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## Research and Education

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### *Education and Research in Health Informatics at the Faculty of Medicine of Marseille, Laboratory for Education and Research in Medical Information Processing (LERTIM)*

**Abstract:** This paper is a brief review of the research and training programs offered in Medical Informatics at the Faculty of Medicine of Marseille (LERTIM). Our laboratory teaches medical informatics and bio-statistics in the medical training curriculum, and prepares for specialised degrees and provides continuing medical education. The research projects developed by our team fall into four groups: clinical decision systems, health information systems, medical education systems, integration systems.

#### **Introduction**

The LERTIM laboratory is part of the Faculty of Medicine, a division of "Université de la Méditerranée" including several campuses in Marseille and Aix-en-Provence, France. The Faculty of Medicine, the Faculty of Pharmacy, and the School of Odontology are located on a common campus next to the largest teaching hospital in downtown Marseille.

Our group is approximately 18 strong, including 2 secretaries and 5 PhD students. Some of the LERTIM members (6 in all) have two sets of responsibilities, because of the way French medical schools and teaching hospitals are organized: they have teaching and research activities both in the Faculty of Medicine and the teaching hospital. Their faculty activities deal with research on medical informatics topics and fundamental aspects, and their hospital activities with practical ones.

Teaching activities proceed within the framework of compulsory studies

and cover University degrees within the teaching hospital and continuing education facilities.

Research activities in the Faculty of Medicine, are concerned with the application of new information and communication technologies (decision support systems, information indexing and retrieval, modelling and access to knowledge bases, health information systems etc.). The main research goal in the teaching hospital is clinical research in various medical fields.

We shall describe the teaching curriculum and the main research aspects our laboratory is involved in. Most of these descriptions are already available (in French) on our web site <http://cybertim.timone.univ-mrs.fr/cybertim/>.

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#### **Education**

In the French medical curriculum, the three first years are dedicated to fundamental medical and biological sciences. The next three years prepare students for internships and residencies.

Our LERTIM laboratory teaches bio-statistics, the methodology of clinical epidemiology, evidence-based medicine, new technologies of information and communication (NTIC), and medical informatics throughout the medical education process. The laboratory covers the complete medical curriculum, from the first year to internship, and even later, in continuing medical education, as summarised in Figure 1.

A medical informatics handbook, co-authored by Patrice Degoulet and translated into several languages [1], summarizes the different aspects of medical informatics as taught by our group.

#### **Bio-statistics teaching**

Bio-statistics and clinical epidemiology are mainly taught over the first three years of the medical training program. We teach a compulsory bio-statistics course during the first year. This 30-hour course is dedicated to medicine, odontology, and physiotherapy curricula and is taught to 1700 students. Less than 350 students

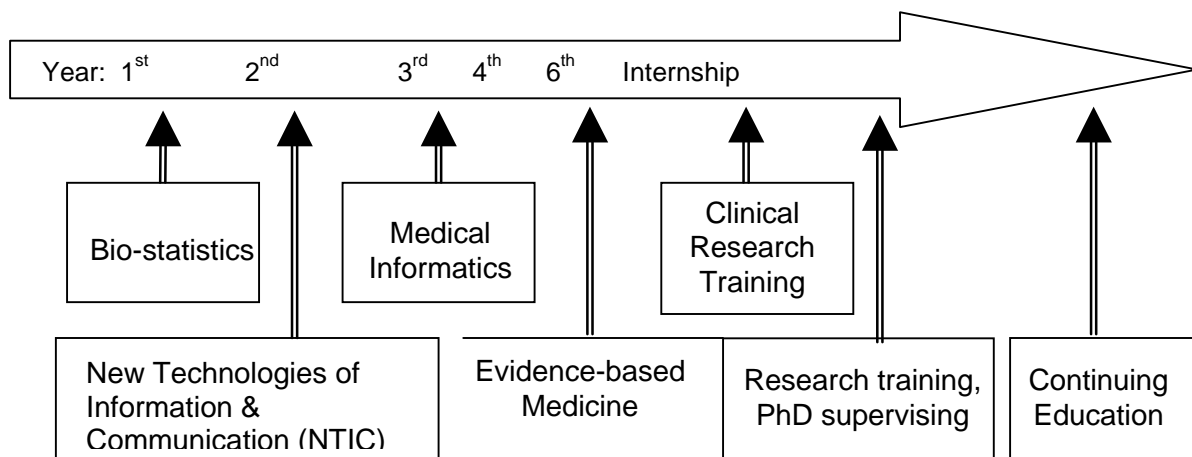


Fig. 1. LERTIM laboratory involvement in medical education curriculum at the Faculty of Medicine of Marseille.

(210 for medicine) are selected in the three disciplines with a competitive examination at the end of the year. The statistics being taught are basic and include descriptive methods used to evaluate everyday clinical data and activities.

### New Technologies of Information and Communication training (NTIC)

NTIC training (20 hours) is provided to students in their second year of medical curriculum. They must practice the basic software currently used: operating system environment, word processing, spreadsheet processing, information retrieval and Internet browsing. Two hours are dedicated to scientific documentation research on the Internet. This training is compulsory.

### Degrees in Medical Informatics and Evidence-based Medicine

Once their year of first medical curriculum has been completed, students may decide to take advanced degrees. Individual degree training lasts approximately 100 hours. Our laboratory is responsible for two of those.

The first one (Certificate in Medical Informatics and Communication Tech-

nology) surrounds Medical Informatics, including conceptual modelling, database management, multimedia systems, health care information systems and networks, decision support and artificial intelligence applications.

The second one deals with evidence-based medicine, including meta-analysis principles and practice, statistics tools and models, medical information retrieval. Clinicians from the faculty and from the teaching hospital present case studies in various medical specialties, including infectious diseases, cardiology, oncology, dermatology, etc.

### Pedagogic Web server project of the Faculty of Medicine

The introduction of computer technologies may support a wide range of learning activities and enlarge pedagogic approaches. These technologies also encourage active learning, support cultural changes and increase resource sharing. Consequently, the development of new pedagogic initiatives needs to be integrated with other forms of learning, i.e. on-site traditional training and courses, discussions and comments regarding case studies in small groups, general clinical training and practice, problem-based learning,

virtual situations and simulations, on-site and/or on-line tutoring.

We have been experimenting along those lines with a pedagogic Web site intended for use by our medical school students (<http://medidacte.timone.univ-mrs.fr>) since 1999.

A designated Web server, MEDIDACTE, was preliminarily and partially implemented. This server integrates teaching strategy. It was designed according to a general approach, in which technology can be used to supplement and enhance medical education. Significant efforts were made to:

- train teachers in pedagogic aspects of Web technology,
- recognize their involvement in e-learning.

The MEDIDACTE e-learning environment includes three workspaces implemented for users, including students, visitors, and faculty. The most suitable educational resources are suggested in the student workspace, according to their profiles with identification and access rights attributes. The visitor workspace offers access to pedagogic projects by medical specialty. The faculty member workspace being envisioned has three functions:

- managing projects (developing a course, selecting course tools, organizing courses by topics, etc.),
- applying teaching scenarios,
- Assessing projects and follow-up.

More than 30 educational projects, covering different disciplines, included in the training curriculum were compiled in one year. Traditional pathology laboratory operations were, for example, replaced with virtual ones using digital images. This change was unanimously required by the pathology teachers and generally well accepted by the students.

In 2000, with the support of the Dean of the Faculty of Medicine, we decided to design and experiment with an evidence-based medicine degree course in French using Internet facilities and taking the new paradigms emerging in medical education into account.

**National training program in Medical Informatics**

We are taking part in a national training program for PhDs in cooperation with the universities Paris V, VI and Rennes. This is a DEA (Advanced Research Diploma) in Medical Informatics and is taught in Paris. We are involved in teaching knowledge representation and artificial intelligence applications for decision support in medicine (25 hours), as well as cognitive approaches for knowledge transfer and learning (10 hours).

**Continuing education in the hospital**

Our group is also involved in continuing education in two different fields including:

- the use of statistics in clinical research with the associated software
- medical language, indexing and retrieving information (Medline queries included).

The courses are given in the hospital environment to healthcare professionals only.

**Research**

Our research topics have included medical decision support and artificial intelligence applications in medicine for many years now. In the eighties, we designed, developed and experimented with expert systems based on symbolic and fuzzy logic (SPHINX [2] and PROTIS [3]). We also developed expert systems for investigating knowledge representation, decision modelling and knowledge evaluation.

Our current research activity is still centred on decision support and guidelines in medical practice; these are integrated into health information systems to provide "knowledge coupled tools" that are usable in real practice. This must include:

- various researches in medical concepts representation, artificial intelligence and cognitive psychology methods, reasoning models, cognitive man-machine interaction models;
- the development of software components for the representation, treatment and communication of information and knowledge, as well as using multimedia technologies.

We have 5 to 7 students (PhDs, DEA and other researchers) involved in the various projects.

The current research activities of the LERTIM (Medical Informatics Laboratory) are summarised in Figure 2 below.

**The ARIANE project**

The aim of the ARIANE project is to provide healthcare professionals with efficient access to information sources helpful to their daily practice [4-12]. This means the users need quick and seamless access to the expected level of information. Information sources may either be integrated in their institution network (intranet), or on an Internet site. In the first case, the engineers controlling the quality of information supervise the efficiency of access to those databases integrating information sources within the institution's intranet. Whenever a source of information is located outside an institution's network, questions arise as to how the quality of its contents can be guaranteed and how users can have efficient access to this source. In any case, ARIANE is not only intended to

Main research topics	Medical information and knowledge: decision aids, education			Semantic interoperability
	<u>EsPeR project</u> Guideline-based decision support	<u>ASTI project</u> Guideline-based drug prescription	<u>Learnet project</u> Education and hypermedia knowledge	<u>ARIANE project</u> Medical ontology and language, information system architectures
Projects	<u>Health Information Systems</u>			
	"UMVF" project Virtual French-speaking medical university			

Fig. 2. Synopsis of LERTIM research activities in Medical Informatics.

connect users with servers, but above all, to query servers, and then connect users with those servers at the point of result delivery.

In this framework, we have designed, are currently developing, and will experiment with a complete middle-ware architecture composed of:

- a conceptual interface that helps end-users express their queries,
- a broker identifying relevant information sources and suggesting access to them
- mediators able to express end-user queries in the languages of resources and send them.

This architecture uses the NLM's Unified Medical Language System, knowledge sources and an "Internet Sources Catalog" describing the contents of the information sources and how to access them.

A project named WRAPIN recently accepted (June 2001) by the European Commission aims to integrate both ARIANE results and the currently existing information retrieval and indexing tools developed by the Health On the Net (HON) foundation in Geneva, Switzerland.

### The Lernet project

This project is intended to design develop and evaluate interactive environments to optimise decisions and acquire medical knowledge in an NTIC background [13-17]. The courseware allows greater student autonomy; it can individualise the educational process and may contribute to the various phases of the pedagogical process, i.e. presenting information, repetition, control, and usage on simulations or in real situations. The project takes the educational and cognitive aspects, knowledge bases and their methods of access into account. Its goal is to provide teachers with the means to integrate knowledge bases into their own educational projects.

The project takes several problems inherent to the acquisition and spread of medical knowledge into account:

- identifying the level of knowledge to be spread: superficial, extensive etc.
- modelling and representing the knowledge to be spread,
- developing tools for faculty to integrate NTIC in their educational projects,
- identifying objects and metaphors available to students for accessing knowledge.

Coupling encyclopaedic knowledge and educational projects should help teachers better adjust NTIC and lead to an evolution in medical education.

### Partnership projects

The UMVF ("Université Médicale Virtuelle Francophone") project is funded by the French Ministry for Research and is based on a federation of resources either existing or currently being developed in several French Medical Schools. The objectives of this project are not only to share experiences across the country but also to integrate several resources while using NTIC to support new pedagogical approaches for medical students and also to continue medical education [18]. This project includes:

- a virtual Medical Campus securely accessed from several sites,
- the integration of new interactive resources, based on pedagogical methods,
- the implementation of new indexing and search engines, based on medical vocabularies and ontologies,
- the definition of general and specific portals, as well as a system evaluation for ergonomics and contents.

Those French medical faculties not initially involved will evaluate the results of this project.

The EsPeR ("Estimation Personnalisée du Risque") project is based on rules and guidelines and features an Internet server [19]. We developed this project in cooperation with the Paris VI University's Medical Information

Group (Pr P. Degoulet).

This project has two main objectives:

- Providing a tool for physicians to evaluate the risks of death according to patients' individual symptoms,
- Offering suggestions and guidelines for preventive measures that take individual patient risks into account.

A probability based method covering pathologies for which preventive measures exist has been developed to help physicians objectively assess the main causes of death of their patients.

The ASTI ("Aide à la Stratégie Thérapeutique Informatisée") project deals with drug prescriptions that are often inadequate in the hospital or ambulatory setting. We collaborated with the Paris V (Pr. A. Venot) and Paris VI (Pr. JF. Boisvieux) Medical Informatics Groups to conduct this project. Although computer-based physician ordering systems already exist and provide effective drug-centred checks, their optimisation of the patient-centred therapeutic strategy overall is poor. Although evidence-based clinical guidelines were developed to disseminate state-of-the-art and strategic therapeutic knowledge, they are not used very often in daily practice. The ASTI project is intended to design a guideline-based decision support system to help general practitioners avoid prescription errors and comply with best therapeutic practices.

- A « critical mode » is applied as a background process without modifying the physician's entry habits and corrects his/her prescriptions with elementary rules that are automatically triggered and take individual recommendations into account.
- A « guided mode » is selected by the physician to browse through the comprehensive guideline knowledge represented as a decision tree and to access the best treatment.

A first prototype is currently under development and applies the management of hypertension. General practitioners will validate the results.

EasyCare was a project developed by an industrial partner for whom LERTIM team members acted as expert consultants. It was used to process the results of the European STAR project involving health scientists from several countries (France, United Kingdom, Ireland, Italy and the Netherlands). EasyCare was designed to provide modelling and implementation tools for an information system that describes health supplies in a given area (region, country, continent (Europe)). This supply system is open to both laymen and healthcare professionals via querying and navigation applications. The results are:

- a conceptual model,
- a telematics infrastructure for continuity of care,
- navigation tools within resources,
- available health services within a geographical area,
- communication and information services.

Its first application is a "Yellow Pages" service for health professions.

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## Health Information systems

L. Weed [20] said "We would all like to live in a society where the logic and actions of everyone are based on the best available knowledge and analyses of the day"; but we know that this does not happen most of the time. To meet this objective, the designers of new-generation hospital information systems must be compelled to effectively couple medical knowledge and action. Our group is working on architectures and models for better integration of standardised knowledge in health care information systems.

## Bio-statistics and clinical research

A LERTIM research group, composed of methodologists and bio-statisticians, commonly handles clinical or public health studies on request by

healthcare practitioners. We provide physicians with methodological advice for their research design and the statistical analysis of their data. We are associated usually as authors in the resulting, indexed articles.

Two fields are currently being prioritised. The first one is a fundamental study on survival data analyses and models undertaken in cooperation with McGill University in Canada, and the Faculty of Dijon in France. The second one is related to melanoma in cooperation with dermatology experts [21-22].

The first research tasks mainly cover survival analysis and, particularly, relative survival analysis. We performed an assessment of the two relative regressive survival models frequently used (Hakulinen's and Esteve's method) and gave practical advice to users. We also developed two new relative regressive survival models: the first one uses B-spline functions to accommodate the variation of prognostic factors over time, and the second one, which is being assessed, is based on Markov Chain's Monte Carlo methods applied to perform relative Bayesian survival analyses.

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## Conclusion

Modern, quality-oriented medicine requires rational management of medical information. The goal of the medical informatics graduation program is for students to learn how to analyse and evaluate health care information and related systems. One must train those students in the daily use of information technologies in the clinical environment. These courses should help students improve the quality of their healthcare using these technology resources.

We shall continue, on the one hand, to focus our research on various areas including integrated systems, decision support and clinical informatics and, on

the other hand, to strengthen the bio-statistics research groups. Our aim is to enhance cooperative medical informatics research projects between our own group and other national and international institutions.

## Acknowledgement

The authors wish to thank all current and past members of the department for their contributions.

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