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A French national research project to the creation of an auscultation's school: The ASAP project

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ABSTRACT

Auscultation of pulmonary sounds provides valuable clinical information but has been regarded as a tool of low diagnostic value due to the inherent subjectivity in the evaluation of these sounds. This paper describes an ambitious study of in the so-called ASAP project or "Analyse de Sons Auscultatoires et Pathologiques". ASAP is a 3-year-long French collaborative project developed in the context of the *News Technologies of Information and Communication*. ASAP aims at making evolve the auscultation technics: by 1) the development objective tools for the analyse of auscultation sounds: electronic stethoscopes paired with computing device; 2) the creation of an auscultation sounds' database in order to compare and identify the acoustical and visual signatures of the pathologies; and 3) the capitalisation of these new auscultation techniques around the creation of a teaching unit: "Ecole de l'Auscultation". This auscultation's school will be destined to the initial and continuous formation of the medical attendants.

1. Introduction

Since the invention of the first stethoscope by the French physician René Laënnec in 1816, auscultation via a stethoscope is widely used by physicians as a simple, non-invasive and patient-friendly diagnostic method of chest diseases, where the sounds heard are correlated with the underlying pulmonary pathology [1,2]. Despite its popularity, however, a stethoscope is not an ideal acoustic instrument since it does not provide a frequency-independent transmission of sounds. Auscultation of pulmonary sounds provides valuable clinical information but has been regarded as a tool of low diagnostic value due to the inherent subjectivity in the evaluation of these sounds. In addition, auscultation is a subjective process that depends on the experience and hearing capability of the individual, which may lead to a large variability in findings. Moreover since auscultation does not allow a permanent record of data, long-term monitoring of pulmonary sounds in follow-up studies is not possible. Over the last 30 years, advancements in the field consist of digital signal processing, analysis of waveforms by computer and recording of respiratory sounds but to date, there is only research and no development in clinical practice [1].

In the context of the MERCURE telemedicine platform, we started a project called ASAP. It deals in developing objective tools for the analysis of auscultation sounds and creating an auscultation sounds' database in order to compare and identify the acoustical and visual signatures of the pathologies. Finally, it aims at capitalizing of these new auscultation techniques around the creation of a teaching unit: the Auscultation's School.

2. Context of the project

ASAP or "Analyse de Sons Auscultatoires et Pathologiques" is a 3-year-long French collaborative project [1]. It is part of a collaborative telemedicine platform called MERCURE or "Mobile Et Réseau pour la Clinique, l'Urgence ou la Résidence Externe". MERCURE deals with projects for remote monitoring or in clinical context thanks to modern tools principally coming from the *News Technologies of Information and Communication* (Fig. 1). STETAU is the first project of the MERCURE platform. It aims at providing the patient and medical staff, measurement tools that are non-invasive, mobile, communicant and that allows to transmit vital information by a secured way, objectively qualified by signal processing tools. Thus, physicians will have access to a tool for remote monitoring and exploration of cardiac and pulmonary sounds. ASAP aims at making evolve the auscultation techniques by:

–the development objective tools for the analyze of auscultation sounds: electronic stethoscopes paired with computing device

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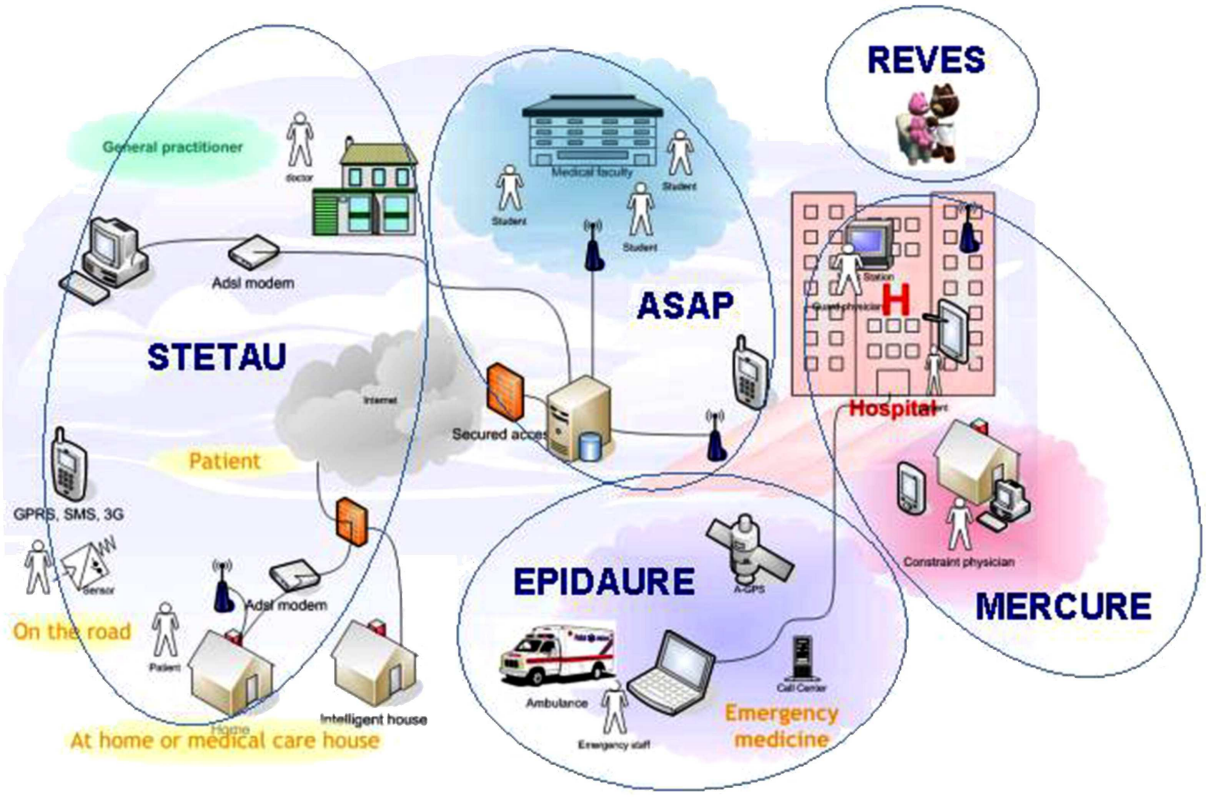

Fig. 1. The MERCURE platform with the projects STETAU and ASAP.

–the creation of an auscultation sounds' database in order to compare and identify the acoustical and visual signatures of the pathologies (Fig. 1)

–the capitalization of these new auscultation techniques around the creation of a teaching unit: «*Ecole de l'Auscultation*». This auscultation's school will be destined to the initial and continuous formation of the medical attendants.

Auscultation is the first medical act that the medical students can realize on patients; it is realized empirically. Our project proposes to introduce an *evidence-based medicine* dimension at auscultation thanks to an association with signal processing, visualization and archiving technologies [2]. These new technologies will be considered for the formation of the future physicians and will be accessible by e-learning. In the same way, the creation of a worldwide database named *WebSound* is an indispensable asset for capitalizing these news technologies around a pertinent and exhaustive knowledge base. An example of interesting utilization of the auscultation sounds database is the formation and the training of a physician to a specific pathology. Moreover, it will be possible to share auscultation sounds between experts thanks to a unified format. Thus, they will be able to discuss about a case and to affine their diagnosis. Finally, our project aims at initializing fundamental research works for the definition of a visual and acoustical signature of pathology. The first pathologies studied will be asthma, bronchitis, CODP and cardiac pathologies [2]. The success of the projects is conditioned by the definition of standard formats of the data and exchange protocols.

3. Goal of the project and main technological challenges

The studied system is a pair:

– a communicant electronic stethoscope: a stethoscope with possibilities of recording, send sounds to a computing device (PC, PDA…)

– a software to process auscultation sounds: auscultation enter in evidence-based medicine thanks to sounds transformed in images, objective and quantifiable data, transmission, comparisons, archiving [3,4].

Our project aims at deploying this system on a medical community and at collecting an important number of qualifying sounds in order to create a referential [4–6]. Thus, the global system is not only a measurement tool, but also a diagnosis tool that fundamentally replaces the auscultation medical act within clinical semiology [2,6,7].

4. Our value-added

Some projects or products already propose an evolution of the stethoscope [3,8]; we can quote the stethoscope Littmann or Jabes. Some firms propose as well as their stethoscope, a CD-Rom with auscultation sounds… Nevertheless, they only allow a basic consultation with some examples, most theoretical, and that are neither interactive nor a diagnosis support. In our project, our ambition is not to propose a stethoscope and to provide in addition sounds, but the exact opposite. Indeed, we will propose a worldwide sound database with visual and acoustical signatures (Fig. 2), that allows to consult and analyze sounds, realize standard exchange of data. These sounds will, all the more, be a support for learning auscultation [2,9]. From those data, a worldwide auscultation sounds database could be created. It will list an important quantity of data and will allow to create models or criteria to improve detecting of pulmonary and cardiac diseases [3]. Another innovative aspect of our project is to make diagnosis aid.

5. Description of the ASAP project

As described on the Fig. 3, there are some major phases in the project [1]. The first point is the realization of a worldwide

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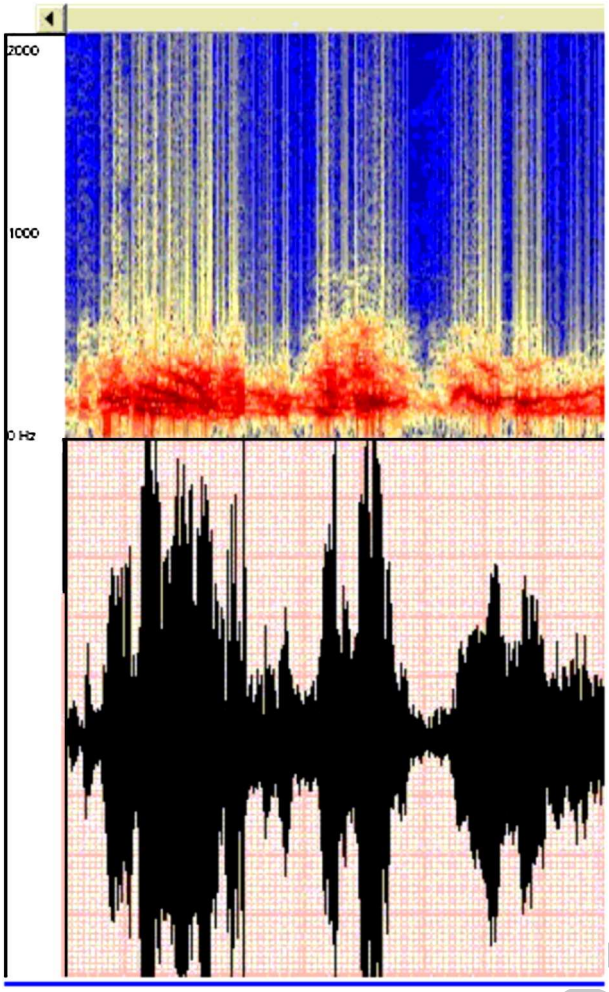

Fig. 2. Example of visual representations with phonopneumogram and spectrogram of a respiratory cycle with several crackles in a patient with COPD.

auscultation sounds database (named *WebSound*). Then, health professionals and medical students could use this database [3,9]. The students would dispose of a diversified palette of sounds via new technologies of communication and information. It will allow to make continuous formations concerning precise pathologies. Thus, the Auscultation's School will be created. Besides, in order to allow the inter-connection of the information systems of the hospitals, we are working on the normalization of the used formats. Afterwards, it will be possible to exchange sounds between experts, thanks to a unified format. The expert could discuss about a medical case, and refine the diagnosis. A study at the state of the art will be realized for the sounds' analysis, in order to be able to qualify and compare them. Finally, the database will be used to initialize research works concerning the definition of the acoustical signature of a pathology [4,7]. The aim is to make auscultation more objective and pre-detect pathology.

6. Perspectives: the Auscultation's School

In a nutshell, it can be said that auscultation is an individual act, difficult to share. On the contrary, the Auscultation's School will lean on an objective definition of the sounds useful for teaching and diagnosis aid [2,9]. The Auscultation's School will have for purpose to learn to student and professionals the new available tools. In the same way, research programs will try to detect new markers, detect pre-markers from some pathologies [7]... The project begins by the scientific and clinical validation of the service for several pathologies: COPD, asthma, bronchitis and several cardiopathies such as cardiac failure, aortic and mitral stenosis (Fig. 4). This step allows to collect auscultation sounds that are categorized and qualified thanks to an intelligent comparison and evaluation of the sounds. The final goal is to create a worldwide referential interconnected to medical study centers, pharmaceutical research laboratories and auscultation sounds processing systems. Empirical methods provides already results to show the value-added of the analyze and the comparison of the sounds for instance for the correlation between the pulmonary blocking of a patient with cystic fibrosis and the rate of detected crackles, the evolution of the acoustic signature of a cardiac valve... The main strengths of such a referential are: 1) improving the incontrovertible medical act that is auscultation, by making it objective, and factual, to share, histories and compare the data; 2) lean on the new technologies to push the exploitation of auscultation sounds as a non-invasive exam and pertinent diagnosis aid and local or remote monitoring; and 3) create a new language exploitable by all the profession [2,4].

The different elements present in the Auscultation's School will be:

- the good practices of auscultation: how to auscultate, what are the abnormalities researched, the stethoscope...
- the classical sounds in the various disciplines: Cardiology, Pneumology, Pediatric, Reanimation, ... the identification of crackles, wheezes, and their correlation with the following of a pathology...
- the new auscultation tools: the electronic stethoscope, signal processing tools, visualization of the sounds and interpretation of the obtained images...
- the ongoing research project
- bibliographical references.

The access to the teaching could be initial or ongoing training. Modern learning tools will be privileged. This formation will be accessible by each medical professional, and maybe more.

The first goal of such an initiative is the repositioning of the auscultation as a fundamental non-invasive exam in the medical diagnosis; while pushing to potentialities thanks to the new technologies.

7. Conclusion/Future work

Today we are testing and studying different algorithm in the context of the ASAP project. The next step will consist in exploiting all the diversity of the sound. This augmentation of the spectrum studied and linked to signal analysis techniques will allow the definition of new characteristic markers. Previous studies demonstrate the need of performing an exhaustive scientific approach, that account of both the definition of a semiology, the consolidation of definition of known characteristics markers, the definition of common or even universal semantics, the development of determinist tools that will allow the detection of these markers (personal communication: e-Auscultation, towards new practice. Workshop on e-auscultation, European ICARE project, Portoroz Sloenia, 2008, May 5). It is precisely the context of an ambitious study of in the so-called ASAP project. This study is handled by a multidisciplinary team including medical from *CHRU de Strasbourg*, Researchers of the *Université Louis Pasteur*, *IRCAD* for web-based teaching tools, *Alcatel–Lucent* research teams for the development of the tools and algorithms. Among the most identified outcome from the project, it is force in to create auscultation school hosted by the "Faculté de Médecine de Strasbourg".

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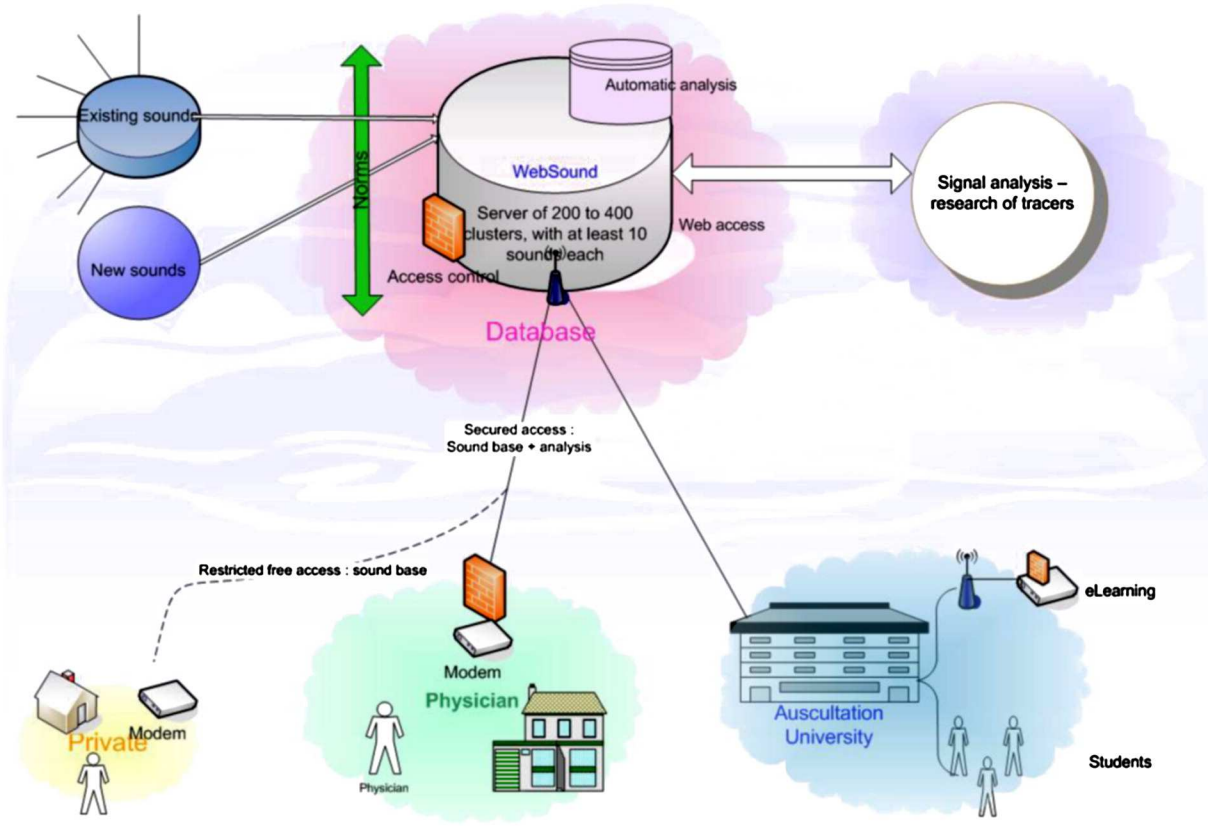

Fig. 3. ASAP project.

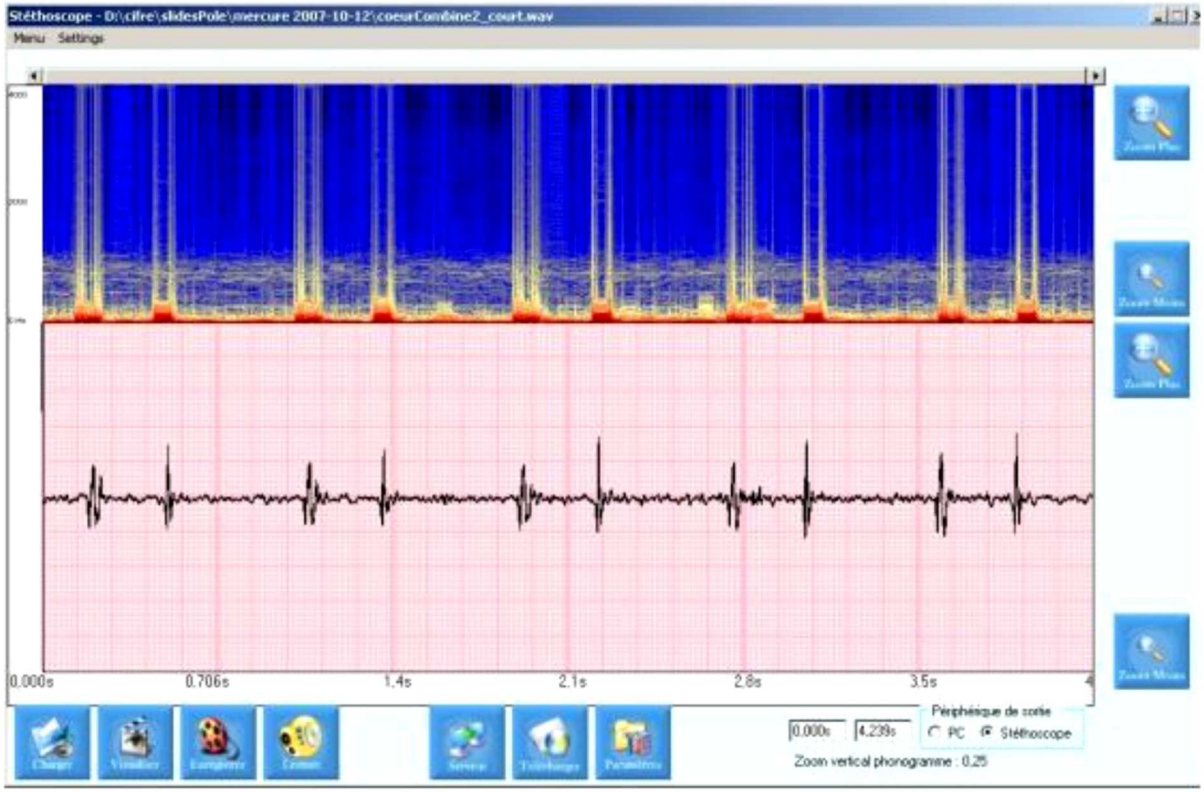

Fig. 4. Phonocardiogram and spectrogram of a cardiac cycle in a normal subject.

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