope

The stethoscope can be regarded as the first of a long line of instruments that have given us an ever greater ability to examine the internal structure and function of the human body in health and disease. Laennec noted that at the time, the

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only tools available to explore the inner workings of the body were the probes used by surgeons. The latest devices such as PET scanners are just a step along the evolutionary progress that has its roots in the work of Laennec and his contemporaries.

Even prior to the invention of the stethoscope and publication of his textbook, Laennec was recognised as one of the great clinical empiricists and teachers. The first translation of his textbook into English by Dr. Forbes was published in 1821 [7], and the first review of his original publication appeared in an American journal the same year. As a member of the Paris school of physicians in the early nineteenth century, he was part of the movement that was revolutionising medical thinking. In the eighteenth century, medicine was still wedded to a 'philosophic' approach to the management of disease that was based on balancing the four 'humours' through practices such as blood-letting and dietary changes that dated back to the ancient Greeks. In a matter of a few decades however, around the turn of the century, Medicine had transitioned to a more questioning profession in which scientific insights from the rapidly developing disciplines of anatomy, pathology and physiology were transforming our understanding of health and disease.

This time of change was reflected in comments by Forbes in the preface to his first translation of Laennec's work, which suggested that the introduction of the stethoscope would not be welcome by physicians who would prefer to continue with their 'philosophical' approach rather than improving their diagnostic skill using a new device and the new ideas associated with it. Fortunately, most physicians and their patients welcomed the move towards the improved diagnostic accuracy and prognostication. Laennec's work can be seen as one of the most significant contributions to the rapid transition of medical practice from centuries of dogma to a scientific discipline.

2.2 Immediate and Mediate Auscultation

The value of assessing breath sounds audible at a distance from the subject, or heard through 'immediate' auscultation achieved by applying one's ear to the chest wall, was known to Hippocrates and the ancient Greeks and is referred to in a number of publications from various sources through the ensuing centuries, though this approach does not appear to have been widely adopted at any stage. The idea of augmenting sounds from the chest had already been explored in the previous century by Hooke, but his initial experiments were not pursued [8].

In his introduction, Laennec mentions that he and his fellow students were aware of listening directly to the chest as a possible adjunct to the examination (Fig. 2.1) but that few practiced this in large part because it was felt that it rarely added any information other than in some cardiac cases. He noted that other reasons for its '*limited application*' included '*it is always inconvenient both to the physician and patient: in the case of females it is not only indelicate but often impractical; and in the class of persons found in hospitals it is disgusting.*' Despite these issues, and in contrast to most of his colleagues, he noted that '*Nevertheless, I had been in the habit of using this method for a long time and it was the employment of it which led me to the discovery of a much better one*'. He then goes on to describe the

Fig. 2.1 Laennec listens to the chest of patient with tuberculosis prior to the invention of the stethoscope *A L'Hopital Necker, Ausculte Un Phtisique*Théobald Chartran (1849–1907)

well-known story of wishing to examine a young lady with a cardiac problem whose '*great degree of fatness*' had negated obtaining any useful clinical information from palpation and percussion and in whom immediate auscultation was '*inadmissible because of the age and sex of the patient.*'

To circumvent these difficulties, Laennec rolled up a 'quire' of paper (24 sheets) and '*was not a little surprised and pleased to perceive the action of the heart in a manner much more clear and distinct than I had ever been able to do by the immediate application of the ear.*' In 3 years between this episode, which took place towards

Fig. 2.2 Painting of Laennec using his stethoscope on a boyThis picture was taken from a painting by Robert Thom, copyrighted in 1960

the end of 1816, and the publication of his textbook in 1819, he refined his stethoscope (Figs 2.2 and 2.3). Having experimented with a variety of designs and materials, he then correlated his auscultatory findings with observations from the numerous post mortems he undertook. This led him to note '*The consequence is, that I have been enabled to discover a set of new signs of diseases of the chest, for the most part certain, simple, and prominent, and calculated, perhaps, to render the diagnosis of the diseases—of the lungs, heart and pleura, as decided and circumstantial, as the indications furnished to the surgeon by the introduction of the finger or sound (probe), in the complaints wherein these are used.*'

This 3-year period also marked an explosion of activity, which included writing a very substantial textbook. This is all the more remarkable as it took place at a time when the effects of pulmonary tuberculosis were increasingly starting to impinge on his wellbeing. This disease would eventually take his life at the age of 45 years. He notes in his first edition that his work was not complete. Both his deteriorating health and the frequent misinterpretation of his discoveries, as they were otherwise spread by word of mouth, prompted him to rush publication. Following this, however, his health did improve for a time, and he was able to expand and develop some of his ideas in the second edition published in 1826, the year of his death.

Laennec recognised that the limited responses of the lungs due to a variety of diseases made it difficult to distinguish them on the basis of history alone—an

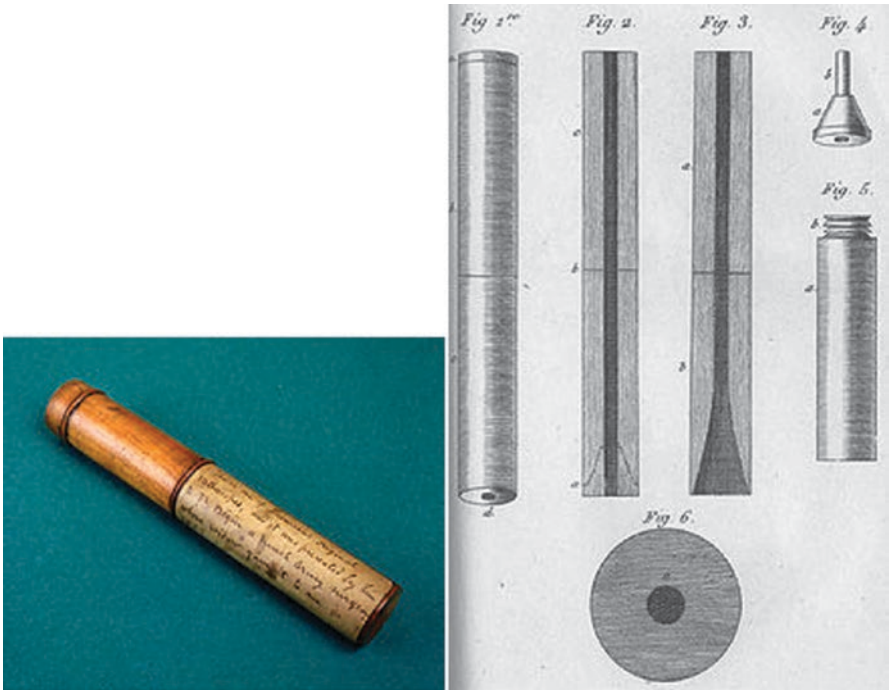

Fig. 2.3 A Laennec stethoscope from 1820

observation that is just as relevant today. This paucity of descriptive symptomatology drove him to try and improve the usefulness of the physical examination. "…*the diseases of the thoracic viscera are very numerous and diversified, and yet have almost all the same class of symptoms. Of these the most common and prominent are cough, dyspnoea, and, in some, expectoration. These, of course, vary in different diseases; but their variations are by no means of that determinate kind which can enable us to consider them as certain indications of known variations in the diseases. The consequence is, that the most skilful physician who trusts to the pulse and general symptoms, is often deceived in regard to the most common and best known complaints of this cavity*."

To further expand the investigative potential of the physical exam, Laennec augmented his use of the stethoscope with the art of percussion. Auenbugger's original book detailing this technique was published in 1761 [9], and following the availability of a French translation by Corvisart in 1808 [10], Laennec was keen to promote its use. By utilising the findings of each of these methods, he was able to accurately diagnose a wide range of pulmonary conditions, including those first described by him such as bronchiectasis.

Laennec focused on the use of the stethoscope for augmenting the diagnostic process in relation to pulmonary and cardiac disease. In the years immediately after the publication of his book, others found a range of diagnostic applications for the

new devices such as listening for crepitus in suspected fractures (less painful and more specific than the traditional prod still used by some in the emergency departments), examining the abdomen and listening to foetal heart beats. Until the use of X-rays for diagnostic purposes were developed in the early twentieth century, the stethoscope reigned supreme as the physician's most useful piece of equipment to enhance diagnostic accuracy.

It is of note that Laennec does not appear to discuss the significance of sounds heard at a distance such as wheeze and stridor. He does comment that sounds such as snores generated in the upper airway are poorly transmitted to the chest, and hence the stethoscope is of little use. Other sounds from the lower airways such as the 'death rattle' due to copious secretions in the large airways, the sonorous rale (again due to secretions in large airway) and the sibilant rale could all be heard on occasions while simply observing the patient. Similarly, he did not make much of trying to attribute inspiratory noises to upper airways pathology and expiratory noises to lower airways pathology even though he recognised this tendency. This is probably because much of the pathology he saw in the hospitalised patients was attributable to excessive secretions associated with chronic diseases such as pulmonary TB or chronic bronchitis, and this gives rise to both harsh inspiratory and expiratory noises generated in the central airways.

2.3 Acceptance of the New Device and Its Evolutionary Decedents

While Laennec's ideas spread rapidly, there was resistance from some quarters, particularly in France [11, 12]. No doubt the inevitable professional jealousies and resistance to new ideas that accompany any leap forward in knowledge were behind some of the initial negative responses noted. In France, many apparently dismissed his book as merely an overlong source of amusement. Forbes, in his introduction to his first translation [7], noted that "*I have no doubt whatever, from my own experience of its value, that it will be acknowledged to be one of the greatest discoveries in medicine*," but he was far from convinced that it would become part of routine practice. "*That it will ever come into general use, notwithstanding its value, I am extremely doubtful; because its beneficial application requires much time, and gives a good deal of trouble both to the patient and the practitioner; and because its whole hue and character is foreign, and opposed to all our habits and associations. It must be confessed that there is something even ludicrous in a grave physician formally listening through a long tube applied to the patient's thorax, as if the disease within were a living being that could communicate its condition to the sense without. Besides, there is in this method a sort of bold claim and pretension to certainty and precision of diagnosis, which cannot, at first sight, but be somewhat startling to a mind deeply versed in the knowledge and uncertainty of our art, and to the calm and cautious habits of philosophising to which the English physicians accustomed.*"

The idea that it would not be adopted because the doctors' actions might appear 'ludicrous' or that the idea a doctor might make a diagnosis with some precision would break the '*habitual cautious habits of philosophising*' that dominated the English physician's art reflect an approach to medicine that may not have completely disappeared. Even though there was rapid and widespread acceptance that mediate auscultation is of considerable clinical value, it is reported that many, particularly in France, adopted 'immediate' auscultation as the preferred method of listening to the chest for a number of decades because, contrary to all the evidence, they believed the stethoscope 'distorted' the sounds emanating from the lungs or heart. Many adopted a similar view when the flexible rubber binaural stethoscope was developed declaring that hearing in stereo adversely affected their ability to hear with clarity.

2.4 Evolution of Stethoscope Design

There are a number of reviews of the evolution of the stethoscope [11, 13–19]. Laennec's original design outlined in his first edition consisted of a length of wood approximately 1.5 in./4 cm in diameter and roughly 1 foot/30 cm in length with a hollow core. At the distal end, the central core was widened into a funnel shape to be applied to the chest. A plug to fill the funnelled end was used when listening for 'pectoriloquism' while the patient spoke, as well as for listening to the heart. When his first book was published, the purchaser was also able to buy one of Laennec's stethoscopes from the same retailer, as was the case when the English translation was published in London a couple of years later. This device was designed with a join in the middle so that it could be taken apart for convenience when not in use.

Within a very short period of time, a number of manufacturers were producing similar devices. Variations soon appeared with the diameter of the tubing being reduced 'to the thickness of a finger' by 1828, and the following year, the first binaural device was produced (but not adopted). The advent of durable rubber in the middle of the nineteenth century led to the development of a useable binaural device (Fig. 2.4), although a wide variety of material including wood, metal and even glass continued to be used. Experiments with diaphragms fitted to the bell apparently occurred through the second part of the nineteenth century with the first commercial devices, based on a design by Bowles in 1894, being available around the turn of the century. While most devices had a bell or diaphragm, some were manufactured with the option of physically changing from one to the other until the combined 'Bowle-Sprague' device was developed in 1926 allowing movement from one to the other with a switch. The double rubber tubing used for almost 100 years largely disappeared with the development of a single tube with a Y-shaped split to each ear piece designed by Dr. Littmann, an academic cardiologist at Harvard, in 1961.

The concept of attaching a number of listening ports for the purposes of teaching is of course not a new idea, with the earliest devices being described in the mid-nineteenth century while 'electronic stethoscopes' start to appear in the literature in the first half of the twentieth century. Microphones with computerised analysis

Fig. 2.4 Cammann stethoscope, 1852. Binaural stethoscope made by George Tiemann. Donated by Dr. Harold Nathan Segall. In the 1850s, flexible tubes began to be used, and in 1851 the Irish physician Arthur Leared created the first binaural stethoscope fitting in both ears. This invention was commercialised the following year by George Cammann. Reproduced by permission of the Osler Library of the History of Medicine, McGill University

designed to help the clinician interpret the sounds emanating from the chest have been in development for decades but have yet to enter routine clinical practice [20–23]. The use of a microphone applied to chest or neck and attached to a mobile phone has also, so far, made little impact. In addition to the cost of these developments, most of the devices have either not been conveniently mobile or lack the necessary precision to be a useful diagnostic tool. As will be discussed later in this book, there is still a considerable amount of work being undertaken in this area, though many clinicians find a video of the child when symptomatic taken on a smartphone more useful than attempts by parents or clinicians to describe clinical signs and adventitial sounds.

2.5 Impact of Disease on Sounds of Respiration, Voice and Cough as Heard Through the Stethoscope

Laennec described the normal sounds of respiration, speech and coughing and how they might alter in disease. To him these were at least as important and telling as identification of any adventitial sounds. '*The signs afforded by mediate auscultation*

in the diseases of the lungs and pleura, are derived from the changes presented by the sound of respiration, by that of the voice and coughing, within the chest, and also by the rale, as well as certain other sounds which occasionally are heard in the same situation,' Indeed, he devoted significantly more pages to the impact of disease on the auscultation of speech heard through the stethoscope than either 'pulmonary sounds' or 'adventitious sounds'. This was in large part because of the impact of consolidation, accumulation of secretions filling airways and the impact of cavities associated with these changes. It should be remembered that more than a third of his patients had advanced pulmonary TB and that to be admitted to the hospital Nectar in Paris, patients were often very ill. The significant mortality amongst these patients from a variety of conditions provided Laennec the opportunity to correlate his auscultatory findings with the underlying pathology. Few if any of those who followed and 'interpreted' his work and nomenclature had such insights.

To Laennec, the term pulmonary respiration was used to describe the normal breath sounds heard over the lungs. The term vesicular was coined by his fellow countryman Andral and advanced by Forbes as a preferable term. Laennec believed that the sound '*answered to the entrance of air into and out of air-cells of the lungs*' (termed vesicles by others). In this section he argues that one can auscultate through clothes provided there is no friction between the instrument and clothing such as silk. He recognised that the sounds were very individual, for example, being more pronounced and often more prominent in exhalation in children, difficult to hear in fit healthy men breathing quietly and 'puerile' (childlike) in those with more diffuse lung disease. Bronchial breathing was the term he gave to the somewhat harsher sound resembling those heard over the upper trachea. He identified this as *one of the earliest signs of "hepatisation" occurring in pneumonia and 'accumulation of tubercles in the upper lobes.*'

2.6 The 'Humpty Dumpty' Problem[1]

One of Laennec's many insights was his recognition that it may prove difficult to convey the meaning of the terms used. In particular, he anticipated that it would be difficult to convey in words the characteristics of the five classes of adventitial sounds or 'rales' (French for rattle) he recognised. He felt, however, that they were so distinct that once heard it would become obvious what he was describing.

> *For want of a better or more generic term I use the word rale to express all the sounds, beside those of health, which the act of respiration gives rise to, from the passage of the air through fluids in the bronchia or lungs, or by its transmission through any of the air passages partially contracted. They are extremely various: and although they possess, in gen-*

[1] 'When *I* use a word', Humpty Dumpty said, in rather a scornful tone, 'it means just what I choose it to mean—neither more nor less'.'The question is', said Alice, 'whether you *can* make words mean so many different things'.'The question is', said Humpty Dumpty, 'which is to be master—that's all'.

Lewis Carroll's *Through the Looking-Glass* (1872)

eral, very striking characters, it becomes difficult so to describe them as to convey anything like a correct notion to those who have never heard them. Sensations, we know, can only be communicated to others by comparisons: and although those which I shall employ may seem to myself sufficiently exact, they may not be so to others. I expect, however, that my description will enable any observation, of ordinary application to recognise them when he meets with them, as they are much more easily distinguished than described.

Sadly, his optimism was misplaced, and what is clear from the literature generated during the following centuries is that we seem destined not to build on Laennec's insights but to undermine them. The confusion appears to have commenced with the first translation of his work [24], Forbes having decided he was going to reorganise the content, improve the language and reduce its length by half. In particular Forbes disliked the term *rale* and replaced it with *rattle* or *rhonchus*. In the introduction to his second edition, Laennec noted that he too used the term rhonchus interchangeably with rale because in the minds of his patients, the term rale was often assumed to equate to the 'death rattle'. To lessen this connection, he would use the term rhonchus (an alternative term for rattle) when discussing his findings in front of patients. 'Rattle' did not prove popular with Forbes' British colleagues, and the term rhonchus became a general term for an adventitial sound which required further characterisation by an additional term. Over time the term rhonchus came to be used by some to describe one particular type of adventitial sound and thus has been a source of confusion ever since.

There have been repeated attempts to 'standardise' or 'rationalise' breath sound nomenclature [25–37], but unfortunately none have significantly impacted on the confusion that characterises this area as emphasised by the steady stream of publications repeatedly highlighting the inability of clinicians to agree on both the description and significance of auscultator findings [38–55] (though this is perhaps no worse than the ability to agree on many other clinical findings).

"***Auscultation of certain sounds adventitious to the respiration***."

Laennec identified four adventitious sounds in his first edition, adding a fifth in the second edition (see Table 2.1). As noted above he used the terms rale and rhonchus interchangeably as terms that denoted an adventitial sound, and the precise type of sound required a further qualifying term.

Eighty years later in a heartfelt plea to stop confusing medical students and doctors alike, Dr. West [26] echoed Laennec's concern that language may be a source of confusion. *'Auscultation is not really a difficult subject. It requires some little preliminary instruction and after that its mastery is only a question of attention and practice; yet there is no doubt that it often appears confusing to students' and 'The difficulties however are chiefly of our own making, and lie not in things but in words; for the facts of auscultation, their significance and their relation to pathological lesions, are well known and understood, while the confusion lied in the technical terms used to express the phenomena observed*'. He considered the two principle offenders the 'technical terms' of 'bronchial breathing' and 'rales' largely because they had acquired more than one meaning. His problem with bronchial breathing centred on the use of the term for sounds that lay somewhere between 'vesicular' breathing and what he considered to be 'true bronchial breathing'. In trying to

Table 2.1 Lannec's classification of adventitious breath sounds with early translations to English

Laennec	Forbes/Herbert rhonchus = rale
Rale humid **Crepitation**[a]	Crepitant rhonchus/rale **Crepitation**
Rale muqueux **Gargouillement**[b]	Mucus rhonchus/rale **Gurgling**
Rale sec sonore **Ronflement**[c]	Dry sonorous Rhonchus/rale **Snoring**
Rale sibilant **Sifflement**[d]	Dry sibilant Rhonchus/rale **Whistling**
Rale crepitant sec grosses bulles **Craquement**[e]	Dry crepitus with large bubbles rhonchus/rale **Crackling**

On line French English translation
[a]Crepitation, crackling; crepitation, making of a crackling sound
[b]Gargouillement, rumble
[c]Ronflement, roar, snore, snoring
[d]Sifflement, whistling, whistle; whiz, hiss
[e]Craquement, crack, snap

clarify this issue, he provided diagrammatic representations to try and obviate the limitations of language.

More importantly he noted that Laennec's 'sonorous' and 'sibilant' rales were by then commonly referred to as a 'rhonchus' and 'sibilus' (hissing). The term rale had acquired two meanings and could be applied to Laennec's five 'adventitious' sounds or, more specifically, to the remaining three sounds which had become labelled as 'crepitations'—both dry and moist. As such he argued that the term rale should be abandoned. It was to be another 80 years before the term was largely abandoned, at least in the UK, where Thorax editors took the step of refusing to include the term in published case reports—an example of the stick being much more effective than the carrot of a brighter future with lesser confusion. West's paper also highlighted the fact that rhonchus had by then also achieved the same feat of being used commonly to describe a single type of adventitial sound, while others continued to use it in the broader sense of referring to any adventitial sound.

West also noted that the term stridor had become widespread to describe 'noisy laryngeal and tracheal breathing' on inspiration due to a stenosis or narrowing. Laennec did not distinguish between inspiratory and expiratory phases, at least not in the translated version of Forbes, and it is therefore unclear whether stridor was a form of Laennec's 'sonorous rale'. Both Laennec and West noted that these sounds were highly variable and at times musical, but at other times, the term 'musical' would be somewhat stretched to incorporate the harsh sonorous sound attributable to secretions in the airway and which frequently clear with coughing. It was noted by Andral and others from soon after the publication of Laennec's book that '*he has not specified the precise moment, during the act of respiration, at which these (rales) are heard.*' While there are those that advance the notion that inspiratory sounds are generated in the extra thoracic airways (upper extrathoracic trachea and above) and

expiratory sounds are generated in the lower airways—as a result of maximal collapse occurring in this phase of the respiratory cycle—this is not true of those sound which Laennec speculated were due to air passing through or over mucus and secretions. The 'sonorous' rale or 'mucous' rale, for example, are described in conditions generating excessive secretions or fluid in the airways and which can occur in both inhalation and exhalation.

In 1932, Kinghorn [27] produced a detailed review of the variation in terminology then in use, choosing to adhere closely to Laennec's classification. He noted, as others had done, that the sonorous rale (otherwise known by many as the 'rhonchus') was highly variable and could often be cleared by coughing, while the sibilant rale (hissing) was generally unaffected by coughing. Echoing Laennec, he attributed the former to secretions in the large airways and the latter due to narrowing, from whatever cause, of the smaller airways.

By 1984, a review of terms used in English language case reports of respiratory conditions [40] noted that American journals '*most often use the terms 'rale', 'wheezes' and 'rhonchi'* though the use of 'crackles' was increasing. In British journals, fashion had led to a decrease in the use of the terms 'rales' and 'crepitations', while the use of 'wheezes' and 'crackles' had increased. In fact 'crackles' was mandated by the editorial board of Thorax, who apparently altered all references to 'crepitations' and 'rales'.

The American practice was presumably influenced by the publication in 1975 of the musings of the ACCP-ATS Joint Committee on Pulmonary Nomenclature [29] which noted that *'There is considerable confusion in the use of the terms rale and rhonchus to describe adventitious sounds heard over the chest'. Some continue to use rhonchus and rale as general terms for all abnormal lung sounds. However, rhonchus is used by others to describe only a continuous sound (wheeze) and rale to describe only short interrupted explosive sounds (crackles) heard usually during inspiration. The simplest way to resolve the confusion is to select the two most commonly used words, rhonchus and rale, and arbitrarily define the term rale to indicate only crackling or bubbling (discontinuous) sounds or vibrations and rhonchus to define only musical (continuous) sounds or vibrations, usually of longer duration. Alternative acceptable terminology substitutes crackles for rales and wheezes for rhonchi.'* A rhonchus is now synonymous with wheeze (a hissing sound) and musical in nature despite embracing Laennec's sibilant and sonorous rales which have very different characteristics, origins and implications for diagnosis.

Leap ahead another quarter of a century and an ERS Task Force [34] recommends abandoning the term bronchial breathing as being 'confusing', keeping the rhonchus as a low pitched wheeze, and defines a wheeze as a 'continuous' 'musical' sound with a duration of >100 ms and a dominant frequency of >100 Hz together with coarse and fine crackles. This Task Force believed they could '*standardise*' terminology as part of a process which would result in the production of a '*mass-produced multipurpose computerised stethoscope which may replace the current acoustic stethoscope as a basic tool for future doctors*'—that is removing the human from having to interpret what he/she hears. In this iteration the word wheeze which for generations had been used to describe a sound audible without mediate or

immediate auscultation of the chest is now to be used to describe the 'higher-pitched' musical sound attributable to fluttering of the central airways secondary to flow limitation and to the 'low-pitched' 'sonorous' sounds that appear to be attributed to secretions in the airways, thus becoming descriptive of at least three different types of sounds with at least two different underlying mechanisms. It is perhaps not surprising that universal clarity has not been achieved.

Unfortunately, many doctors faced with the dilemma of labelling something as a crackle or wheeze will label the harsh 'sonorous rale' of Laennec or 'rhonchus' of the ERS Task Force a wheeze as it does not have the discontinuous properties of a typical fine crackle and then compound the mistake by forgetting the maxim that 'all that wheezes is not asthma.'

Laennec, having an enquiring and methodical mind, would, if he returned, be fascinated by the technological advances of the past two centuries such as CT scanning, MRI and echocardiography but would no doubt be profoundly saddened by the confusion evident in the literature regarding the use of his simple but very important aide to interpretation of clinical findings. As he appears to have been both immensely practical and logical, he is likely to question, given the digital world we live in, why there is no 'gold standard' resource for physicians to refer to rather than continuously trying to propose new nomenclature and assuming that the reader will know precisely what the author has in mind. A number of online resources exist, but again there is no standardisation of terminology. A recent ERS Task Force was established in large part to produce such a resource, but this aim was not achieved [56]. As Renetti observed in 1979 when considering the respiratory physicians' uncanny similarity to Humpty Dumpty, 'Laennec, if aware of this chaotic state, must be restless in his grave' [38].

2.7 Reports of the Stethoscope's Demise Have Been Somewhat Premature

Predictions of the demise of the physical examination and its replacement by radiology appear soon after the introduction of chest X-rays. By 1946, while it was recognised that the technical quality of imaging was still relatively primitive and that abnormalities on chest X-rays were often not specific, many were arguing that the stethoscope and physical examination in general had been relegated to third spot behind history and radiology in its value in the diagnosis of pulmonary disease [57]. One of the key charges laid against the use of the stethoscope by doctors was the tendency for doctors to confabulate the finding of a 'clear' chest with absence of pulmonary pathology—again a situation that has not changed 70 years later. Dr. Maxwell noted '*Most doctors are apt to assume and, even worse, to announce to their patients that the failure to detect physical signs implies a healthy respiratory tract. Nothing could be further from the truth.*' This observation can be borne out when re-examining a young child's chest after a CXR has shown evidence of a lobar pneumonia, listening to the 'clear' chest of an asthmatic patient in the afternoon when the patient is complaining of having been awake with shortness of breath and

wheeze in the early hours of the morning or listening to the chest of a patient with cystic fibrosis in whom a 'clear chest' can be accompanied by considerable airways secretion that can be revealed with a good cough or huff.

A number of 'authorities' have, over a number of years, argued that auscultation is an anachronism in the age of detailed imaging both of the heart and lungs, particularly given the low level of expertise in describing and interpreting the findings observed in many studies. As such its use is often dismissed as a desire to hold onto a fashion item or status symbol. In contrast its use is often stoutly defended by enthusiasts who feel it provides an invaluable screening tool that is cheap and portable: properties that are likely to contribute to its continued use for some time [58–62]. The largest challenge for the young medical student trying to understand the role of what is often thought of as the defining symbol of the profession they are entering is to convert the contradictory statements contained in textbooks, journal articles and the Chinese-whispered lessons of bedside teaching into a useful model on which to make accurate inferences.

It is of interest to note that in the *American Academy of Pediatrics* textbook on Pediatric Pulmonology, the topic of auscultation as part of the assessment of a child with a respiratory problem warrants barely a page of the 1182-page tome and refers to only 3 sounds—discontinuous crackles which can be course or fine, rhonchi and wheeze. There is no discussion of the mechanisms by which they are generated and little comment regarding the implication of the sounds. This suggests the authors consider mediate auscultation to be of little value to the 'pulmonologists', yet there is no sign that the stethoscope will disappear in the immediate future. We will no doubt continue to see the publication of articles expressing surprise at the inability of clinicians to agree on the terminology that describes a sound they hear and observe further suggestions for addressing this embarrassing reality.

King and Crewe noted in their book '*The Blunders of our Governments* [63] *that if cars continually crash at a junction, eventually it becomes pointless to blame the driver, and a new solution to the design of the junction is required.*' In the case of the stethoscope, the ongoing failure of clinicians to communicate their findings coherently could be addressed by automated sound analysis. This would mitigate the language difficulties but removes the extraordinary abilities of the human brain to interpret sound, the latter being one of the main reasons that this approach has not entered routine clinical practice. An alternative solution, as noted above, is to generate a gold standard teaching programme (as with the platinum/iridium standard metre in Paris) to which everyone in practice and training can refer.

Once pre-eminent amongst the tools we had available to assist the diagnostic process, the stethoscope became the symbol of the medical profession. More recently it has, in many ways, been overtaken by other technological advances. However, despite all the problems associated with its use, it is likely to be around for some time to come. The stethoscope remains a potentially valuable, powerful, portable tool that, if used appropriately, may provide valuable clinical information at low cost and minimal inconvenience. Its role has changed from being the single piece of equipment that could enhance our ability to reach a diagnosis when examining a patient with pulmonary disease to being a screening tool that is frequently

used in the initial assessment of potential disease by helping to inform the choice of further, more detailed, investigations. As with any tool, however, it is the skill of its user that defines its true value, and Laennec might well turn in his grave given the problems the profession has contrived to introduce since he produced such a clear guide for the future use of his simple but potent invention.

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