Education and Training

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Graduate Programs in Medical Informatics at the Paris Universities

Abstract: Most medical schools in France have chairs in Biostatistics and Medical Informatics to coordinate the teaching of these two disciplines both within the regular curriculum of the medical studies and as a specialized teaching. This paper describes the current medical informatics specialized program offered at the Paris Universities. Since 1968 the program has comprised a Master of Science and a Ph.D. degree. At the Master Level, despite several reforms and in-depth program revisions, the curriculum is still organized as a set of modules of 100 hours teaching with a large freedom for the medical faculties to define the contents of the courses and for the students to organize their studies and combine medical informatics, biomathematics and biostatistics training. Since 1990, an intensive one-year full-time course is offered, called Advanced Study Diploma in Medical Informatics, which is strongly research oriented. This program seems a good strategy to form medical informatics specialists who have initially received a broader education in informatics and statistics.

1. Historical background

The University of Paris has a long tradition in medical informatics teaching. After two sets of conferences organized by Professors François Grémy, Rinaldo Alfiéri and Jean-Claude Pagès in mid 1965 and 1966, the first dedicated yearly teaching in medical computing was organized at the Paris New Faculty of Medicine in November 1966 (see Figure 1).

In 1967, a national teaching framework called Human Biology Study and Research Cycle (Cycle d'Etudes et de Recherches en Biologie Humaine) was created by the French Ministry of Education. The curriculum was open to students who had completed at least two years of medical, pharmacy, or veterinary studies but also to students with a master in sciences, to engineers and to dentists. The Master's Degree in Human Biology was obtained after validation of six modules of 100 hours each. Students could then follow a two-year advanced program called Diploma of Study and Research in Human Biology (Diplome d'Etudes et de Recherches en Biologie Humaine or DERBH) including two years of full-time research activity in a reference laboratory, the validation of additional mandatory teaching and a diploma thesis. Students could then prepare a State Doctorate Thesis (3 to 5 additional years). Two informatics modules (general informatics and informatics applied to medicine) and two statistics modules were necessary to obtain the Master degree in Informatics and Statistics [1,2].

In 1968 the Paris Faculty of Medicine was split into 10 schools of medicine affiliated to one of the 13 Paris universities. Pitié-Salpêtrière School of Medicine was the first in Paris to be accredited for teaching Medical Informatics. Similar teaching was progressively organized in Bordeaux, Clermont-Ferrand, Lyon, Marseille, and Nancy [2].

In 1979, three additional Master modules were created: micro-computing, medical decision, and advanced medical informatics, giving students the opportunity to devote most of their Master's training to medical informatics.

UNIVERSITE DE PARIS — FACULTÉ DE MEDECINE

Année scolaire 1966-1967

CHAIRE DE BIOPHYSIQUE

Professeurs A. DOGNON et A. DJOURNO

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Le Centre de Calcul et de Statistique organise un enseignement sur les :

TECHNIQUES DU TRAITEMENT DE L'INFORMATION

Cet enseignement comprendra trois parties :

— **Fonctionnement des machines informatiques.**

● Description technologique des Machines informatiques.
● Langages de Programmation : langage machine, langages symboliques, langages évolués.
● Systèmes d'exploitation : programmes de service, assembleurs, compilateurs, moniteurs et superviseurs.

— **Cours de programmation FORTRAN** et notions de calcul numérique.
Cette partie comprend des Travaux pratiques.

— **Principales applications médicales des machines informatiques.**

Un examen récapitulatif aura lieu à la fin de l'enseignement. Celui-ci aura lieu au premier semestre, les mardi et vendredi de 17 h 30 à 19 h 30, Salle K, 1er Etage, à la Nouvelle Faculté. Le premier cours aura lieu le mardi 15 Novembre 1966.

Au second semestre auront lieu des enseignements spécialisés consacrés cette année à la **Théorie de l'information** et à **l'Analyse des signaux neuro-physiologiques.**

DROITS D'INSCRIPTION : **50 francs**

L'inscription a lieu l'après-midi entre le 1er et le 15 OCTOBRE 1966 au Centre de Calcul et de Statistique — Nouvelle Faculté — 1er étage, porte T 133 — (Mme PIERCY) Téléphone : BABylone 00-71, poste 268

Paris, Imp. Administrative Centrale, 8, rue de Furstenberg (4?)

Le Doyen de la Faculté : **Georges BROUET.**

Figure 1. First medical informatics curriculum at the University of Paris.

Table 1 shows the number of medical informatics modules validated since 1968 at the Pitié-Salpêtrière School of Medicine. From 10 to nearly 90 students per year validated in the General Informatics module and from 10 to 20 students per year validated the Applied Informatics module. Thirty students completed the full curriculum up to the State Doctorate degree.

In 1988, university curricula were fully revised at a national level and a new framework for biostatistics and medical informatics was designed, including a Master and a Ph.D. level. The current framework and its application are described in the following sections.

Module	[1968 - 1969]	[1970 - 1979]	[1980 - 1987]	Total
General Informatics	21	201	634	856
Informatics applied to medicine	21	123	136	280
Micro-informatics	0	9	66	75
Medical decision making	0	0	62	62
Advanced medical informatics	0	0	35	35

Table 1: Number of students who validated in the different medical informatics modules of the Master Degree in Human Biology at the Pitié-Salpêtrière School of Medicine in Paris.

2. The Current Specialized Medical Informatics Curriculum at the ParisUniversities

2.1 The Master's Degree in Biological and Medical Sciences

The Master's degree of Medical and Biological Sciences (Maîtrise de Sciences Biologiques et Médicales) consists of 3 certificates of 100 hours each, called C1, C2 and C3. Certificates are open to students who have completed their first year of medical, pharmacy, dental or veterinary studies. The Master's degree can be delivered after completion of the second cycle of the main studies (i.e., after six years for medical students) and validation of three Master certificates. Two of the 13 Paris universities have been accredited to organize a specialized curriculum in medical informatics, the

University Pierre & Marie Curie (or Paris VI University) with teaching at the Pitié-Salpêtrière and Broussais-Hôtel-Dieu schools of medicine and the University René Descartes (or Paris V) with teaching at Cochin-Port-Royal and Paris-Ouest schools of medicine.

* The "Statistics, informatics and modelling", C1, certificate is a common trunk for the Master's degree in Informatics and Statistics. It introduces technological informatics (i.e., 40% of the certificate), probabilities, statistical methods and biomathematics used in physiology and pharmacology. Basic hardware and software concepts are presented. Students need to learn and practice a programming language.

* The "Informatics", C2, certificate is entirely devoted to medical informatics. Part I concerns the methodology of development of medical applications; Part II is de-

voted to the different application domains and Part III to the achievement of a small project in a hospital environment.

* The "Methods in clinical research and epidemiology", C2, certificate of the Paris VI university consists of three parts with a strong medical informatics contribution. Part I is devoted to nomenclatures, coding and archiving systems; part II to medical decision support systems, and part III to methods in epidemiology and evaluation of health systems.

There is not *a priori* selection, except for the prerequisite entry level, but there is a relatively strong selection for this kind of teaching with success rates between 20 and 40%. Table 2 summarizes the flow of students through the three corresponding certificates for the five school years from October 1989 to September 1994.

Certificate	C1 Statistics, informatics & modelling	C2 Methods in clinical research	C2 Informatics
Teaching location	Paris V, VI	Paris VI	Paris V, VI
Percentage of teaching devoted to medical informatics	50%	66%	100%
Nb. of registered students (1989-94)	697	180	151
Nb of validated certificates (1989-94)	266	42	42
% of success	38%	23%	28%

Table 2: Flow of students in the Master of Medical and Biological Sciences, during the five school years from October 1989 to September 1994.

2.2 The Advanced Study Diploma in Medical Informatics

The Advanced Study Diploma in Medical Informatics (Diplome d'Etudes Approfondies) was created in 1990 by the initiative of the Paris V (Prof. B. Auvert, Prof. M. Goldberg and Prof. A. Venot), Paris VI (Prof. P. Degoulet) and Rennes I (Prof. P. Le Beux) universities. It is a one-year full-time training, preparing students to perform research in the field of medical informatics. The Diploma is jointly organized by the three universities but has a national dimension since teachers from major French Medical Informatics departments participate in the courses and/or receive students in their laboratories, including departments in Angers, Dijon, Lille, Marseille, Montpellier and Rennes. There is a beginning of Europeanization with the active participation of Bari University (Italy) in the courses and the exchange of students via Erasmus grants. The curriculum is open either to physicians, pharmacists, dentists or veterinarians with a Master's degree of Medical and Biological Sciences (as defined above) or to graduated students with a Master degree of Sciences or an Engineering degree. Since the number of students is limited to 20, a priori selection is high, based on the curriculum vitae of the candidates and their state of knowledge and motivation, which are appreciated during an interview with one of the three Diploma coordinators.

The teaching program consists of two parts. Part I, from October to March, consists of 270 hours of medical informatics teaching through direct teacher/student interaction. The program is divided into modules of 25 to 30 hours. The main topics include: logical reasoning and programming, knowledge representation, software engineering and component based development, expert systems and medical decision analysis, medical image processing, signal analysis, medical applications of numerical simulation

and modelling, neural networks applications, and groupware developments and applications. The knowledge control of the student is focused on brief practical projects concluded by a project dissertation and an oral presentation of the work achieved.

Part II, from April to October, consists of a six-month full-time research training in an accredited medical informatics laboratory. During this training the student remains under the responsibility of a full-time teaching Ph.D. acting as diploma tutor. A diploma tutor cannot accept more than one student per term. At the end of the term the student must complete a diploma thesis (structured as an article to be submitted to a peer review journal plus technical annexes on the design, on the problems encountered in the analysis or implementation and on the solutions proposed). Results are presented orally in the form of a scientific communication in the plenary October session that concludes the term. Since 1990, 81 students have been selected from 301 applicants (27%) and they have entered the curriculum. Among them were 40 graduated physicians, 4 pharmacists, 2 veterinarians, while the remaining 35 were either engineers or students graduated from scientific curricula; 74% originated from France and 26 from foreign countries. The high success rate which is observed (almost 90%) can be directly related to the strict selection process employed.

A similar program is offered at the Saint-Antoine School of Medicine of the University Paris VI for students who want to specialize in Biomathematics (Prof. A.J. Valleron) or at the Paris-Sud School of Medicine of University Paris XIII for Biostatistics (Prof. J. Lellouch).

2.3 The Ph.D. thesis in Medical Informatics

Twenty-two students who successfully received the Diploma have entered into the Ph.D. program. The duration of the Ph.D. program is 3 to 4

years in an accredited laboratory under the responsibility of a Ph. D director. The Ph.D. director must be a full-time professional in medical informatics. Student direction is limited to one (occasionally two) students per director. Publication of a minimum of two papers in peer-review journals of the discipline is a prerequisite beside the redaction of the Ph.D. dissertation before the oral thesis presentation and discussion. Students with an Advanced Study Diploma in Biomathematics or Informatics can also be accepted in the Medical Informatics Ph.D. program.

3. Basic Medical Informatics Teaching

Teaching of biostatistics is mandatory within the first cycle of medical studies (i.e., during the first two years). For medical informatics this is not yet the case in all schools of medicine. Medical faculties frequently offer an optional teaching module in medical informatic of 15 to 30 hours to be followed during the second cycle of medical studies (year 3 to 6 of the second cycle).

4. Discussion

The graduate student program in medical informatics at the Universities of Paris was initiated nearly 30 years ago. Despite various reforms of the French education system, several characteristics remained constant and need to be emphasized. The program has always been organized into two main streams. The first stream called the Master's level relies on a broad understanding of information sciences and processing that includes informatics, biomathematics and statistics, a strategy also followed in the Utah and Heidelberg/Heilbronn curricula [3,4]. The program is organized in modules that the students can validate

at their convenience. It is primarily open to students in medicine or pharmacy but also to dentists or veterinarians. We believe that the broad scope of initial information, the wide audience and the flexibility in following the curriculum which is offered to students, are necessary conditions to trigger interest and to help the students to decide on their future specialization and to obtain open-minded specialists [5].

The second stream now called Advanced Study level requires a full-time study and research activity in an accredited Medical Informatics laboratory with direct interaction with professionals of the domain. In the period 1968-88, the teaching load (600 hours plus two full-time years in a research laboratory) was probably too high for students with a medical diploma, a master's in sciences or an engineering degree. It probably explains the relatively small number of students who completed the full curriculum up to the State Doctorate level. The current situation of the French Advanced Study level in medical informatics is closer to the international understanding of what a Master's degree in medical informatics should mean [6] and this will facilitate the training of the professionals who are now required by the development of the discipline both within the public and private sectors.

Among the four recommendations to health-care policy makers and academic administrators that were issued at the end of the 1983 Chamonix (France) meeting on informatics & medical education of IMIA WG 4, the last two must be remembered: "(3)

Teach informatics in medicine to all health professionals; (4) for all health professionals, examine on informatics in medicine at the local and national levels as appropriate" [7]. We still believe that these are valid and we would only replace, with many others, Informatics and Medicine by Health Informatics [8,9]. But looking at the future of health informatics, it is relevant to wonder which meaning is to be given to the word "informatics": computer sciences, which is often oriented towards the technological aspects, or more preferably information sciences, which insists more on the content and the aim than on the tool. The role of informatics in human understanding, human decision making and human interaction needs to be investigated further. How can the syntactical and automatic handling of physical symbols represent human reality, essentially of semantic nature, should be supported. What can and may be formalized in human thinking, and what are the theoretical and operational limits of the formalization? The techniques of computers and information networks are exploding but in the man-machine coupling, we must not forget that the former is the main component. Informatics progress implies deeper and deeper reflections on epistemology, on psychology of human interaction, on decision and action, on sociology of organizations and, finally, on philosophy. This effort is especially necessary when one has to deal with one of the main values for mankind, that is part of human happiness: health.

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