

# Special themed issue: Education in clinical chemistry and laboratory medicine in various European countries

## The organization of an educational program for specialists in Clinical Chemistry by the Greek Society of Clinical Chemistry-Clinical Biochemistry

Demetrios Rizos<sup>1\*</sup>, Photini Karababa<sup>2</sup>, Angeliki Sarandakou<sup>1</sup>, Othon Panagiotakis<sup>3</sup>, Alexander Haliassos<sup>4</sup>, Konstantinos Makris<sup>5</sup>, Katerina Psarra<sup>6</sup>, Eleni Bairaktari<sup>7</sup>, Panagiota Spyropoulou<sup>8</sup>, Chara Nikolou<sup>9</sup>, Nikolaos Galiatsatos<sup>10</sup>, Nikolaos Trakas<sup>11</sup>, Angeliki Ferderigou<sup>12</sup> and Konstantin Seferiadis<sup>13</sup>. (Greek National Clinical Chemistry Registration Commission)

<sup>1</sup> Hormone Laboratory, "Aretaieion" Hospital, Athens, Greece

<sup>2</sup> Certification body TUV Hellas, Athens, Greece

<sup>3</sup> Department of Clinical Biochemistry, "Evangelismos" General Hospital, Athens, Greece

<sup>4</sup> Greek External Quality Assessment Scheme (ESEAP), Athens, Greece

<sup>5</sup> Department of Clinical Biochemistry, "KAT" General Hospital, Kifissia, Greece

<sup>6</sup> Department of Immunology- Histocompatibility, "Evangelismos" General Hospital, Athens, Greece

<sup>7</sup> Laboratory of Clinical Chemistry, Medical School, University of Ioannina, Ioannina, Greece

<sup>8</sup> Blood Bank, "Tzaneion" General Hospital, Piraeus, Greece

<sup>9</sup> Research Center for the Certification of Biological Material (EKEVYL), Athens, Greece

<sup>10</sup> Department of Clinical Biochemistry, "Hippocrateio" Hospital, Athens, Greece

<sup>11</sup> Department of Clinical Chemistry, "Sismanoglio" General Hospital, Athens, Greece

<sup>12</sup> Department of Clinical Biochemistry, "Agios Savvas" Hospital, Athens, Greece

<sup>13</sup> Medical School, University of Ioannina, Ioannina, Greece

\*Corresponding author: [drizos@aretaieio.uoa.gr](mailto:drizos@aretaieio.uoa.gr)

### Abstract

In Greece, there is no officially organized training in clinical chemistry for scientists. The Greek Society of Clinical Chemistry-Clinical Biochemistry decided to organize an intensive educational program of 18 seminars on clinical chemistry content as it is described in the EC4 Syllabus.

The duration of each seminar was about 6 hours and consisted of 6 to 9 lectures. At the end of each seminar there was a voluntary written examination, comprised of 24 multiple choice questions. Successful completion of the Educational program was leading to a Certificate of Competence.

Two cycles of the 18 seminars were performed: 1st cycle from October 2003 to December 2005 and 2nd cycle from March 2005 to October 2007. One hundred eighty nine colleagues was the mean attendance per seminar for the seminars of the 1st cycle and 38 colleagues for the seminars of the 2nd cycle. The mean participation to the examination for each seminar was almost 80% for the 1st cycle and 68% for the 2nd cycle. More than 80% of the participants performed *Good* or *Very good* in the examination in both cycles.

It is estimated that more than 40% of the scientists who practice Clinical Chemistry in Greece, participated to this educational activity. This program is now provided as an e-learning application, and it is open for all scientists who want to follow the discipline of clinical chemistry.

**Key words:** clinical chemistry; education; Register; EC4

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## Introduction

The Greek Society of Clinical Chemistry-Clinical Biochemistry (GSCC-CB) was founded in 1989 by scientists who were working in the clinical laboratories in the state hospitals of Greece. The Society has been a member of the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) since 1994 and also a member of the European Federation of Clinical Chemistry and Laboratory Medicine (EFCC) and the European Communities Confederation of Clinical Chemistry and Laboratory Medicine (EC4). Almost 90% of the Society members are of scientific background (chemists, biochemists, biologists), but there are also a 7% of medical doctors, specialized in Biopathology or Clinical Chemistry.

In Greece, the specialty of Clinical Chemistry and Laboratory Medicine is not officially recognized for scientists. Although in 1973 the Greek State passed a law (law 131/1973) that was introducing the Clinical Chemistry specialty for scientists (chemists, biologists, biochemists, pharmacists), this law was never implemented due to the strong opposition of the medical Biopathologists (formerly named Microbiologists) and therefore, officially organized education and training in clinical chemistry for scientists was never introduced in Greece (1,2). The clinical chemistry labs of the public hospitals in Greece are staffed almost exclusively by scientists while medical Biopathologists are working mainly in the microbiology or hematology labs of the hospitals. There are about 180 public hospitals and health centers of various sizes in Greece. The small size hospitals have usually one central laboratory that is doing microbiology, hematology, biochemistry and immunology while the bigger hospitals have separate specialized laboratories. In the private sector there are more than one thousand diagnostic centers and laboratories, usually of small to very small size.

## The Educational program of the GSCC-CB

In 2002, after the encouragement and help by the Registration Commission and the Board of EC4, the Board of the GSCC-CB decided to start a voluntary

Register for specialists in clinical chemistry, aimed to accomplish the following goals:

- to provide high standards of professional education and practice in clinical chemistry in Greece, equivalent to those of the other European countries;
- to provide the possibility for each member to register in the European Register for Clinical Chemists and thus, facilitate the free movement of scientists within the European Union;
- to contribute to the improvement of the quality of laboratory results in clinical chemistry and as a consequence to promote the public health services; and
- to strengthen the efforts towards the recognition of the specialty of clinical chemistry in Greece.

The main problem that the GSCC-CB had to solve in the process of establishing the Register in Greece was the lack of proper and official education and training for scientists that had been working for many years in the State or private clinical laboratories. Many of them had as many as 20 years of service. In order to overcome this situation the Board of the GSCC-CB decided to organize an intensive educational program for all the colleagues, independently of their professional experience.

## Organization of the educational program

The educational program comprised of a series of 18 seminars each one dedicated to a different part of the clinical chemistry content as it is described in the EC4 Syllabus (3). The responsibility for the organization of the seminars was assigned to a Scientific and Educational Committee (SEC) appointed by the Board and voted by the general assembly of the Society. The SEC was responsible for choosing a coordinator for each seminar who, in collaboration with the SEC, was liable for the scientific program of the seminar, the choice of the speakers and the examination. The duration of each seminar was about 6 hours and consisted of 6 to 9 lectures (presentations). Each speaker had to provide an extended text of 10 to 15 pages, of his/her lecture. The texts were edited by the coordina-

tor and the SEC and were published in print as a separate volume (book) for each seminar, which was available to all participants on the day of the seminar. The texts were also available on the internet, through the web page of the Society, at least 10 days prior to the date of the seminar. Access to the texts was limited only to those who had confirmed attendance in that particular seminar.

## Written examination

At the end of each seminar there was a voluntary written examination which comprised of 24 multiple choice questions. The questions were proposed by the speakers and the coordinator had the responsibility for the final choice. For each participant, the attendance to the seminar and the performance in the examination were graded up to a maximum grade of 10 points. Successful completion of the Educational program was leading to a Certificate of Competence under the following prerequisites:

- attendance of at least 14 out of the 18 seminars (78%);
- total examination score of at least 60% of the possible maximum score (180 points).

## Statistics of the educational program

Two cycles of the 18 seminars were completed. The first cycle started in October 2003 and ended in December 2005. In March 2005 a second cycle of the same seminars was started and ended in October 2007. The titles of the 18 seminars as well as the titles of the topics presented in each seminar are shown in Appendix A.

The seminars were attended by both, members and non-members of the GSCC-CB. The non-members of the GSCC-CB were holding at least a four years university degree in chemistry, biology or biochemistry. One hundred eighty nine colleagues was the mean attendance per seminar for the seminars of the 1st cycle. One hundred forty six (77%) of them were members of the GSCC-CB and 43 (23%) non-members. The mean attendance per seminar for the seminars of the 2nd cycle was 38

colleagues of whom 19 (50%) were members and 19 (50%) non-members of the GSCC-CB (Table1).

**TABLE 1.** Mean number of colleagues who attended the seminars of the 1st and 2nd cycle, participated to the examination and had a successful examination.

	<b>Total participation N</b>	<b>Participation to examination N (%)</b>	<b>Successful examination N (%)</b>
1st cycle	189	150 (79.4%)	148 (98.7%)
2nd cycle	38	25 (67.6%)	24 (96.0%)

The mean participation to the examination for each seminar of the 1st cycle was almost 80% and the vast majority of the participants (98.7%) passed the examination. For the seminars of the 2nd cycle, the mean participation to the examination was lower (67.6%) but with the same high success rate (96%).

Five hundred colleagues (277 members and 223 non-members of the GSCC-CB) attended at least one seminar of the 1st or the 2nd cycle. Eighty nine members of the Society (32.1%), attended almost all the seminars (16-18 seminars) while 169 members (61%) attended at least 10 seminars. The greatest percentage of the non-members (152; 68.2%) attended 1-3 seminars (Table 2).

**TABLE 2.** Number of seminars attended by the members and non-members of the Society

<b>Number of Seminars</b>	<b>Members N (%)</b>	<b>Non-members N (%)</b>	<b>Total</b>
1-3	60 (21.7)	152 (68.2)	212
4-6	22 (7.9)	23 (10.3)	45
7-9	26 (9.4)	2 (0.9)	28
10-12	26 (9.4)	6 (2.7)	32
13-15	54 (19.5)	18 (8.0)	72
16-18	89 (32.1)	22 (9.8)	111
Total	277	223	500

The performance of the participants in the written examination is presented in Table 3. According to the number of the correct answers, the performance was characterized as: *Fail* (less than 12 correct answers), *Fair* (12-16 correct answers), *Good* (17-20 correct answers) and *Very Good* (21-24 correct answers). The members of the Society had a better performance than the non-members in both cycles. More than 90% of the members and more than 80% of the non-members performed "Good" or "Very good" in both cycles.

One hundred fifty four presentations were given during each cycle of the educational program (about 7 to 9 presentations per seminar) by 109

speakers. Forty eight of them were medical doctors, 55 were of scientific background (chemists, biologists, biochemists, clinical chemists) and 6 were scientists of various specialties. Thirty six of the speakers were holding academic appointments (lecturers, assistant, associate and full professors) while 66 were professionals working in Hospital laboratories.

In each seminar, participants filled in a questionnaire for the evaluation of the seminar. Sixty participants per seminar on average filled in this questionnaire. About 78% of the responders declared *Satisfied* or *Very Satisfied* about the content as well as the organization of the Seminars.

**TABLE 3.** Percentage of members and non-members of the Society who failed, performed *Fair*, *Good* or *Very Good* in the written examination in the two cycles of the educational seminars.

		Performance (number of correct answers)			
		Fail (<11)	Fair (12-16)	Good (17-20)	Very Good (21-24)
1st Cycle	Members	0.6	8.3	36.3	54.9
	Non-members	3.3	19.2	44.2	33.3
2nd Cycle	Members	1.3	7.5	31.8	59.4
	Non-members	2.9	14.6	36.9	45.6

## Discussion

According the presented statistics, the two cycles of the educational seminars of GSCC-CB should be considered very successful. It is estimated that more than 40% of the scientists who practice Clinical Chemistry in our country, participated to some extent to this educational activity. This successful massive educational activity of the Greek Society raised the scientific level of clinical chemistry professionals in our country and had also a positive impact on the level of laboratory medicine services provided in our country. The series of the 18 seminars in a two-year period raised an enthusiasm among the colleagues, since they had the opportunity to cover again most of the discipline of clinical chemistry and their participation strengthened their professional confidence.

This educational activity and the general efforts of GSCC-CB as well, for the establishment and operation of the Greek Register were positively evaluated by the EC4. In its November 2005 meeting in Prague the EC4 Registration Commission decided, after voting among the European countries, that the standards of the Greek Register were equivalent to the standards of the European Register (4,5). Today, the Greek Register has 218 members and more than 80 of them have become members of the European Register.

The educational program is now provided by the GSCC-CB in the form of distance learning. All the educational materials (texts, presentations and additional information) of the seminars are available on-line through the web-site of the Society orga-

nized as an e-learning application. Anyone who wants to participate to the program can have access to the application with a password. The written examination is organized twice a year under the responsibility of the Greek National Clinical Chemistry Registration Commission. The GSCC-CB encourages all the young scientists who enter the field of laboratory medicine to follow this educational program and also to follow the on-the-job

training according to the log-book provided by the GSCC-CB.

In conclusion, the GSCC-CB has successfully introduced an educational program in clinical chemistry for the first time in Greece, through the organization of two cycles of 18 seminars. This program is now provided as an e-learning application and it is open for all scientists who want to follow the fascinating discipline of laboratory medicine and its sub-disciplines.

## Appendix A: Titles of the 18 seminars and titles of the topics presented in each seminar

### 1st Seminar: Analytical evaluation of laboratory methods and data

- Guidelines and implementation of a quality control system for medical laboratories
- Principles of biostatistics I
- Principles of biostatistics II: Introduction to regression analysis
- Pre-analytical and meta-analytical factors affecting the variability of biochemical parameters
- Analytical errors and their determination
- Characteristics and evaluation of analytical methods
- Uncertainty and traceability in clinical chemistry
- Setting quality goals in clinical chemistry

### 2nd Seminar: Quality Control and Quality assurance

- The basic planning for quality
- Reference materials and methods
- Internal quality control - Control charts – Methods of a single rule
- Internal quality control - Westgard multi-rule control charts
- Internal quality control - Facing the out of control situations
- Assessment of quality control methods – Power curves
- Other methods of internal quality control

- External quality assessment schemes

### 3rd Seminar: Clinical Assessment of Laboratory results

- Introduction – Basic principles of epidemiology
- Reference values
- Diagnostic sensitivity and specificity
- Cut-off limits - Receiver Operating Curves (ROC)
- Bayesian methods – Calculation of a-posteriori odds
- Methodological principles of medical research

### 4th Seminar: Carbohydrates

- Structure and metabolism of carbohydrates. Blood glucose homeostasis
- Diabetes mellitus (pathogenesis-classification-diagnostic criteria- epidemiology-metabolic syndrome)
- Determination of glucose in body fluids. Glucose tolerance test. Glycated-haemoglobin
- Determination of pancreatic hormones and peptides. (Pro-insulin, Insulin, C-Peptide and Glucagone)
- Hereditary and acquired metabolic diseases
- Diabetic ketoacidosis and hyperosmosis
- Diabetes mellitus – macro and microvascular complications.
- Detection of antibodies against GAD65 and IA2



- Pathogenesis of type 1 and type 2 diabetes mellitus. Gene Therapy
- Advanced glycation end-products (AGEs)

#### **5th Seminar: Lipids-Lipoproteins**

- Structure and metabolism of lipids
- Structure and metabolism of lipoproteins
- Apolipoproteins: biochemistry, metabolism, clinical significance
- Primary dislipidaemias
- Current strategies for the management of dislipidaemias
- Current guidelines for laboratory diagnosis of dislipidaemias
- Laboratory tests for the determination of lipid parameters in human blood
- Laboratory measurement of the non classic parameters for dislipidaemias
- Evaluation and clinical significance of molecular tests for three well-known genes (LDR-R, Apo B, Apo E).

#### **6th Seminar: Proteins-Amino acids**

- Proteins: Structure, properties and importance
- Protein metabolism in health and disease
- Methods of protein determination
- Amino acids. Metabolic diseases
- Proteomics. New frontiers in protein research
- Qualitative and quantitative analysis of amino acids
- Dysproteinaemias – Paraproteinaemias
- Evaluation of laboratory determinations of proteins

#### **7th Seminar: Acid-base balance, Electrolytes**

- Historical review
- Oxygen and carbon dioxide transport
- Introduction to acid-base balance
- Evaluation of anion gap
- Respiratory compensation of metabolic disturbances
- Renal compensation of respiratory and metabolic disturbances
- Water and electrolytes balance
- Clinical evaluation of laboratory results for blood gases

#### **8th Seminar: About enzymes**

- Introduction to diagnostic enzymology
- Mechanisms and kinetics of enzyme-catalyzed reactions
- Regulation of enzyme activity
- Clinical goals for laboratory enzyme measurements
- The enzymes as reagents
- Laboratory measurement of enzyme activity
- Laboratory measurement of iso-enzymes
- Correct laboratory practice for enzyme measurements

#### **9th Seminar: Liver function and digestive tract**

- The anatomy of the liver
- Liver functions
- Laboratory tests related to liver function
- Jaundice
- Viral hepatitis
- Non-viral liver diseases
- Liver transplantation
- The physiology of stomach, pancreas and intestinal secretion
- Diagnostic approach of gastrointestinal disorders

#### **10th Seminar: Heart and circulatory system**

- Physiology of the cardiovascular system
- Pathology of the cardiovascular system
- Developments in the laboratory prognosis of cardiovascular disease
- Laboratory diagnosis of acute myocardial infarction
- Developments in laboratory diagnosis of heart failure
- Markers of hemostasis activation in cardiovascular syndromes
- Hereditary and acquired thrombophilia

#### **11th Seminar: Renal function**

- Anatomy of the kidneys
- Pathophysiology of the kidney function
- Laboratory tests for the assessment of renal function
- Urinalysis

- Markers of proteinuria
- Clinical evaluation of laboratory tests for renal function

### 12th Seminar: Immunology topics

- Structure of the immune system
- Immune system cells
- MHC – Structure
- MHC – biologic role
- Autoimmunity: Mechanisms - Diseases
- Complement: Description - Diseases
- Immunoglobulins: Description - Diseases
- Monoclonal antibodies
- Flow cytometry - general principles
- Flow cytometry – applications
- High throughput technologies and after-ELISA times

### 13th Seminar: Haematology topics

- Basic topics of erythropoiesis
- Approaching the diagnosis of anaemia
- Physiology and pathology of Iron metabolism
- Laboratory diagnosis of Hemoglobinopathies
- Haematological malignancies
- Haemostasis mechanism
- Laboratory investigation of haemostasis disorders
- Principles of transfusion therapy

### 14th Seminar: Neoplasias-Cancer markers

- Cancer as a biological phenomenon. Mechanisms of carcinogenesis. The role of angiogenesis
- Receptors of steroid hormones and cancer
- Cancer markers: general characteristics, classification, laboratory methods
- Cancer markers in serum (Enzymes, Hormones, Antigens, Proteins)
- Cancer markers in other body fluids. Oncofetal antigens
- The contribution of immuno-histochemistry in diagnosis and prognosis of cancer, Applications
- Evaluation of cancer markers in clinical practice

### 15th Seminar: TDM-toxicology

- General principles of drug action-Pharmacodynamics
- Drug interactions and their importance – Receptors
- Monitoring and regulation of therapeutic doses
- Laboratory methods for determination of drugs
- Immunosuppressive drugs
- Cardiac glycosides
- Pharmacokinetics of antidepressant drugs
- Antibiotics
- From the Pharmacogenetics to Pharmacogenomics

### 16th Seminar: Endocrine system I

- Hormones: secretion, metabolism and mechanism of action. The crucial role of the hypothalamus-pituitary axis
- General principles of immunoassays and their evolution through the years: from the first radioimmunoassays to the platforms of automatic analyzers
- Preanalytical factors and methodological limitations that influence the determination of hormones
- Prolactin, Growth hormone and IGF1: Production, secretion, methods of determination
- Biochemistry of steroid hormones
- Normal female menstrual cycle – Disorders
- Male: Testicular function – Disorders
- Determinations of FSH, LH and steroid ovarian hormones
- Determinations of testosterone, free testosterone and SHBG

### 17th Seminar: Endocrine system II

- Physiology of thyroid function. Clinical evaluation of thyroid parameters
- Determinations of thyroid parameters
- Hormones in pregnancy
- Diagnostic approach of the adrenal disease
- Determinations of ACTH and adrenal steroids
- Determinations of aldosterone and renin activity

- Determinations of VMA, catecholamines and metanephrines
- Hormones during neonatal life, infancy, childhood and puberty
- Fat tissue: an endocrine gland
- Quality control of hormone determinations

#### 18th Seminar: Diagnostic applications of molecular biology

- Historical review
- Structure and properties of nucleic acids
- The genetic information flow

- The DNA organization in the chromosomes. Gene structure
- Laboratory methods of molecular biology. Future prospective
- Molecular diagnosis of genetic disorders
- Molecular diagnosis of hereditary malignancies
- Molecular diagnosis of haematological malignancies
- Molecular diagnosis of virus and other pathogenic microorganisms
- Molecular techniques for the transfusion blood testing

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## Uspostava programa obrazovanja specijalista kliničke kemije u organizaciji Grčkog društva za kliničku kemiju i kliničku biokemiju

### Sažetak

U Grčkoj ne postoji službeno organizirano obrazovanje za stručnjake kliničke kemije. Grčko društvo za kliničku kemiju i kliničku biokemiju odlučilo je organizirati intenzivan program školovanja koji se sastoji od 18 seminara s područja kliničke kemije prema odrednicama *EC4 Syllabus*.

Svaki je seminar trajao oko 6 sati te se sastojao od 6 do 9 predavanja. Na kraju svakog seminara održan je izborni pismeni ispit koji se sastojao od 24 pitanja s više ponuđenih odgovora. Uspješno završenim programom obrazovanja polaznici su dobili Potvrdu o stručnosti.

Do sada su se održala dva ciklusa od po 18 seminara: Prvi je ciklus započeo u listopadu 2003. i završio u prosincu 2005., a drugi je započeo u ožujku 2005. te završio u listopadu 2007. Srednja vrijednost prisutnosti kolega na seminaru u prvom ciklusu bila je 189, a u drugom 38. Za prvi je ciklus srednja vrijednost broja izlazaka na ispite za svaki seminar iznosila gotovo 80%, a za drugi 67,6%. Više od 80% sudionika bilo je ocijenjeno s *dobrim* ili *vrlo dobrim* uspjehom na ispitima u oba ciklusa.

Procjenjuje se da je više od 40% stručnjaka koji danas rade na području kliničke kemije u Grčkoj sudjelovalo u ovom programu obrazovanja. Ovaj je program danas dostupan kao *e-learning* aplikacija te je otvoren svim stručnjacima koji žele pratiti kliničku kemiju.

**Ključne riječi:** klinička kemija; edukacija; Registar; EC4