Research Article

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Compliance of medical biochemistry education in medical schools with national core education program 2014

Tıp fakültelerindeki biyokimya eğitiminin ulusal çekirdek eğitim programı 2014'le uyumu

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Abstract

Background: Medical school curriculums are not standardized in Turkey and around the world, which results in great diversity in education. National Core Education Program (NCEP) has been prepared as a frame program and the aim of the program is to train medical doctors with basic abilities.

Objective: The objective of this work is to compare biochemistry curriculum based on NCEP among medical schools in Turkey.

Materials and methods: Twelve-question long survey was prepared. Sixty-nine out of 84 medical schools were participated the study using 2017–2018 curriculum data. Biochemistry curriculums of medical schools are compared based on NCEP 2014.

Results: Number of biochemistry hours and content of the lectures varies among medical schools. While biochemistry was intensely studied in the first and second years of the education program, biochemistry hours and number

of universities offering biochemistry have dramatically decreased after the second year. Clinical biochemistry questions had lower positive response. Accredited medical schools include NCEP subjects in their curriculum in higher ratio than the unaccredited ones.

Conclusion: Biochemistry curriculum shows variation among medical schools. Addition of clinical biochemistry beyond second year would improve NCEP adaptation. Multidisciplinary approach and vertical integration should be employed to improve quality of medical education.

Keywords: Medical biochemistry; Medical education; Clinical biochemistry; Biochemistry curriculum; National Core Education Program (NCEP); Teaching in medical school; Curriculum design development and implantation.

Öz

Giriş: Hem ülkemizde hem dünyada tıp eğitiminde standardizasyon eksiklikleri vardır. Temel bilgi ve becerilere sahip hekimlerin yetişebilmesi için hazırlanan çerçeve bir program olan UÇEP ulusal anlamda tıp eğitiminin belirli standartlara göre yapılmasını hedeflemektedir.

Amaç: Bu çalışmanın amacı Türkiye'deki Tıp fakültelerinde uygulanan biyokimya müfredatını Ulusal Çekirdek Eğitim Programı (UÇEP)'e göre karşılaştırmaktır.

Materyal ve Metot: Bunun için 12 sorudan oluşan anket formu düzenlenmiştir ve Türkiye'de bulunan 84 tıp fakültesinin 69'u ankete katılmıştır. Anket, biyokimya bölüm başkanları tarafından veya fakülte web sitelerinde bulunan 2017–2018 müfredat bilgisine dayanarak doldurulmuştur.

Bulgular: Biyokimya ders saati ve içeriği tıp fakülteleri arasında değişiklik göstermektedir. Tüm tıp fakültelerinde biyokimya ilk iki yıl yoğun bir şekilde yer almaktadır. Üçüncü yıldan itibaren hem biyokimya ders saati

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azalmakta hem de biyokimya dersini programlarına dahil eden fakültelerin sayısı azalmaktadır. Klinik biyokimya bilgisi gerektiren sorulara verilen olumlu yanıt yüzdesinin daha az olduğu görülmüştür. Akredite olan tıp fakültelerinin biyokimya eğitimi görece olarak akredite olmayanlara göre UÇEP’le daha uyumludur.

Sonuç: Elde edilen bulgular tıp eğitiminde biyokimya ders saatlerinin ve ders içeriklerinin standardize olmadığını göstermiştir. Klinik biyokimya dersinin 2. sınıftan sonra müfredata eklenmesi UÇEP’le uyumu arttıracaktır. Tıp eğitimindeki kalite dikey entegrasyonunun artması ve multi disiplinler yaklaşımıyla mümkün olacaktır.

Anahtar Sözcükler: tıbbi biyokimya; tıp eğitimi; klinik biyokimya; biyokimya müfredatı; Ulusal Çekirdek Eğitim Programı (UÇEP); tıp fakültesinde eğitim; müfredat geliştirme ve uygulama.

Introduction

Medical training is a long marathon that requires commitment, hard work and patience. Admission to medical school as well as achievement of the medical doctor (MD) diploma at the end of the journey is not easy task in any country in the world. Admission requirements, program curriculum, the length of the program, experience and knowledge acquired at the end of the program varies from country to country creating non-uniform medical education programs around the world [1, 2]. Even though it would not be rational to expect to have global standards in every medical school in the world, it is crucial to have uniform curriculum at the nation-wide level to feed the every medical student with standardized compulsory knowledge and skill before pronouncing him/her as a MD.

Since the foundation of Tıphane Cerrahhane-i Amire by Mahmut (II) in March 14, 1827, number of medical schools has dramatically increased in the past 20 years. The oldest medical school, Ankara Medical School, in Turkey was established in 1945. Ankara Medical School followed by Ege Medical School (1955) and Hacettepe Medical School (1963) [3]. Currently; there are 84 active public and private medical schools in Turkey [4, 5]. Thirteen thousand academicians are training 77 thousand MD candidates in these medical schools. While some countries such as China, India and United States of America (USA) has over 150 medical schools, and 26 countries in sub-Sahara region of Africa have only one or two medical schools in each country [5].

Medical education differs from country to country. For instance, while USA requires Bachelor’s or pre-medical degree for admission and completion of medical school

takes 4 years [6, 7]. In Germany students are accepted to medical school directly after high school and completion of the program takes 6 years [2, 6, 7].

Due to increasing demand and competition only top two percentile of the students are eligible to be admitted to medical schools in Turkey. Medical school is 6 years long, which composed of 2 years basic sciences and 4 years clinical sciences integrated curriculum.

Even superficial comparison of three different countries’ medical education reveals major disparities. There are disparities among medical schools curriculums within the same country. To be more specific, we will be focusing on biochemistry curriculum in medical schools.

Biochemistry is a fundamental discipline in the medical curriculum. Many other foundational sciences such as physiology, pharmacology, pathology, microbiology and immunology utilize biochemistry to teach their concepts. Also, biochemistry serves as a direct background for clinical problems as it perfectly links basic concepts to clinical knowledge. In clinics, increased number and diversities of biochemical tests make the role of biochemistry in diagnosis and treatment is more significant [8]. Seventy percent of the clinical diagnoses are made based on laboratory test results. Besides diagnostics, clinical biochemistry tests plays role to make decision on inpatient care, patient discharge, and/or drug treatment plans [9].

Like in the case of all other disciplines, number of biochemistry hours in the curriculum and subjects covered in biochemistry lectures and labs are quite different among medical schools in Turkey.

However, a MD should graduate from medical school with certain skills such as measurement and evaluation of blood glucose with glucometer, ordering appropriate laboratory tests and complete urine analysis and/or evaluating complete urine analysis. In addition, with recent technological advancements, it is vital to graduate MDs with basic necessary skills. All these variances indicate that standardization at nation-wide is necessary to educate MDs with basic abilities.

Therefore, Medical School Dean Counsel has initiated National Core Education Program (NCEP, a.k.a.UÇEP) in 2001. The curriculum has been revised several times and the latest version of NCEP has been released in 2014. NCEP has been prepared as a frame program and the aim of the program is to graduate medical doctors with basic abilities. NCEP does not provide any explicit guidance regarding the hours and the content of medical biochemistry. Instead, NCEP delivers information about symptoms and cases list, core diseases/clinical problem list and MD primary application list. NCEP has four main components:

(i) Purpose of medical education and national competence frame, (ii) Symptoms and cases list, (iii) Core diseases/Clinical problem list and (iv) MD primary application list [10]. In short, NCEP defines necessary skills and knowledge that a candidate has to gain before pronouncing him/her as a MD.

Since clinical biochemistry is in the center of the many disciplines and gaining more attention and importance, we aim to compare biochemistry curriculum among medical schools in Turkey. The biochemistry curriculum employed in 2017–2018 academic year in various medical schools will be evaluated based on NCEP 2014.

Materials and methods

Currently, there are 84 active faculty of medicine in Turkey. Sixty-nine out of 84 faculties were participated the study. Fifty-four out of 69 participants filled out the survey. The rest of the 15 faculties' information acquired by elaborating faculties' 2017–2018 curriculums that are published in their updated websites. Four medical schools that did not have graduates by 2018 are excluded from the study. In addition, required data from 11 faculties could not be obtained by either way. Thirty-six out of 84 faculties are accredited and 24 out of 36 were participated the study. The survey was filled out based on 2017–2018 academic year curriculum.

NCEP does not specify neither the number of lecture and laboratory hours for medical biochemistry nor the content of the lectures. Also, NCEP, does not specify any subjects such as fatty acid synthesis, protein metabolism and/or pancreas function test that are covered during the pre-clinical phase of medical education. Instead, NCEP provides Symptoms and cases list, Core diseases/Clinical problem lists and MD primary application list. Therefore, the survey questions were prepared based on MD primary application list. In this study, all these topics were included in the survey. Twelve-question long survey was prepared. Questions were generated based on the biochemistry subjects that were included in NCEP 2014.

In the survey form, 10 questions related to MD basic abilities (Supplementary info). There was a section named 'any suggestions and/or comments' for participants to write their opinions regarding biochemistry subjects that would be included in/improved NCEP. In addition, two questions related to biochemistry lecture and laboratory hours were included in the survey form in an additional table. The conducted research is not related to either human or animal use. Non-invasive research ethical committee has approved the study with ethical committee approval number 10846098-604.01.01-E.3261 on 02.11.2015.

Statistics

Statistical analysis was performed using SPSS 22.0 (SPSS Inc, Chicago, IL, USA). The results were presented in numbers and percentage with standard deviation of the mean. Chi square test was used and significance level of $p < 0.05$ was accepted as statistically significant.

Results

The survey was filled out by 69 Biochemistry Departments in different medical schools. It was seen that in every medical school, biochemistry was taught in the first and second years of the curriculum and after the third year, the number of biochemistry hours dramatically decreased (Table 1). Further evaluation has shown that starting from the third year, number of biochemistry hours as well as number of universities including biochemistry in their curriculum has dramatically decreased (Table 2). Percentage of universities offering theoretical; practical biochemistry in the third, fourth, and fifth year was (56.4%; 27.5%), (1.4%; 0%), and (1.4%; 0%), respectively (Table 2). The subjects, such as 'Complete urine analysis and evaluation (including microscopic assessment)' (97.1%), 'Obtaining biological sample using appropriate methods and on time delivery of the biological sample

Table 1: Biochemistry lecture and laboratory hours in medical schools.

Class year (n)	1st		2nd		3rd		4th	5th
	Lec (69)	Lab (69)	Lec (69)	Lab (59)	Lec (39)	Lab (19)	Lec (1)	Lec (1)
Minimum–Maximum	34–208	4–54	4–200	2–90	2–142	1–24	4	2
Average ($\bar{x} \pm \text{std}$)	89.89 $\pm$ 31.57	17 $\pm$ 11.77	56 $\pm$ 27.5	8 $\pm$ 13.53	26.33 $\pm$ 23.8	7.16 $\pm$ 5.3	–	–

Lec, Lecture; Lab, laboratory.

Table 2: Distribution of biochemistry education in the medical school curriculum.

Class year	1st		2nd		3rd		4th		5th	
	Lec	Lab	Lec	Lab	Lec	Lab	Lec	Lab	Lec	Lab
Universities (n)	69	69	69	59	39	19	1	–	1	–
%	100%	100%	100%	85.5%	56.5%	27.5%	1.4%		1.4%	

Lec, Lecture; Lab, laboratory; University (n), number of universities offering biochemistry lecture and laboratory; %, percentage of universities offering biochemistry lecture and laboratory.

to the laboratory' (82.6%), 'Application of principles of working with biological material' (89.9%) were covered by most of the universities (Table 3). On the other hand, subjects including but not limited to 'If needed, planning detailed laboratory tests' (23.2%), 'Filling out laboratory request form, (44.9%), 'Ordering appropriate laboratory tests' (53.6%) and 'Evaluation of frequently ordered test results' (55.1%) are covered by relatively small percentage

of the universities (Table 3). In addition, it was noted that roughly in 50% of universities, 'Measurement and evaluation of bleeding time' (44.9%) was included in physiology department's syllabus (Table 3). When accredited medical schools were compared to unaccredited ones based on their positive responses to survey questions, it was clear that accredited medical schools successfully implanted NCEP 2014 subjects in their curriculum (Table 4). When

Table 3: Percentage and number of universities including the subjects stated in NCEP in their curriculum.

Subjects included in NCEP 2014	Number of universities that include the subject in their curriculum (n)	Percentage of universities that include the subject in their curriculum (%)
Application of principles of working with biological material	62	89.9
Measurement and evaluation of blood glucose with glucometer	45	65.2
Measurement and evaluation of bleeding time	31	44.9
Filling out laboratory request form	31	44.9
Obtaining biological sample using appropriate methods and on time delivery of the biological sample to the laboratory	57	82.6
Complete urine analysis and evaluation (including microscopic assessment)	67	97.1
Interpretation of diagnostic and scanning test results	47	68.1
Ordering appropriate laboratory tests	37	53.6
Evaluation of frequently ordered test results	38	55.1
If needed, planning detailed laboratory tests	16	23.2

Table 4: Percentage and number of accredited and unaccredited universities including the subjects stated in NCEP in their curriculum.

Subjects included in NCEP 2014	Accredited medical schools n=24 n (%)	Unaccredited medical schools n=45 n (%)	p-Value
Application of principles of working with biological material	22 (91.7%)	40 (88.9%)	0.999
Measurement and evaluation of blood glucose with glucometer	16 (66.7)	29 (64.4)	0.999
Measurement and evaluation of bleeding time	9 (37.5)	22 (48.9)	0.999
Filling out laboratory request form	13 (54.2)	18 (40)	0.383
Obtaining biological sample using appropriate methods and on time delivery of the biological sample to the laboratory	23 (95.8)	34 (75.6)	0.046 ^a
Complete urine analysis and evaluation (including microscopic assessment)	24 (100)	43 (95.6)	0.54
Interpretation of diagnostic and scanning test results	19 (79.2)	28 (62.2)	0.243
Ordering appropriate laboratory tests	13 (54.2)	24 (53.3)	0.999
Evaluation of frequently ordered test results	13 (54.2)	25 (55.6)	0.999
If needed, planning detailed laboratory tests	7 (29.2)	9 (20)	0.576

p < 0.05 (% is given based on positive response).

the percentage of positive responses was compared, accredited medical schools percentage was higher in eight out of 10 questions. (Table 4). Among these, there was a significant difference in 'Obtaining biological sample using appropriate methods and on time delivery of the biological sample to the laboratory' between accredited and unaccredited medical schools (Table 4). The subject is covered by 95% of the accredited medical schools. On the other hand, 'If needed, planning detailed laboratory tests' is included by only 29.2% of the accredited and 20% of the unaccredited medical schools, respectively. Percentage of 'Ordering appropriate laboratory tests' question was almost equal in accredited and unaccredited medical schools.

Discussion

Accreditation is a process in which a designated authority evaluates faculty based on some well-defined standards. Accreditation supports institute to offer high quality education. In order to catch some certain standards and to be globally recognized, there is increase emphasis on accreditation of medical education in Turkey and around the world.

While accreditation is essential to catch certain quality in the medical education, graduating intern doctors with basic MD skills to practice medicine is comparably critical. In this regard, NCEP plays a key role highlighting MD primary application list without specifying subjects and lecture hours.

Content and lecture hours of biochemistry vary among medical schools in Turkey and around the world [6, 7, 11]. For instance, in the USA currently 46 out of 180 medical schools require one semester of biochemistry prior to the admission to medical school. In addition, medical school's curriculum covers clinical biochemistry topics and laboratory [11]. On the other hand, Germany employs integrated curriculum in which the biochemistry is taught during the first 2 years of education [2, 6].

Medical education in Turkey is well distinguished as well. Medical school is 6 years long period which composed of 2 years basic sciences and 4 years clinical sciences curriculum. While all the medical schools follow up the 6 years schedule, syllabus, distribution of teaching hours of subject as well as content of the subject is moderately different from one institution to another. In addition, number of medical schools has dramatically increased in the past 20 years in Turkey. There are 84 active medical schools and consequently calibration of outcome of

medical school education is becoming almost obligatory. Therefore, the latest version of NCEP has been released in 2014.

The last content of NCEP, which is MD primary application list, could be used to evaluate/compare the skills that candidates gain before receiving the MD degree. Since neither the title of subject needs to be covered in medical biochemistry nor lecture hours are specified in NCEP, each medical school's curriculum differs from each other. Consequently, there is inconsistency in biochemistry lecture and laboratory hours. For example, during the first 2 years of medical education, 100% of medical schools offers biochemistry lectures, this number decreases to 56.5% in the third year and further reduced to 1.4% in the fourth and the fifth year. Number of biochemistry hours significantly fluctuates among medical schools. For instance, in the first year of medical school, while a medical school offers 34 h of biochemistry during the first year, this number might be as high as 208 h in another institute (Table 2). Similar results are seen in the second and third year as well. The number of biochemistry hours changes from 4 h to 200 h in the second year and 2 h–90 h in the third year (Table 2). Significant difference in the biochemistry hours should be normalized in nation wide. In addition, since the border of contents of the biochemistry is not clearly drawn, other departments teach some of the subjects. For instance, in roughly 50% of the faculties, physiology departments cover 'measurement and evaluation of bleeding time'. Another similar example is for 'Measurement and evaluation of blood glucose with glucometer' and 'If needed, planning detailed laboratory tests'. While some faculties include these subjects in biochemistry curriculum, some of them include them in family medicine, internal medicine and/or emergency medicine departments.

Topics ordering an appropriate laboratory test (53.6%) and filling out a laboratory test request form (44.9%) are not covered by every medical school's current curriculum. The student should be introduced to these subjects after clinical education. Based on these findings, it can be concluded that biochemistry education in medical school does not ideally cover clinical aspects. It is definitely necessary to include medical biochemistry beyond second year of the medical school to be able to complete inadequate curriculum. Accredited medical schools include NCEP subjects in their curriculum in higher ratio from the unaccredited ones. It might be due to revision of curriculum during accreditation process. Medical schools overview and improve their curriculums using NCEP as a guide before application to accreditation. Therefore, accredited medical schools give more positive response to the NCEP related subjects. In addition, more than half

of the accredited faculties have biochemistry lectures and laboratories beyond second year in their curriculums. This issue is also related to faculty's curriculum approach. For instance, adoption of horizontal or vertical curriculum has role in the introduction of the subjects in different phases of medical school [12]. Among the survey questions, significant difference is seen 'Obtaining biological sample using appropriate methods and on time delivery of the biological sample to the laboratory' between accredited and unaccredited medical schools. However, very low positive response for 'If needed, planning detailed laboratory tests' and 'Ordering appropriate laboratory tests' (Table 4) emphasizes the importance of clinical biochemistry education in the clinical science phase of medical education.

In the USA and Germany, medical school graduates are required to take license exam to practice medicine [6]. Such an application would be supportive to NCEP and be beneficial for our country to have MDs with basic medical doctor abilities. In addition, NCEP suggests some standards for design and delivery techniques of undergraduate curriculum such as classic curriculum, blended learning technique and problem-based learning. We did not include any questions related to these subjects in the survey for this study. Elaboration of these aspects of NCEP will be completed in another study. Limited number of participants filled out comments and suggestion section of the survey. Therefore, strong conclusion from comments and/or suggestions could not be accomplished.

Last but not least, some of the comments written in the last section of the survey were very critical and might be helpful to reorganize biochemistry curriculum in medical schools. For instance, one faculty suggested that clinical biochemistry lecture would be more beneficial to students if it was offered in the fifth year of the medical schools. Many medical schools offered to add a new subject called 'pre-analytical factors/errors affecting test results' to NCEP. In addition, calculation of concentration and blood gases were the other two subjects supported to be added to NCEP. Besides, some universities applying problem based teaching strategies are also using biochemistry discussion sections in addition to biochemistry lectures.

Conclusion

While defining global standards for medical education is utopic, standardized medical education within the country is definitely fundamental. As the number of medical schools dramatically increases in Turkey,

outcome of medical training has become the main focus for authorities. Therefore, NCEP is very critical to employ for every medical school. Even though NCEP is not a standard program of medical education, it perfectly set up a framework based on outcomes of the graduates.

Based on the results obtained from the survey, it was seen that both theoretical and practical biochemistry were introduced in the first and the second years of every medical school. However, percentage of the medical schools giving biochemistry education beyond second year is dramatically decreased. Topics including 'choosing an appropriate laboratory test' and 'filling out a laboratory test request form' are not included by every medical school's current curriculum. The student should be introduced to these subjects after clinical education. Therefore, it is necessary to include medical biochemistry after the second year to be able to complete inadequate curriculum.

Establishment of connections between clinical biochemistry and clinical applications should be the major goal of biochemistry education. Strong bias about 'pure memorization is required to learn biochemistry' and/or 'biochemistry is ineffectual in the following years of medical education' should be demolished. In addition to solid knowledge, students should gain basic MD abilities as well as manner during sixth years long medical education. Therefore, the whole medical education should be taken into account and revised in a multidisciplinary way.

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References

1. Dezee KJ, Artino AR, Elnicki DM, Hemmer PA, Durning SJ. Medical education in the United States of America. *Med Teach* 2012;34:521–5.
2. Mestres-Ventura P, Becker KW. Studying medicine in Germany. *Educ Med* 2012;15:69–76.
3. Baser A, Sahin H. Ataturk'ten Gunumuze Tip Egitimi Medical Education From Ataturk to Present. *Tip Egitim Dunyasi* 2017;48:70–83.
4. 100 Tip Fakultesi Var: Bunlardan 84'u Aktif: Medimagazine. <https://www.medimagazin.com.tr/guncel/genel/tr-yok-baskani-100-tip-fakultesi-var-bunlardan-84u-aktif-11-681-73871.html>. Accessed July 2018.

5. Yekta Sarac'in Konusmasi. http://www.yok.gov.tr/documents/10279/33340450/YOK_Baskani_Sarac_Tip_Fakulteleri_Dekanlar_Konseyi_Toplantisi_Konusma_Metni.pdf/. Accessed July 2018.
 6. Zavlin D, Jubbal KT, Noe JG, Gansbacher B. A comparison of medical education in Germany and the United States: from applying to medical school to the beginnings of residency. *Ger Med Sci* 2017;15:1–12.
 7. Association of American Medical Colleges. <https://www.aamc.org/about>. Accessed July 2018.
 8. Chaney SG, Pelley JW, Seifert WE. The role and value of the basic sciences in medical education (with an Emphasis on Biochemistry). *Med Sci Educ* 2011;20:280–3.
 9. Ferraro S, Braga F, Panteghini M. Laboratory medicine in the new healthcare environment. *Clin Chem Lab Med* 2016;54:523–33.
 10. Mezuniyet Öncesi Tıp Eğitimi Ulusal çekirdek Eğitim Programı 2014.
 11. Premedical Information for Harvard Students. <https://ocs.fas.harvard.edu/files/ocs/files/premed-academic-publication.pdf>. Accessed July 2018.
 12. Atwa HS, Gouda EM. Curriculum integration in medical education: a theoretical review. *Intel Prop Rights* 2014;2:113–8.
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