1

VOLUME 2 | NO. 1 | 2014

mefanet JOURNAL

ISSN (print) 1805-9163 | ISSN (on-line) 1805-9171

Indexed in Bibliographia medica Čechoslovaca,
Bibliographia medica Slovaca
Google Scholar

mj.mefanet.cz

CONTENTS

MEFANET Journal | Periodicity twice a year | Registration code of Ministry of Culture of the Czech Republic MK ČR E 21223| ISSN (print) 1805-9163| ISSN (on-line) 1805-9171| Title abbreviation Mefanet J | Publisher Facta Medica, Ltd., Srbská 2186/19, 612 00 Brno, Czech Republic, Company identification number 28298110, GSM +420 737 985 593, +420 737 287 512; email fama@fa-ma.cz | Editor-in-charge Boris Skalka | Graphic design and typesetting Radim Šustr (Institute of Biostatistics and Analyses, Faculty of Medicine at Masaryk University, Czech Republic) | Composed in Skolar, typeface designed by David Březina in 2011 | On-line version available at WWW <http://mj.mefanet.cz/>

PREFACE

Let me welcome readers of the second volume of the "MEFANET Journal (Mefanet J)", which was launched in June 2013, and thank all those readers who sent us comments on the first volume comprising two maiden issues (June 2013, December 2013). This journal has been envisioned and founded to represent the growing needs of computational science as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations in medical education. Now we are about to ramp up the publication of the second volume, which will again comprise two issues, consisting of around eight original articles – complemented by useful tutorials and editorials. A stream of quality manuscripts has been quite steadily arriving at the publisher's online peer-review system (Open Journal System), enabling regular biannual publication of the journal.

This editorial touches on three original articles, one reviewed tutorial and another editorial material published in the current issue. The reviewed tutorial by M. Švída & J. Majerník deals with tools and techniques used to manage secured data access on external data storage devices. Hospital information systems address the data security and protection at least at the level of authorized users, but many problems will arise if external sources of data are used, e.g., in educational or research activities. This tutorial aims to increase the awareness in this area and comes up with an introduction to well-proven ICT tools, such as TrueCrypt or KeePass. The original research article by M. Mateják explores physiology programming with Modelica. The author discusses the use of various solvers and toolboxes for Modelica, such as Dymola, OpenModelica or JModelica and presents Physiolibrary (www.physiolibrary.org) – a free, open-source Modelica library for human physiology, including explicit examples and the source code – attached as a supplementary material to the electronic version of the paper. P. Měřička et al. present the design and experience from a pilot implementation of an e-learning course focused on tissue banking. The authors highlight the differences in the methods of assessment when studying the e-learning version compared to the classical version of their optional course. The qualitative structured study by N. Beckett et al. touches upon students' attitudes to Objective Structured Clinical Examinations (OSCEs) designed to assess specific competencies using standardized peer-reviewed checklists. The final editorial material by J. Gregor et al. recall the most important memories from the last 7th year of the MEFANET conference, which took place in Brno at the end of November 2013. The MEFANET conferences have always been providing an exciting meeting place for delegates from medical and healthcare faculties, computer scientists as well as medical teachers and students from the Czech Republic, Slovakia and other countries. In 2014, the upcoming 8th year of the MEFANET conference (26th to 27th November 2014 – Brno, Czech Republic) will be focused on technology-enhanced learning and teaching in acute medicine.

This issue would not have been possible without the great support of the Editorial Board members and reviewers – I would like to express my sincere thanks to all of them. I hope that the whole second volume of the MEFANET Journal will be another valuable resource for the MEFANET community and will stimulate further research into the vibrant area of medical education science. The wide range of topics presented in this issue emphasizes the complexity of the ICT use in medical education. Readers are encouraged to submit both comments on these and other published articles as well as their own relevant manuscripts.

June 2014

Daniel Schwarz
Editor-in-chief

DATA SECURITY MANAGEMENT ON STORAGE DEVICES IN REAL TIME

Marián Švída*, Jaroslav Majerník
Department of Medical Informatics, Faculty of Medicine, Pavol Jozef Šafárik University in Košice, Slovakia
** Corresponding author: marian.svida@upjs.sk*

ARTICLE HISTORY
Received 28 February 2014
Revised 28 March 2014
Accepted 16 April 2014
Available online 13 May 2014

KEYWORDS
data protection
data security
encryption
storage media

ABSTRACT — *The article deals with some basic approaches to the management of secured access to data on external storage devices in real time. Basic steps of effective, safe and easy-to-use handling of personal and/or confidential data are described. Further, a method to protect logins and passwords during their registration into the various applications is presented in the article. Main features of several most commonly used software products are also described considering data protection when used online and stored on various storage devices. The main reasons to apply data protection in the area of medicine and health care services are stated in this article as well.*

INTRODUCTION

Recent trends of data management have been subject to dynamic changes. Reason for this is particularly an immense growth in development of new technologies and their almost unlimited usage in personal and commercial areas. The need to have data always available rises together with this growth. Users want to have their documents, pictures, songs or movies wherever they are and available from any device connected to the Internet including Personal Computers (PCs), tablets, smartphones etc. In principle, it achievable quite easily thanks to features of today's technologies, which allow for data transmission, synchronization and storage. Various devices are available for these purposes, either traditional such as internal or external Hard Disk Drive (HDD), Compact Discs (CD), Digital Versatile Disc (DVD), Blue-ray disc (BD), flash memory, e-mail account, or the "modern" ones such as remote storage services, Network Attached Storage systems (NAS), cloud computing and many others.

Whatever is used to satisfy the needs of a particular user, it is necessary to secure all important data and protect it against any unauthorized manipulation. Unauthorized persons include not only accidental finders of physical storage devices, but also hackers, network administrators and others who may get in to the digital contact with data along the data flow path.

Even if the most of the data storage services guarantee that the data will not be offered to the third-party, there is always the chance the data can be stolen, manipulated or misused while transferred, stored or archived. Unfortunately, many users still work with their data without any hardware or software protection including both the local and the distributed data files. These unfavorable conditions are caused either by their poor computer literacy, absence of information about security tools or by the fact the work without encryption is mistakenly considered as easier and faster. Consequences arising from this non-acquaintance or indifference may be fatal, depending on the importance of randomly or intentionally misused data. The real hazard with confidential data is usually recognized in internet banking usage through free Wi-Fi networks, especially if these are weakly or not protected at all. It is also important to recognize whether the data are personal or belong to the company's database, although both of them may be of high importance.

Transfer and subsequent leak of data from commercial to private sphere and vice-versa is the main reason for increasing technical level of digital information reliability, especially in the case of confidential data (clients, business partners etc.). Very high importance of digital files protection is considered in the case of patients and their personal and health related data. Information systems designed for clinics and hospitals solve the data security and protection at least at the level of authorized users, but the problem may arise if such kind of information is used outside the system, for example to be applied in educational or research activities. Therefore, the paper aims to increase the awareness in this area and to introduce the need of use data security and protection tools.

DATA MANAGEMENT IN REAL TIME

We do not consider the questions of safe data storage in the sense of guaranteed storage period or possibilities of physical destruction; our focus is mostly safe usage and direct work with data, including processes as distribution, storing as well as file protection with passwords. There are plenty of methods how to manage secured data and they can be available either as free or commercial. All have their pros and cons, but our primary requirement is a simple and effective handling in real time, where almost no delay should be registered by the users. Nevertheless, passwords usage is considered as a standard that is also essential while working with data on local computers. From this point of view, it is possible to use tools intended to manage passwords immediately when needed while ensuring protection against their tracing during systems' entering process (keylogger). Here, a freeware tool KeePass can be used quite efficiently as mentioned later. Activity of keylogger, if not revealed by antivirus program, can be partially eliminated using virtual onscreen keyboards with screen capture protection, no copy and paste features or randomly located keys. In such case the password (for example password to access Keepass) is entered using computer mouse and drag and drop method (Neo's SafeKeys). Characters on this on screen keyboard can be selected pressing the left mouse button or using "Hover mode" where no mouse clicks are needed to select particular character/symbol.

Other anti-keylogger tools with possibilities of randomly specified key layouts like "Oxynger KeyShield" or older but still powerful "Mouse Only Keyboard" are based on similar principles and allow for entering sensitive data protected against mouse logging in web browsers as well.

In general, the digital data management can be subdivided into three main phases. These are data file opening, data editing and data file closing. Another optional phase, called data backup, can be also considered because of its usefulness. Direct access to data files is convenient only in cases of public and open information. However, data related to scientific research, patients' health status, bank transfers etc., has to be hidden in order to be inaccessible and/or invisible for unauthorized persons.

Applications that accept passwords use hashing algorithms as an essential security consideration to protect passwords that are stored in application's database. Hashing algorithm applied to user's passwords before storing makes original passwords hard to be revealed by attackers. Hash functions can be characterized as follows:

- small change of input data will result in meaningful changes of output data,
- it is not possible to reveal original text from hash data,
- statistically, it is not likely to have identical hash data for two different texts.

In this point of view, the hashing processes should be based on "salt" method rather than on former MD5 or SHA1 because of modern computer equipment makes "brute force" attacks faster and trivial. A cryptographic salt can be imagined as additional data which makes hashes significantly more difficult to crack.

REQUIREMENTS OF SECURE DATA MANAGEMENT

Management of sensitive or personal data requires ensuring of several basic conditions to prevent their stealing, misuse or destruction. Such conditions include:

- data encryption using strong passwords,
- files stored on technically reliable memories,
- regular backup using various drives or storage places,
- periodic readability checking of all stored records,
- backup of applications used to encrypt and decrypt data files,
- save storage devices on physically different places,
- functional and reliable hardware to read and write data on storage media.

SECURITY SOFTWARE TOOLS

Software products intended for the secure data management can be classified into several categories.

Simple encryption

The most frequently used method represents traditional and direct password entering technique through ZIP or RAR file compression with encryption, but files access and management itself is usually uncomfortable and cumbersome. Weakness of the method is that the weak password used to protect compressed files can be unlocked using special hacking software. Moreover, the data files can be mistakenly stored/kept on memories of device on which such data files are managed. Simple encryption is provided by applications like 7-ZIP, WinRAR, WinZIP etc. These compression and encryption techniques are widely used, but offers only very basic password protection settings. Usually, they are not equipped by features to control strong

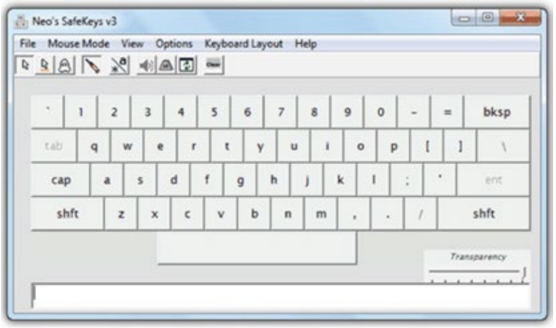

Figure 1: On screen keyboard Neo's SafeKeys defeats keyloggers very efficiently

Figure 2: Volume creation wizard in TrueCrypt

password rules or to specify secure encryption algorithms. Then the data files protection can be broken using brute-force methods. In general, this category can be considered as outdated and inappropriate.

Encrypted data package

Encrypted data packages provided by tools as BitLocker, FileVault, Pointsec or TrueCrypt offer more secure work with sensitive data on local as well as remote drives. These products are usually equipped by special key features including "on the fly" encryption, data protection in the case of unexpected power supply interruption, random number generator with enhanced mechanisms, standard and cascade encryption algorithms (AES, Serpent, Twofish, AES-Twofish, AES-Twofish-Serpent, Serpent-AES, Serpent-Twofish-AES, Twofish-Serpent), HASH-algoritmy (RIPEMD-160, SHA-512, Whirlpool) etc. Encrypting applications can usually encrypt files, folders or whole drives into the form of data package where the work with files and applications is realized in real time as it is in the case of data that are not encrypted. On the other hand, users should work with appropriate responsibility to keep computer up-to-date, protected in networks, and not opened to access encryption key.

Effective and very secure data management can be obtained using one of the above mentioned tools. We prefer to use application called TrueCrypt that offers easy-to-use features for the majority of common users, who can simply open a storage space (folder, disk drive, remote folders and drives etc.) and use it for direct work with data files. The only additional operation is entering the password to open the system by an authorized person. TrueCrypt offers both the user friendly graphical interface and the command prompt mode. Graphical mode allows specifying various settings using mouse control, selection of virtual drives as well as other parameters used to open data files under operating system. Command mode is intended for users who prefer to specify particular settings in the form of short scripts. Both modes initiate particular files and their virtual opening to be able to work with them as it is in traditional way. The difference is in data protection while used in open files. Traditional way, for example ZIP compression with encryption, uses open files stored directly on physical storage devices and thus unprotected and easily discoverable. Using tools like TrueCrypt, allows managing files where the open part of data file is stored only in RAM, which is always erased when the computers is turned off. The time of potential security risk is significantly reduced. Figure 2 shows the screen during encrypted volume creation process in free open source disk encryption software TrueCrypt.

Graphical user interface and availability of its features make TrueCrypt very popular and easy to use. Management of data files and applications is almost the same as their common usage. Therefore, it can be also considered as useful for non-technical users, to be used for everyday work with data including medicine.

To create TrueCrypt data storage place it is necessary to download this application. It is recommended to use the only developer's website (http://www.truecrypt.org) as prevention against downloading infected products equipped with various add-ins and/or so called backdoors. TrueCrypt can be used on Windows, but also Mac and Linux computers. Once installed, the user will create new volume using "Create Volume" button. Wizard will guide users through several simple steps where they confirm or specify creation of encrypted file container, standard TrueCrypt volume, file location, encryption algorithm, volume size, volume password and volume format. The volume will be created and ready to be used within few minutes. It is recommended to use some of the cleaning tools (for example DiskWipe, http://www.diskwipe.org) to clean former disk space and ensure irreversible deletion after copying of old unencrypted files into the new encrypted disk storage place created by TrueCrypt. Figure 3 shows a virtual encrypted drive created in TrueCrypt.

Password depositories

Passwords depositories offer advanced management of passwords used for various applications and

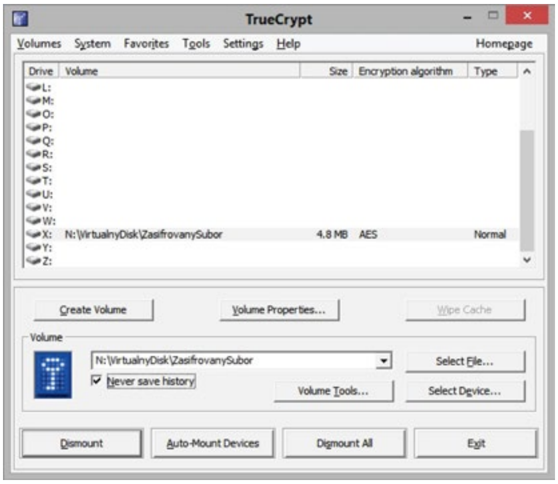

Figure 3: Virtual encrypted drive in TrueCrypt

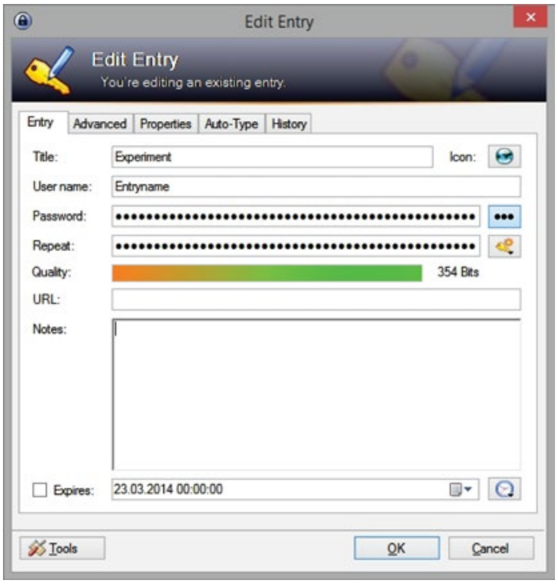

Figure 4: Password edited in KeePass

systems. Users usually consider passwords as core elements in most of the data security processes. Their decisions often fight between strong passwords and passwords that can be efficiently memorized. Here, the application KeePass is considered as very useful and secure. It belongs to the password managers where all users' passwords are protected by one so called master password. Using such applications it is not possible to reveal sequence of characters entered on the keyboard. Users usually prefer portable versions that can be used everywhere and with no risks to keep digital tracks in the system. Passwords are stored in a separate encrypted file as in depository, and their management is clear as a multilevel tree structure. Using password for a certain application is based on copy or drag and drop methods. Very useful security feature is the possibility to set time after which the copied sequence of characters will be automatically deleted from the cash memory. Password generator is also a common feature included in such types of password security tools.

KeePass should be downloaded from http://keepass.info to ensure the original version is obtained. This free open source tool can be operated under Windows, Mac OS X, Linux and also other OS. Both the installed and portable versions are available. The user has to create a new password database at first. The master password should be specified here. In order to increase security level a key file and/or windows user account can be combined to open this database. Once the password database is created and opened the user can easily manage his/her passwords for different systems. New entry (access data) allows specifying title of the system, username, password, URL, and additionally adds the files, change colors, enable auto-type feature etc. An integrated password generator (Figure 5) can be used to generate strong passwords according user's preferences. Saved access data can be used in particular application using recommended drag and drop method. If the users prefer to use copy and paste method than the clipboard, the auto-clear function can be used to delete access data automatically. The predefined time is set to 12 seconds, but it can be changed according to user's needs.

Data protection on web pages

Data protection on web pages should be a matter of high importance as well. In real practice, it is very often required to store data files in public accessible storage places as domain portals. These data files even if encrypted are then accessible for particular groups of users using their logins and passwords. Owners of such domains should use some of the security forms to allow access from public network. Here, the server application Apache with security files .htaccess, .htpasswd and other commands is the way how to protect misuse of data files. This can be used to allow or deny access for various groups of users based on their login data or even IP address. In this case it is necessary to remark that the data files are not well protected inside the networks, where for example the authorized personnel can access the data.

Real-time dataflow security in public networks

"Real-time dataflow security in public networks" especially, but not only in wireless networks can be ensured using Virtual Private Networks. VPN offers high security level and high reliability applicable in personal as well as commercial areas while communicating in the public networks. Various VPN tools (i.e., OpenVPN) protect data using encrypted connection based on the standard security protocols.

SLA, QoS and other features can be applied in such real-time communication. Co-workers can be interconnected all around the world and use company services with permissions and restrictions as it is in company's LAN network. VPN connection has features of private cloud computing for local networks and computerized systems.

Cloud computing

"Cloud computing" represents a specific way to handle computerized programs and digital data. Considering economic and organizational aspects, it can be used for unevenly distributed activities during year and companies with a lack of skilled specialists. Industrial and big administrative working environments should plane its usage very carefully, especially when having own infrastructure and professionals at their disposal, and the data to be processed are confidential or secret. The main advantages of clouds are high flexibility of data access and reliable administration of data storage infrastructure. Many users prefer to use clouds because of relatively simple data sharing with friends or co-workers. Economic advantages of cloud computing include financial, personal, material and office facilities. To mention disadvantages, the confidentiality of administrator or data transfer risks are the most resonant ones.

CONCLUSION

Recent trends in the development of new technologies equipped with many on-line applications and services lead to following a few main ICT perspectives, including dynamic network services, team co-operation, mobile business, data protection and security, green IT for sustainable development with low energy consumption demands. The data security plays the most significant role in all of these areas. Unfortunately, many users and organizations still depreciate it. The reasons may originate in weak computer erudition or low information level of the data security tools. In this point of view it will be necessary to instruct users about the ways and possibilities to prevent misuse of their data. Organizations should improve internal rules and specify personal liability according to the legislation given by the national authorities.

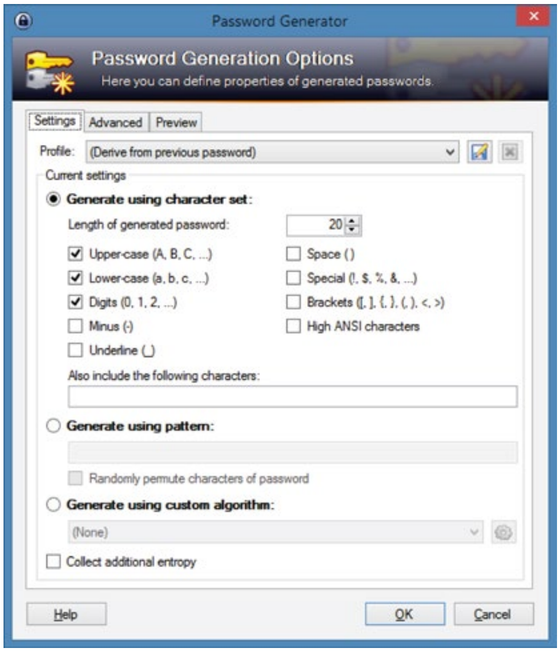

Figure 5: Password generator options available in KeePass

Ing. Marián Švída

ACKNOWLEDGEMENTS

This paper was elaborated within the framework of the project KEGA 005UPJS-4/2012 (50%) and within the framework of the project "Support research and development in the Moravian-Silesian Region 2013 DT 1 – International research teams" (RRC/05/2013), financed from the budget of the Moravian-Silesian Region (50%).

REFERENCES

[1] Útoky na operační paměť. [On-line] Available at WWW: <http://www.pepak.net/bezpecnost/utoky-na-operacni-pamet/#more-1823>
[2] Seďa J. Zabezpečená L2 síť. [On-line] Available at WWW: <https://dip.felk.cvut.cz/browse/pdfcache/sedaj2_2009bach.pdf>
[3] Hallová M. Cloud computing – definícia, výhody a nevýhody. [On-line] Available at WWW: <http://www.fem.uniag.sk/konferencie_a_seminare/zborniky/ki2013/zbornik/Hallova.pdf>
[4] Cloud computing. [On-line] Available at WWW: <http://skola.elibos.sk/?page_id=413>
[5] Rezek, J.: Pět klíčových trendů pro budoucnost ICT. [On-line] Available at WWW: <http://computerworld.cz/technologie/pet-klicovych-trendu-pro-budoucnost-ict-44055>
[6] Penhaker M, Kasik V, Snasel V. Biomedical distributed signal processing and analysis. Lecture Notes in Computer Science 2013; 8104: 88–95.
[7] Šimšík D, Siman D, Galajdová A, Krajňák S. Mainstreaming on ambient inteligence and the role of eaccessibility networking. Assistive Technology Research Series 2013; 33: 391–396.
[8] Program KeePass. [On-line] Available at WWW: <http://keepass.info>
[9] Program TrueCrypt. [On-line] Available at WWW: <http://www.truecrypt.org>
[10] Hašovací funkce. [On-line] Available at WWW: <http://cs.wikipedia.org/wiki/Ha%C5%A1ovac%C3%AD_funkce>

PHYSIOLOGY IN MODELICA

Marek Mateják
Institute of Pathological Physiology, 1st Faculty of Medicine, Charles University in Prague, Czech Republic
** Corresponding author: marek@matfyz.cz*

ARTICLE HISTORY
Received 7 March 2014
Revised 29 April 2014
Accepted 30 April 2014
Available online 12 May 2014

KEYWORDS
modelica library
physiology
integrative physiology
system biology
physiolibrary

ABSTRACT — *Modelica is an object-oriented language, in which models can be created and graphically represented by connecting instances of classes from libraries. These connections are not only assignments of values; they can also represent acausal equality. Even more, they can model Kirchhoff's laws of circuits. In Modelica it is possible to develop library classes which are an analogy of electrical circuit components. The result of our work in this field is Physiolibrary (www.physiolibrary.org) – a free, open-source Modelica library for human physiology. By graphical joining instances of Physiolibrary classes, user can create models of cardiovascular circulation, thermoregulation, metabolic processes, nutrient distribution, gas transport, electrolyte regulation, water distribution, hormonal regulation and pharmacological regulation. After simple setting of the parameters, the models are ready to simulate. After simulation, the user can examine variables as their values change over time. Representing the model as a diagram has also great educational advantages, because students are able to better understand physical principles when they see them modeled graphically.*

INTRODUCTION

Guyton's model from 1972 [1] was our first model implemented using Modelica diagrams [2]. We immediately saw that the Modelica language has big potential in physiology. Further, we implemented huge models such as DigitalHuman/QHP and HumMod [3–7]. The result of abstracting these implementations is Physiolibrary [8], a freely-accessible Modelica library. Using Physiolibrary (www.physiolibrary.org) it is possible to very quickly write huge models in a nice graphical way. Physiological diagrams in the chemical / hydraulic / thermal / osmotic domain are similar to electrical diagrams. Connections generate equations according to Kirchhoff's laws. The sum of generalized flows (molar / volumetric / thermal) is zero, and generalized efforts (concentration / pressure / temperature) are equal in connections [9]. Each physical law can be described by just one class in the library. Please note that "class" here means the actual definition of the physical law, while "instance" means the one parameterized entity of this definition, as is usual in object-oriented programming. For example, instances describing the aorta, pulmonary artery or systemic large vein can be defined by just one class for blood vessels.

Other Modelica models and libraries covering the biological domain preceded Physiolibrary [10–15]. Most notable is the BioChem library, which implements a large part of the SBML library in Modelica [12–16]. However, nobody has such wide support for integrative physiology in Modelica as we have today, although many teams and projects throughout the world deal with this formalization and integration of physiology without using Modelica, for example: Physiome [17], SBML [15,16], EuroPhysiome [18], VPH[19], CellML [20] etc.

METHODS

Integrative physiology needs exact interfaces and terminology to interconnect parts accurately. Primitive data types must be physical quantities with physical units. Above the quantities, the programmer must define physical connectors, and above the connectors library classes must be built, which are based on physical laws. From these elementary definitions in libraries, a user can build up more complex processes and regulations; and, finally, construct a whole-body physiological model. Because we use Modelica, it is not necessary to deal with the typical algebraic or numerical problems, since models are solved automatically. This allows building large models without huge effort.

In Physiolibrary (as in other correctly-defined Modelica libraries), all values are calculated in SI units only. This is really useful for compatibility with other libraries and models in case of integration. However, non-SI units are also integrated in some Modelica environments [8] (these units can be selected in parameter dialogs or in plotting of results).

The library structure is described in detail by Mateják [21]. The main packages are presented in the following sections.

Chemical package

The main class from "Physiolibrary.Chemical" package is called "Substance". It has one chemical connector, where molar concentration and molar flow is presented as usually. An amount of a substance ("solute") is accumulated by molar flow inside an instance of this class. In the default setting the solvent volume is set to one liter, so in this setting the concentration at "mol/L" has the same value as the variable solute at "mol". But in the advanced settings the default volume can be changed with external inputs. The molar flow at the port can be also negative, which means that the solute leaves the Substance instance. Most of the other chemical classes determine the molar flows from concentration gradients such as membrane diffusion, chemical reactions, Henry's law of gas solubility, chemical degradation or physiological clearance.

An idealized Henderson-Hasselbalch equation is presented here as an example of the Chemical package, see Figure 1. The fixed parameters in this example are: Henry's coefficient of CO_2 (kH_T0 = 0.33 mmol/(L.kPa) at 25°C); the gas-liquid specific constant for Van't Hoff's temperature change (C = 2400 K) for the GasSolubility instance; and the acid dissociation coefficient of the chemical reaction (Ka=$10^{-6.103}$ mol/L at 25°C). The enthalpy change (dH = 15.13 J/mol) of this reaction can also be used to correct the dissociation coefficient for 37°C, but the correction is not significant in this case. All these fixed parameters are tabulated chemical values.

Other user inputs to this equation are the partial pressure of carbon dioxide in gas (pCO_2) as a parameter of CO_2_gas, and the activity of hydrogen ions as a parameter of the pH instance. Each parameter is always connected with one Physiolibrary class instance and can be viewed or set by clicking the instance. The outputs of this model are the amount of free dissolved carbon dioxide [CO_2] and bicarbonate [HCO_3^-] in solution. For example, when pCO_2 = 5.33 kPa, T = 37°C and pH = 7.4, the simulation can reach the equilibrium values [CO_2] = 1.24 mmol/L and [HCO_3^-] = 24.55 mmol/L. In reality it is not possible to hold pH constant for varying amounts of carbon dioxide. For real behavior with changing pH, the model must be extended with acid-base-buffers and electrolytes.

Hydraulic package

For modeling the cardio-vascular system, it is necessary to have support for basic hydraulics, and to have a connector that provides pressure and volumetric flow. Pressure can be generated by an elastic tissue surrounding some accumulated volume, as in the ElasticVessel class. Typically there is a threshold volume, below which the relative pressure is equal to external pressure and the wall of the blood vessels is not stressed. But if the volume rises above this value, the pressure increases proportionally. The slope in this pressure-volume characteristic is called "Compliance".

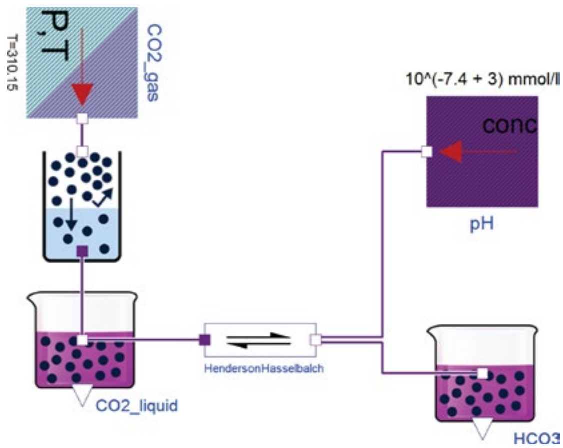

Figure 1: Henderson-Hasselbalch reaction in ideally buffered solution, where the Chemical classes GasSolubility, ChemicalReaction, Substance, UnlimitedGasStorage and UnlimitedSolution are used to build the model

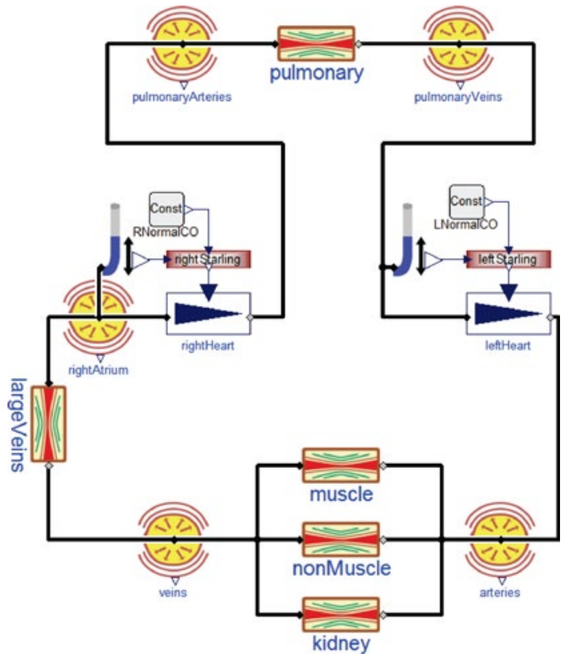

Figure 2: Cardiovascular part of Guyton, Coleman and Granger's model from 1972 [1], where the Hydraulic classes ElasticVessel, Conductor, Pump and PressureMeasure are used together with the cubic spline interpolation of a Starling curve

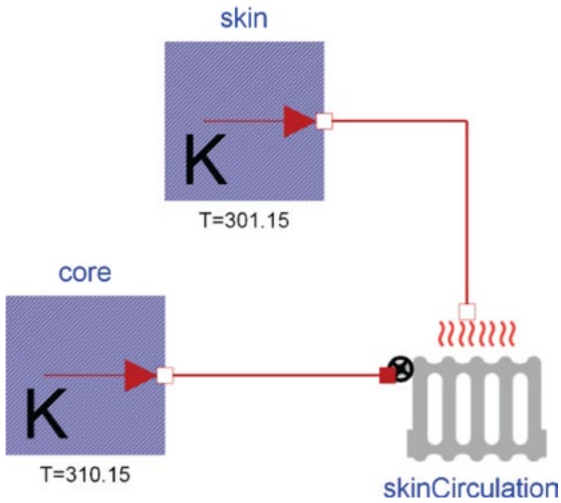

Figure 3: Heat losses from body core to skin, where the Thermal class IdealRadiator connects constant temperature sources represented by the class UnlimitedHeat

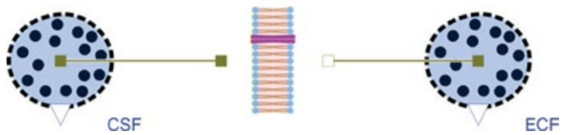

Figure 4: Osmotic example simulating liquid transfer between extracellular fluid and cerebrospinal fluid, which may cause a cerebral edema. The Osmotic classes OsmoticCell and Membrane are used

Another way to generate the pressure is using a class that simulates the hydrostatic column. The hydrostatic pressure is proportional to height of the column. Between the two generated pressures a flow-generating class can be used, such as hydraulic resistance or hydraulic pump. An example model using the hydraulic package is Guyton's cardiovascular system [1] in Figure 2.

Thermal package

The "HeatAccumulation" library class models heat accumulation in Physiolibrary. This class has one thermal connector with temperature and heat flow. Heat energy is accumulated inside the class, stored in the variable "relativeHeat". This value is relative to normal body temperature of 37°C; a positive value therefore indicates an internal temperature above 37°C, while a negative value indicates temperature below 37°C. Of course the particular value of temperature depends on the mass and specific heat of the instance.

In addition to heat convection or heat conduction the library also extends the Modelica Standard Library (MSL 3.2) with the IdealRadiator class. This class has two thermal connectors – one for liquid inside the radiator and another for the material around the radiator. Note that there is no liquid flow inside these connectors. The liquid flow can be described by a parameter or input to the instance. Together with the liquid specific heat, this flow determines the amount of heat flux from the liquid to a surrounding environment of different temperature. The calculation fulfills the ideal condition of microcirculation, where the outflowing blood has the same temperature as a tissue. This is really useful for modeling body thermal transfers, because the transfer of heat with blood flow is more significant than the typical rate of conduction through solid mass. Another example of its utility: the blood flow near the skin is regulated. This flow rate can affect how much heat leaves the body, especially in cold conditions. This is shown in Figure 3, where modeling constant temperatures of the body core (37°C) and skin (28°C), with a skin blood flow of 170 g/min and blood specific heat of 0.92 kcal/(kg.K), gives heat losses of about 1.4 kcal/min.

Osmotic package

To simulate the cell volume in hypertonic or hypotonic liquid, we use the classes from the Osmotic package. The main element is a semipermeable membrane, which generates the flow of penetrating substances together with water. The connector on both sides is composed of molar concentration of non-penetrating solutes (osmolarity), and from penetrating volumetric flow (osmotic flux). Flow through the membrane depends on a pressure gradient, where pressure on both sides is calculated from the osmotic and hydraulic component.

The liquid volume of the penetrating solution is accumulated in "OsmoticCell", where the nonpenetrating solutes are held. Instances of this class can represent both sides of the membrane, for example intracellular space, extracellular space, interstitial space, blood plasma or cerebrospinal fluid. An example model of the osmotic fluxes between extracellular fluid and cerebrospinal fluid is shown in Figure 4.

USAGE EXAMPLE

Even though the Modelica language specification contains many pages (https://www.modelica.org/documents), creating models with Physiolibrary is simple. For example, imagine creating a model of the simple chemical reaction A<–>B. First we create a new model called "SimpleReaction" via the File menu. Then we drag the class Physiolibrary.Chemical.Components.ChemicalReaction out of the libraries browser, and drop it in our SimpleReaction diagram to create its instance in our model. In the same way, we also insert two instances of Physiolibrary.Chemical.Components.Substance. After that, we connect (by drawing a line with the mouse) the small square chemical connectors from the middle of the substance to the connectors of the chemical reaction. We just designed a model, shown in Figure 5.

After that we double-click the instance of the first substance, and use the parameter dialog to set its initial value to solute_start = 0.01 mol. We do the same for the second substance, setting its initial value to solute_start = 0.1 mol. For the reaction, we define dissociation as K = 1 and set the forward reaction rate to kf = 1 s^{-1}.

Now we can simulate the model by just clicking the Simulate button. The results (Figure 6) of the simulation are accessible in Simulation or Plotting mode by selecting an option in the bottom-right corner of the environment.

If we examine the model in text mode, we can see that the following text representation is automatically generated from the graphically-developed model:

```
model SimpleReaction
   Physiolibrary.Chemical.Components.Substance
   substance1(solute_start = 0.01);
   Physiolibrary.Chemical.Components.Substance
   substance2(solute_start = 0.1);
   Physiolibrary.Chemical.Components.ChemicalReaction
   chemicalreaction1(K = 1, kf = 1);
equation
   connect(chemicalreaction1.
   products[1],substance1.q_out);
   connect(substance2.q_out,chemicalreaction1.
   substrates[1]);
end SimpleReaction;
```

Looking at the relevant library classes we can see that each of them contains the chemical connector Physiolibrary.Chemical.Interfaces.ChemicalPort, with its molar concentration and molar flow. Instances of these connectors are being used as operands of the Modelica operator connect(), which during translation of the model automatically generates equality equations for the connected concentration, and for Kirchhoff's equation of zero-sum-of-flows for connected molar flows.

After the code is translated via the Modelica compiler, the compiler generates low-level code, where the following assignments describe the same model:

```
// Dynamics Section
   substance1.q_out.conc := 1000.0*substance1.state;
   substance2.q_out.conc := 1000.0*substance2.state;
   chemicalReaction.rr := 0.001*(chemicalReaction.
   kf*((chemicalReaction.as[1]*
     substance1.q_out.conc)^chemicalReaction.
     s[1]-(chemicalReaction.ap[1]*
     substance2.q_out.conc)^chemicalReaction.
     p[1]/chemicalReaction.KaT));
   der(substance1.state) :=  -chemicalReaction.
   rr*chemicalReaction.s[1];
   der(substance2.state) := chemicalReaction.
   rr*chemicalReaction.p[1];
   chemicalReaction.lossHeat := -chemicalReaction.
   dH*chemicalReaction.rr;
```

It is possible to see many other details in the translated code. For example, each parameter not assigned by the user is automatically set to its default value. For instance, "s" (stoichiometric coefficients of substrates), "p" (stoichiometric coefficients of products), "as" (activity coefficients of substrates) and "ap" (activity coefficients of products) are all set to one; while

Figure 5: SimpleReaction diagram

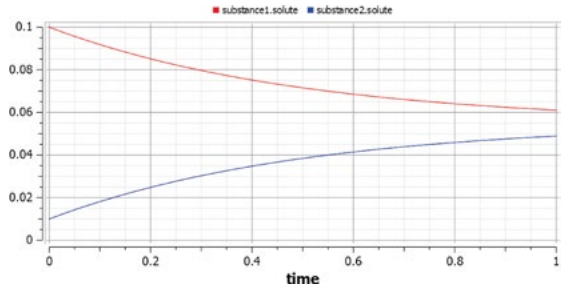

Figure 6: Results of SimpleReaction simulation

"dH" (reaction standard enthalpy change) is set to zero. And instead of "K" (the parameter value of the dissociation constant) the compiler uses the variable "KaT", which may differs from "K" when the user also defines a nonzero value for "dH".

CONCLUSION

Graphical modeling with Physiolibrary is very easy and intuitive. Using these physiological diagrams as a higher-level mathematical language is sufficient for describing the elementary physical processes of physiology. But these diagrams suffer the same limitations as electric diagrams. For example, the user must not directly connect instances of chemical substance, for the same reason as connecting two capacitors with different charges can cause a short circuit in the electric domain. In other words, both instances of a substance want to equalize their concentration without any resistance. To add a resistance some distribution class such as diffusion, chemical reaction, gas solubility or stream must be used.

Download the current version of Physiolibrary from www.physiolibrary.org, or from the Modelica website at www.modelica.org/libraries. After downloading and installing the Modelica environment, the library can be opened by, for example, loading its package.mo file. Today, Dymola is the best environment for Modelica, but there are also free alternatives such as OpenModelica (www.openmodelica.org), which indeed already integrates Physiolibrary (to access Physiolibrary in OpenModelica: from the OMEdit menu, select File > System Libraries). Another option for compiling and simulating the Modelica models is to use the textual environment JModelica. What is more, models created in Modelica can be translated into Functional Mock-up Unit (FMU), which has an open standardized Functional Mock-up Interface (FMI) supported by many simulation tools.

The Physiolibrary classes are implemented to give robust support for many use cases. Each class contains an equation for some physical law. The implementation is open-source, so everybody can see each equation behind each class. The purpose of Physiolibrary is to encapsulate the equations of elementary physical laws and to allow the user to build complex models. Since Physiolibrary models these complex equations graphically, a model will be readable by everybody. This graphical style is much more natural than the text-based code representation. These models could even be directly used for teaching students who have never seen Modelica before. The schematic model representations describe themselves, without needing to reference the underlying code.

But while the mathematical part of the work is made easy, each model still needs the correct parameters. Physiolibrary does not contain any default values for these inputs, but we are now developing a companion database and interface for known base physiological parameters. This project is called Physiovalues (www.physiovalues.org) and will also integrate many research results and measurements from third parties together with parameter identification, optimization and calibration algorithms [22].

Mgr. Marek Mateják

ACKNOWLEDGEMENTS

This paper describes the outcome of research that has been accomplished as part of a research program funded by the Ministry of Industry and Trade of the Czech Republic via the grant FR–TI3/869; and by The Ministry of Education, Youth and Sports via the grant SVV-2014-260033.

In addition, the main author wants to thank Austin Schaefer for English language editing.

REFERENCES

[1] Guyton AC, Coleman TG, Granger HJ. Circulation: overall regulation. Ann Rev Physiol 1972; 34(1): 13–44.
[2] Mateják M, Kofránek J, Rusz J. Akauzální" vzkříšení" Guytonova diagramu. Medsoft 2009: 105.
[3] Hester RL, Summers R, Iliescu R, Coleman TG. HumMod: a modeling environment for the simulation of integrative human physiology. Front Physiol 2011; 2: 12.
[4] Mateják M, Kofránek J. HumMod – Golem Edition – Rozsáhlý model fyziologických systémů. Medsoft 2011: 182–196.
[5] Mateják M, Kofránek J. Rozsáhlý model fyziologických regulací v Modelice. Medsoft 2010: 126–146.
[6] Kofránek J, Mateják M, Privitzer P. HumMod – large scale physiological model in Modelica. 8th International Modelica Conference 2011. Dresden, Germany.
[7] Kofránek J, Mateják M, Privitzer P, Tribula M, Kulhánek T, Šilar J, Pecinovský R. HumMod-Golem Edition: large scale model of integrative physiology for virtual patient simulators. World Congress in Computer Science 2013 (WORLDCOMP'13), International Conference on Modeling, Simulation and Visualisation Methods (MSV'13).
[8] Mateják M, Kulhánek T, Šilar J, Privitzer P, Ježek F, Kofránek J. Physiolibrary – Modelica library for Physiology. 10th International Modelica Conference 2014. Lund, Sweden.
[9] Kofránek J, Mateják M, Privitzer P, Tribula M. Causal or acausal modeling: labour for humans or labour for machines. Technical Computing Prague 2008: 1–16.
[10] Proß S, Bachmann B. An Advanced Environment for Hybrid Modeling and Parameter Identification of Biological Systems. 7th International Modelica Conference 2011.
[11] Cellier FE, Nebot A. Object-oriented Modeling in the Service of Medicine. 6th Asia Simulation Conference 2005.
[12] Nilsson EL, Fritzson P. BioChem – A Biological and Chemical Library for Modelica. 3rd International Modelica Conference 2003. Linköping, Sweden.
[13] Nilsson EL, Fritzson P. Biochemical and metabolic modeling and simulation with Modelica. BioMedSim 2005. Linköping, Sweden.
[14] Nilsson EL, Fritzson P. A Metabolic Specialization of a General Purpose Modelica Library for Biological and Biochemical Systems. 4th International Modelica Conference 2005.
[15] Brugård J, Hedberg D, Cascante M, Cedersund G, Gómez-Garrido À, Maier D, Nyman E, Selivanov V, Strålfors P. Biomax Informatics, AG. Creating a Bridge between Modelica and the Systems Biology Community. 7th International Modelica Conference2009. Como, Italy.
[16] Hucka M, Finney A, Sauro H, Bolouri H, Doyle JC, Kitano H, Arkin AP, Bornstein BJ, Bray D, Cornish-Bowden A. The systems biology markup language (SBML): a medium for representation and exchange of biochemical network models. Bioinformatics 2003; 19(4): 524–531.
[17] Bassingthwaighte JB. Strategies for the physiome project. Ann Biomed Eng 2000; 28(8): 1043–1058.
[18] Fenner JW, Brook B, Clapworthy G, Coveney PV, Feipel V, Gregersen H, Hose DR, Kohl P, Lawford P, McCormack KM. The EuroPhysiome, STEP and a roadmap for the virtual physiological human. Philos Trans R Soc A-Math Phys Eng Sci 2008; 366(1878): 2979–2999.
[19] Hunter PJ, Viceconti M. The VPH-physiome project: standards and tools for multiscale modeling in clinical applications., IEEE Rev Biomed Eng 2009; 2: 40–53.
[20] Smith L, Butterworth E, Bassingthwaighte JB, Sauro H. SBML and CellML translation in Antimony and JSim. Bioinformatics 2014; 30(7): 903–907.
[21] Mateják M. Physiolibrary - fyziológia v Modelice. Medsoft 2014.
[22] Kulhánek T, Mateják M, Šilar J, Kofránek J. Identifikace fyziologických systémů.

E-LEARNING COURSE: BASIS OF HARVEST AND PRESERVATION OF TISSUES – DESIGN AND INITIAL EXPERIENCE

Pavel Měřička[1], Lubomír Štěrba[1], Hana Straková[1], Pavel Navrátil[2]
[1] Tissue Bank, University Hospital Hradec Králové, Czech Republic
[2] Deptartment of Urology, Faculty of Medicine in Hradec Králové, Charles University in Prague, Hradec Králové, Czech Republic
** Corresponding author: mericka@fnhk.cz*

ARTICLE HISTORY
Received 14 March 2014
Revised 6 May 2014
Accepted 6 May 2014
Available online 14 May 2014

KEYWORDS
e-learning
programmed instructions
tissue bank
cryopreservation
transplantation

ABSTRACT — ***Background:*** *The design and initial experience with the e-learning course "Basis of Harvest and Preservation of Tissues" used as a support of an elective subject is presented. The aim of the e-learning course was to enable the students to learn the theoretical principles of the subject individually and to present the gained knowledge at the final seminar.*

Methods: *All functions of the course were operated in Moodle, local application of the Charles University in Prague, Faculty of Medicine in Hradec Králové. The course was divided into 3 main topics corresponding with topics of lectures: 1. Principles of tissue and organ donation, 2. Low temperature preservation of cells, tissues and organs, 3. Quality and safety assurance in practice of tissue and procurement establishments. A test consisting of 5 questions selected randomly from the bank of questions followed each topic. If the student answers correctly at least 3 questions he is allowed to pass to the next topic. The fourth topic "Basic processes in the tissue establishment and principles of their validation" was added into the electronic version as a tool for repeating and improving of knowledge. The fifth topic was represented by a database for uploading theses presented by students at the final seminar. The final test consisted of 15 questions (5 ones from each basic topic). It was necessary to answer correctly at least 10 questions to receive a certificate of completing the course.*

Results: *The course was put into operation during the summer term of the academic year 2012/2013. To the date 15 of September the total of 23 students enrolled (17, i.e., all students of the elective subject in the Czech version, 2 students of this subject in the English version, 2 postgraduate students and 2 medical doctors). All enrolled students used the course for on-line learning, downloading, or printing course study materials. All undergraduate students were obliged to use it for preparation, consultation and presentation of seminar theses, i.e., 10 minute Power Point presentations followed by 5 minute discussion. Verification of the course was planed during the summer term of the academic year 2013/2014.*

Conclusions: *The first experience showed that the presented e-learning course could serve as a useful support of the elective subject "Basis of Harvest and Preservation of Tissues". It substantially enlarged the choice of study materials that can be regularly updated, so that the students receive the newest information. It can be also attractive for students that are not enrolled in the elective subject because of its limited capacity (not more than 20 persons) The efficiency of such form of education is being a subject of further verification.*

INTRODUCTION

The elective subject "Basis of Harvest and Preservation of Tissues " was established at the Charles University in Prague Medical Faculty Hradec Králové by authors in the academic year 2001/2002 both in Czech and English versions as an extension of teaching activities of the Tissue Bank University Hospital Hradec Králové existing before [1,2]. The schedule of this subject was traditionally divided to lectures, practicals and a final seminar. To complete this face to face course the students were obliged to pass through a final knowledge test consisting of 30 questions and to present seminar theses on a topic selected from 5 to

6 ones. The totals of 12 to 18 under-graduate students have been enrolled annually, mostly in the third year of their studies. The maximum capacity of the course was 20 persons. The study materials were represented predominantly by Power-Point presentations elaborated by authors as the published textbook "Transplantology for Medical Students" [3] covered this special area only marginally. The aim of the construction of the presented e-learning course was to fill in the existing gap and to offer the students a complex multimedia supported study material covering all aspects of the elective subject and to enable them to learn individually its theoretical principles as well as to facilitate preparation, presentation and archivation of seminar theses. In construction of the course the authors used their previous experience with programmed instructions [4] and combined it with the new technical support available in the framework of the project: "Innovation and development of the study programme of general medicine at the Charles University in Prague, Medical Faculty Hradec Králové by means of information technologies (IT Medik)". The authors have also expected simplification of the agenda connected with evaluation of the knowledge tests.

METHODS

E-learning course prerequisites, its design and comparison with the standard face to face learning programme

An introduction to the e-learning course informs the students on the course prerequisites, content, available study materials and methods of assessment the gained knowledge and skill. Knowledge of medical physics, medical biology, anatomy and physiology is regarded as a general prerequisite for entering the course. A special knowledge of basis of tissue transplantation is required as well. For this reason study of selected chapters of the textbook "Transplantology for Medical Students" [3] is recommended.

All functions of the course were operated by Moodle, local application of the Medical Faculty Hradec Králové supervised by the IT management team of the Department of Medical Physics. The e-learning course design is presented in the Figure 1. It preserved the three main topics corresponding with topics of lectures: 1) Tissue and organ donation; 2) Low temperature preservation of cells, tissues and organs; 3) Quality and safety assurance in the practice of tissue and procurement establishments. A short intermediate knowledge test consisting of five questions followed each topic. If the student passed successfully through this test, i.e., answered correctly at least three questions, he/she was allowed to continue with the next topic. If not, he/she was returned to the beginning of the particular topic and had to study again all obligatory materials. The fourth topic "Basic processes in the tissue establishments and principles of their validation" was added in the electronic version as a tool to repeating and enlargement of knowledge.

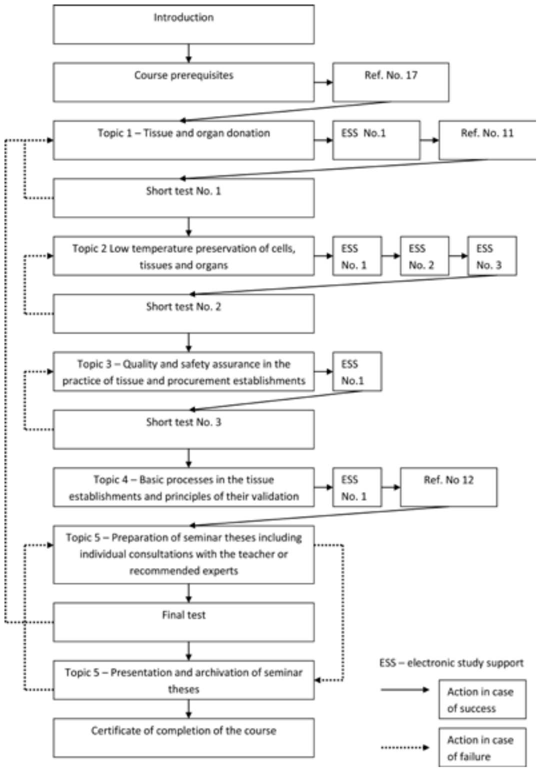

Figure 1: Basic schedule of the e-learning course

The fifth topic was represented by a database for uploading seminar theses. The number of topics usually used in the standard learning process was preserved as well. In the academic year 2012/2013 the students had the following choice of themes: 1) Principles of tissue and organ donation in the European Union member states; 2) Mazur's two factor hypothesis and its practical applications; 3) Main mechanisms of cryoprotection; 4) Methods of preservation of musculoskeletal tissues; 5) Methods of preservation of haematopoietic tissue, 6) Methods of preservation of cardiovascular tissue.

To complete the e-learning course the students had to pass successfully through three short intermediate knowledge tests (each consisting of five questions) and trough the final knowledge test consisting of fifteen questions. In the case of failure in the final test (less than ten correct answers) he/she was allowed to repeat the test maximally twice. The minimal interval between two consecutive attempts was adjusted to 48 hours. A certificate of attendance of the course was issued automatically and immediately after its completion. The course was ready for use after being reviewed by Jaroslav Špatenka, M.D.,Ph.D., Head of the Transplantation Centre, University Hospital Motol, Prague and was put on the website: http://moodle.lfhk.cuni.cz/moodle2/course/index.php?categoryid=43.

Table 1: Overview of obligatory study materials

Topic number	Electronic study supports	Chapters in monographs [references]
1	1	1 [8]
2	3	0
3	1	0
4	1	1 [9]
Total	6	2

Table 2: Content of obligatory electronic study supports

Total number of slides with text	242
Total number of slides with static pictures	84
Total number of references	34

Course aim qualification and quantification

The aim of the course was to enable the students to learn individually theoretical principles of the subject and to give them the skill in preparation, presentation and discussing seminar theses.

The effectiveness of the learning process was assessed by the final knowledge test in which the student had to answer correctly at least 10 from 15 questions (5 from each basic topic) selected randomly from the bank of questions.

The tools used to achieve the aim

These tools were represented by study materials, bank of questions and means of communication with the teacher and with other students.

Study materials

The multimedia supported study materials were divided to obligatory and recommended. Without studying obligatory materials the student was not allowed to pass to the short intermediate test. The study materials consisted of: 1) Electronic study supports; 2) Published full texts in Czech and English; 3) Audio and video presentations; 4) Important website addresses. The overview of obligatory study materials covering individual topics is presented the Table 1. The content of electronic study supports is summarized in the Table 2. The recommended study materials are presented in the Table 3. All obligatory study materials are written in the Czech language, the recommended materials include also texts and audio presentation in English. All used and published full texts included in the course were written by authors themselves [2,5,6,8,9]. All obligatory study materials and the majority of the recommended ones could be studied on-line or after downloading or printing.

The bank of questions

The final test consisting of 30 questions used in the standard face to face learning was replaced by three short intermediate tests and the final test as described in the section one. The questions were selected randomly from the bank consisting of more than 100 questions. In order to prevent selection of more than 1 question dealing with similar issue, each topic was divided into 5 categories, so that only one question could have been selected from each category. In the majority of questions only one answer of 4 options was correct. In some questions dealing with the topic 3 selections from 2 alternatives were used. An overview of knowledge tests and the structure of the bank of questions are presented in the Table 4.

The means of communication

The technical support of the project "IT Medik" – Moodle, made it possible that the course participants communicate individually with their teacher by e-mail. The communication among the participants using the function "Chat", was possible as well. The students, who completed the course can use standard questionnaire consisting of seven questions as a feedback. As the replies are automatically analyzed by Moodle, the teacher has immediate information on the level of the students' satisfaction with the course.

RESULTS

Some functions of the course were put into operation during the summer term of the academic year 2012/2013, i.e., before official completion in June 2013. Till now, the course was used exclusively as a support of the standard face to face learning process. The number of students enrolled to the date of 15th of September 2013 is presented in the Table 5.

All enrolled students of the elective subject used the course for on-line learning or downloading study materials. They were also obliged to use it for preparation, consultation and presentation seminar theses, i.e., 10-minute Power Point presentations followed by 5-minute discussion. The final versions of these theses were stored in the course database. Only three students (1 under-graduate, 2 post-graduate) tried to pass through the first intermediate short test and only 1 post-graduate student tried to complete the course. All these attempts were successful. No negative feedback was recorded.

DISCUSSION

E-learning courses have become standard part of the medical and nursing education [10–12]. Although the authors were acquainted with the principles

Table 3: Overview of recommended study materials

Topic number	Published full texts [references]	Audio and video presentation	Website addresses
1	0	1 (E)	1
2	2 (1C, 1E) [5]	1 (C)	0
3	0	0	0
4	2 (1C, 1E) [2,6]	0	5
Total	4	2	6

C – in Czech, E – in English

Table 4: Overview of knowledge tests and structure of the bank of questions

	Number of questions asked	Number of correct answers required	Number of categories	Number of questions available in the bank
Short test No. 1	5	3	5	52
Short test No. 2	5	3	5	35
Short test No. 3	5	3	5	27
Final test	15	10	15	114

Table 5: Number of students enrolled in academic year 2012/2013

Student group	Number of students
Students of an elective subjects in Czech	17
Other undergraduate students in Czech	1
Students of an elective subject in English	2
Post-graduate students (Pharmacy)	2
Medical doctors (Neurosurgery and vascular surgery)	2
Total	24

of programmed instructions already 40 years ago [4,13,14], they were not able to use it in the practice until the necessary technical background comparable with the current trends [15–17,19] was available at their workplaces. The presented course is oriented primarily on pre-graduate medical students which is a feature that differs from other courses available abroad that are aimed mostly on post-graduate training of the staff of tissue and procurement establishments [18]. As the course also attracted attention of under-graduate students studying in English (Table 5) the authors are ready to prepare its English version. It was also documented (Table 5), that attention of post-graduate students or even of medical doctors was attracted. Our course is aimed exclusively on support of theoretical parts of the elective subject and on preparation of seminar theses. In this form it does not support the practical part of the subject, e.g., electronic study supports include only static pictures. In order to achieve this, the course should be supplemented with a higher number of video presentations of individual processes used in the tissue and procurement establishments. In this paper the authors present the pre-verification stage of the construction of the course, its verification was performed in the academic year 2013/2014. The results of this verification are being analyzed now and will be published later. On its basis some modifications of the course are planed, such as enlargement of number of questions in the bank for use in the tests no. 2 and 3 (Table 4) to achieve the number of at least 50 questions for each intermediate short test. Enlargement of number of video presentations or of published full text dealing with the topics still uncovered by published study materials (Table 1) is planned as well. The effectiveness of the learning process is being assessed at this stage on results of the final knowledge tests only. Pre-test is not included in this version of the e-learning course.

CONCLUSION

The first experience showed that the presented e-learning course could serve as a useful support of the elective subject „Basis of Harvest and Preservation of Tissues". It substantially enlarged the choice of study materials that could be regularly updated, so that the students receive the newest information. It could be also attractive for students that were not enrolled in the elective subject because of its limited capacity. The efficiency of such form of learning is being a subject of further verification.

MUDr. Pavel Měřička, Ph.D.

ACKNOWLEDGEMENTS

The paper was supported by the project number CZ.1.07/2.200/15.0164.

REFERENCES

[1] Klen R. Tissue Banking in Czechoslovakia. Transplantation Proceedings 1976; 8(Suppl 1): 49–51.
[2] Měřička P. Brief History of the Tissue Bank, Charles University Hospital, Hradec Králové, Czech Republic. Cell Tissue Bank 2000; 1(1): 17–25.
[3] Třeška,V. et al. : Transplantology for medical students. Karolinum: Prague 2002 [In Czech].
[4] Měřička P, Vít P. Initial Experience with the use of audiovisual programmes in practical teaching of anatomy. Sborník vědeckých prací LF UK v Hradci Králové 1974, 17(Suppl. 17): 207–216 [In Czech].
[5] Měřička P. Refrigeration in Biology. In: 100 years at the service of developments of refrigeration and its applications. French Association of Refrigeration and International Institute of Refrigeration: Paris 2008: 62–63.
[6] Měřička P. Medical Priorities of Hradec Králové (2): History of the tissue bank. Scan 2008; 2: 16–17 [In Czech].
[7] Měřička P. Cryoprotection in biological systems and its application in haematology. In: Pecka M (ed.). Practical haematology – laboratory methods. Infiniti Art: Český Těšín, 2010: 305–308 [In Czech].
[8] Měřička P, Navrátil P, Špatenka J. Legislation of tissue donation and harvest in the Czech Republic. In: Baláž P, Janek J, Adamec M (eds.). Organ harvests for transplantation. Karolinum: Prague 2011: 223–239 [In Czech].
[9] Měřička P, Špatenka J, Navrátil P. Organization and surgical technique of the tissue harvest in multi-organ harvests. In: Baláž P, Janek J, Adamec M (eds.). Organ harvest for transplantation. Karolinum: Prague 2011: 240–251 [In Czech].
[10] Brumini G, Spalj S, Mavrinac M, Biočina-Lukenda D, Strujić M, Brumini M. Attitudes towards e-learning amongst dental students at universities in Croatia. Eur J Dent Educ 2014; 18(1): 15–23.
[11] Felder E, Fauler M, Geiler S. Introducing e-learning/teaching in a physiology course for medical students: acceptance by students and subjective effect on learning. Adv Physiol Educ 2013; 37(4): 337–342.
[12] Segal G, Balik C, Hovav B, Mayer A, Rozani V, Damary I, Golan-Hadari D, Kalishek S, Khaikin R. Online nephrology course replacing a face to face course in nursing schools' bachelor's program: a prospective, controlled trial, in four Israeli nursing schools. Nurse Educ Today 2013; 33(12): 1587–1591.
[13] Talyzinová NF. Theoretical issues of programmed learning. SPN: Prague 1971 [In Czech].
[14] Tollingerová D, Knězů D, Kulič V. Programmed learning. SPN: Prague, 1966 [In Czech].
[15] Kulič V. Psychology of guided learning. Academia: Prague 1992 [In Czech].
[16] Lau RWH, Yen NY, Li F, Wah B. Recent development in multimedia e-learning technologies. World Wide Web 2014; 17(2): 189–198.
[17] Paechter M, Kreisier M, Luttenberger S, Macher D, Wimmer S. Communication in e-learning courses. Students´ experiences and their preferences for online or face-to-face communication. Gruppendynamik und Organisationsberatung 2013; 44(4): 429–443.
[18] University of Barcelona: Institute for Life Long Learning IL 3. Tissue Banking E-learning course. [Online] Available at WWW: <http://www.eatb.org/media/uploads/TBon-line09.pdf>
[19] Wang TH. Developing an assessment-centered e-Learning system for improving student learning effectiveness. Comput Educ 2014; 73: 189–203.

A QUALITATIVE EVALUATION OF UNIVERSITY OF CAPE TOWN MEDICAL STUDENTS' FEEDBACK OF THE OBJECTIVE STRUCTURED CLINICAL EXAMINATION

Nazlie Beckett, Derek Adriaan Hellenberg, Mosedi Namane
Division of Family Medicine, School of Public Health and Family Medicine, University of Cape Town, South Africa
** Corresponding author: nazlie.beckett@uct.ac.za*

ARTICLE HISTORY
Received 10 March 2014
Revised 5 June 2014
Accepted 23 June 2014
Available online 26 June 2014

KEYWORDS
OSCE
new medical curriculum
University Of Cape Town
South Africa

ABSTRACT — ***Background:*** *All medical students at the University of Cape Town (UCT) rotate through a Family Medicine clerkship during their final year. Students are based at community health centres (CHCs) in the Western Cape Metropole, and at a rural site in Vredenburg. At the end of the four week clerkship, students do an Objective Structured Clinical Examination (OSCE).*

Aim: *The purpose of this study is to evaluate the students' feedback of the OSCE at the end of the 6th year Family Medicine rotation, and to make recommendations which can be used to improve the OSCE.*

Methods: *This is a structured qualitative study. The study population included final year medical students rotating through the Family Medicine clerkship, over a period of seven months. Each student completed a structured questionnaire immediately after the OSCE. These evaluations were analysed using a "content analysis" method.*

Results: *The majority of students were happy with the structure and content of the OSCE, as well as the fact that it was aligned to what was taught during the clinical rotation. However, the majority of students complained that the time allocated per station was inadequate.*

Conclusion: *Objective ways should be utilized by the Division of Family Medicine to improve the time allocation and the current format of the OSCE.*

INTRODUCTION

The OSCE was first used to assess clinical competence in 1975. It has been used as both a formative and a summative assessment. The success of the OSCE depends on adequate resources such as time and money, as well as the number and content of the stations [1]. It traditionally consists of a series of stations, and each station is designed to assess a specific competency using standardised peer-reviewed checklists [2]. The OSCE is a reliable and effective multi-station test which is used to assess practical skills, the demonstration of applied knowledge as well as communication skills. It is organized in the form of a number of stations, usually 10–20 stations (more stations improve reliability), through which students have to rotate [3]. The stations are timed, usually ranging from 3 to 15 minutes per station [3]. The Accreditation Council for Graduate Medical Education (ACGME) recommends a time of 10–15 minutes per station. By giving more time, you are able to test more competencies associated with the task [2]. Each station is focussed on testing a particular skill, e.g., history-taking, interpretation of test results, and the students are marked against prepared check lists. The stations which focus on performance of procedures are "manned", and these can constitute up to 6–10 stations in an OSCE. The "unmanned" stations are written stations where answers are set down on answer sheets, and these are also marked against checklists at the end of the examination [3]. A study done by Prislin et al. in 1998 [4] showed that the OSCE tested students' competency skills. Khurseed et al. [1] conducted a study amongst third year medical students at a University in Karachi, to evaluate undergraduate students' perceptions of the OSCE. It was found that the majority of students regarded the OSCE as a practical and useful assessment tool. Students felt that some stations offered ambiguous instructions and time allocation was not enough for the assigned tasks. The students gave constructive feedback on the structure and organization of the OSCE and the overall feedback from that study was used to review that OSCE process.

All UCT medical students do a 4 week Family Medicine clerkship which is integrated with Palliative Medicine during their final year. There are 10 rotations per year comprising of 16–20 students each. A subgroup of about 4 students is allocated to a 24-hour Community Health Centre (CHC) (either at Retreat, Hanover Park, Mitchell's Plain, or Vanguard CHC in the Metro West Geographical Service Area, GSA) of Cape Town. There is also an option for an additional group to do a voluntary rural rotation in Vredenburg in the Saldanha Bay Sub-district on the West Coast, around 160 kilometres from Cape Town. The student base is located at the Vredenburg District Hospital and students also see patients at the Hannah Coetzee CHC as well as at some clinics and non-governmental organizations (NGOs). During their clerkship, students are required to clerk patients with a broad range of presenting complaints. They also participate in a group community project, as well as having to write up individual case studies for Family Medicine and Palliative Medicine. Each of these sites has a senior family physician who supervises the students. On the last day of the clerkship, the students sit for an OSCE examination, which is used to assess core learning outcomes and skills learnt during the clerkship. The outcomes are built on the concept of "spiral learning" that is carried forward from pre-clinical years. The OSCE consists of 16–18 stations, and is a combination of written questions, practical skills and communication skills. Each station is 6 minutes long (with some being preparation stations). The purpose of this research was to evaluate the students' feedback of the OSCE at the end of the 6th year Family Medicine rotation, and to make recommendations which can be used to improve the OSCE.

METHODOLOGY

The study population consisted of all final year medical students rotating through the family medicine clerkship over a period of 7 months. There are 18–20 students in each block and the participation rate was expected to be more than 80%, because the questionnaire was completed immediately after the OSCE. The study was initially set for a period of one year (ten rotations), but due to time constraints it was reduced to seven blocks. The student rotations are all the same, and the OSCE structure is similar throughout the year, with 14 stations consisting of knowledge and procedural skills and 2 stations of communication skills.

A structured pretested questionnaire was used, adapted from an existing one used by the assessment team in 2011(see Supplementary material). The questionnaire consisted of a combination of open-ended questions, which were based on structure, time management and content of the OSCE.

Informed consent was obtained from the students at the start of the rotation and the questionnaires were anonymously completed by each participant at the end of the block.

The questionnaire consisted of seven questions (Supplementary material), most of which had single answers. A content analysis was done manually by the principal author for all the questions and the responses were analysed for common themes. The comments for each question was listed, and grouped into categories based on a common theme. The term "reasonable structure" is an example of a common theme, and included comments such as "good, fair, well organized adequate and excellent". Some responses did not lend itself to further analysis, while others included comments, some of which were used to formulate recommendations. The two other authors analysed the results in the same way as described above, using content analysis, and collaborated both personally or by email with the principal author. The comments for each question were grouped into common themes. The number of responses for each theme was captured in a table on an Excel spreadsheet and transposed into figures. The last question asked students to make suggestions as to how the OSCE could be improved. These suggestions were discussed with three other UCT associated family physicians and final recommendations on how to improve the OSCE were formulated.

Ethics approval for the study was obtained from the Human Research Ethics Committee of the Faculty of Health Sciences at the University Of Cape Town (HREC REF: 105/2012). Funding was provided by a URC start-up grant, which is offered to new UCT academic staff.

LIMITATIONS OF THE STUDY

The research period of the study was intended to be over a period of one year (ten rotations), but due to time constraints this was reduced to seven rotations. The questionnaire was completed immediately after the OSCE, so some students were a bit stressed and this may have influenced their responses. Not all students completed the questionnaire.

RESULTS

The response rate to questionnaires was 95 out of a total student throughput of 126 (75%).

"What did you think of the structure of the OSCE (written stations vs. clinical stations)?"

Fifty five students (58%) responded to this question (Figure 1). Twenty nine of these students (53%) felt that the OSCE had a reasonable structure (adequate, good, fair, excellent, good balance of written and clinical stations or well organized). Examples of comments were: "Well organized – a good balance of written and clinical stations" and "Good structure and balance".

Six students (11%) suggested that the written parts in the OSCE should be housed in a separate written examination. An example of a comment was: "I think the written stations should have been a written exam." Four students (7%) complained that some of the written stations were ambiguous. An example of a comment was: "The written stations were often badly

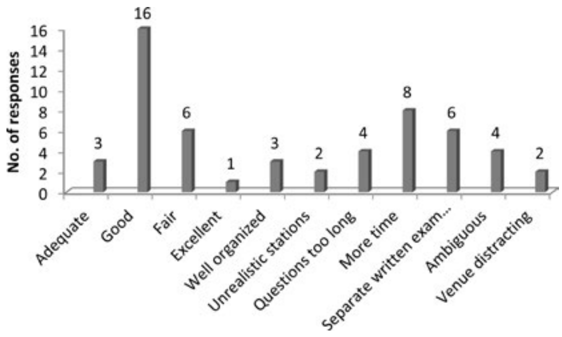

Figure 1: Comments about the structure of the OSCE

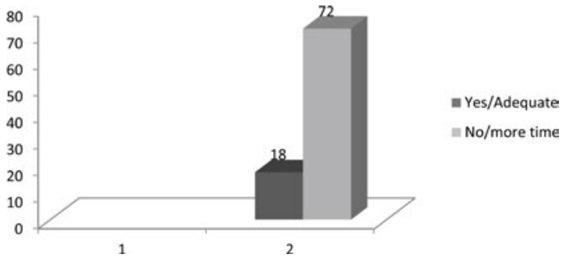

Figure 2: Comments about the time allocation for the OSCE stations

worded/confusing. Eight students (15%) said that more time was needed. Examples: "ECG station – not enough time" and "Found it quite rushed and time pressured". Four students (7%) commented that the questions were too long: "The time was sufficient for answering the questions, but the scenarios for the written questions were too long!" Two students (4%) thought that the venue was distracting: "A bit distracting when you can hear others talking while you are writing".

"Was the time allocated fair/time management adequate for the OSCE stations?"

A total number of ninety students (94%) responded to this question (Figure 2). The replies were mostly "yes" or "no". Examples of statements categorized as "yes" were "Time allocation was fair" and "Time was appropriate" and those who said "no" was "Not enough time" and "Pressured for time".

Seventy two of these students (80%) stated that the time allocation for the OSCE was inadequate. Examples: "Not enough time for some stations" and "Some questions too long and needed more time". Four students (4%) thought that the Evidence-Based Practice Simulated Office Oral (EBP SOO) and the Communication Skills station needed more time. Example: "The live stations (EBP and Motivational Interviewing) needed more time", while 14 students (16%) said that more time should be allocated for the written stations. "Need more than 6 minutes for written stations" and "palliative care stations needed more time" was a few examples. The general response for time allocation was that they needed eight to ten minutes per station, instead of the allocated 6 minutes. Examples of this were "Not enough time – need 8–10 minutes per station" and "Need more time – 6 minutes too short for some questions". Only eighteen students (20%) agreed that the allocated time was adequate.

"Did the questions/OSCE stations cover the content of the block adequately (i.e., Family Medicine and Palliative Care)?"

Eighty-one students (85%) responded to this question. The responses were mostly either "yes' or "no".

Sixty-eight of these students (84%) said that the OSCE content was adequately covered during the block. "Yes, but the detail was more than we were exposed to" and "yes, but there is a lot of self-directed studying" were a few of the comments which were included in this category. Thirteen students (16%) felt that the OSCE content did not adequately cover what was taught in the block. "No, it depended on what you saw at the clinic" and "No, it felt like an examination draining all knowledge of 6th year, rather than applied family medicine knowledge" were a couple of comments.

"Was the format easy to follow?"

Eighty-one students (85%) responded to this question (Figure 3). The answers were mostly either "yes" or "no". Comments such as "fair" and "mostly" were included in the "yes" category.

Sixty-one of these students (75%) agreed that the format of the OSCE was good. Nineteen students (24%) said that the format was not good. This included the students who said "no", as well as the "ambiguous" category. "No, some questions were difficult to understand" was one comment. "No, the palliative care questions were ambiguous" and "The written questions were too detailed with too much to read" were other comments. One student (1%) suggested that certain written stations, for example on X-rays could be a clinical station.

"What did you like about the OSCE?"

Fifty three students (56%) responded to this question. The responses were grouped into five categories, based on common themes (Figure 4). "Comprehensive" included comments such as "covered core knowledge, tested a wide variety of knowledge, good coverage, relevant stuff and relevant knowledge". "Fair assessment" included comments such as "fair test, asked what was expected/ taught, and not trying to trick us".

Seventeen of these students (32%) said that the OSCE was comprehensive and covered a broad range of topics and knowledge. Examples of some comments were "Questions were asking core knowledge" and "testing a wide variety of knowledge". Fifteen students (28%) thought that it was a fair assessment. "They asked us exactly what we were taught – the department is not trying to trick us" was one comment. Ten students (19%) said that essential knowledge was tested. "It covers relevant stuff", "Tt felt like an actual

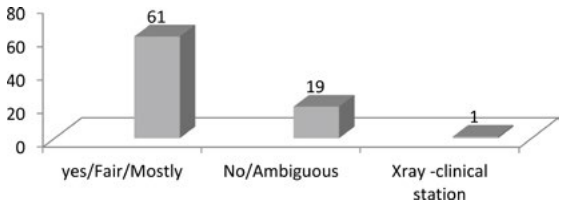

Figure 3: Comments about the format of the OSCE

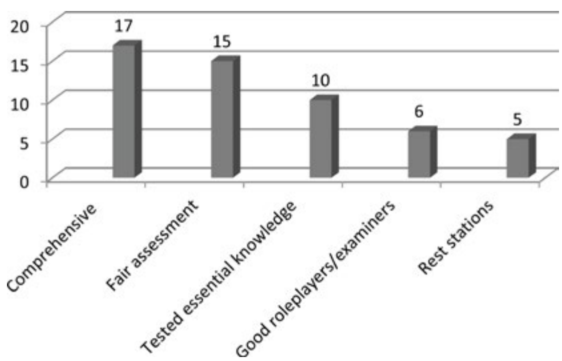

Figure 4: Comments about what students liked about the OSCE

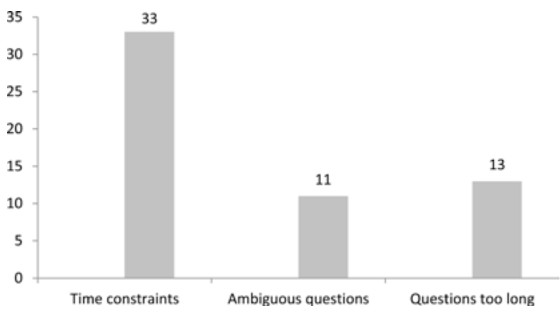

Figure 5: Comments about what students disliked about the OSCE

office environment and realistic scenarios we would face one day" were a few comments. Six students (12%) liked the examiners and role players. "Examiners polite and easy to work with" and "good role players" were a couple of comments. Five students (9%) liked the rest stations. "Time between stations was useful" was one comment.

"What did you not like about the OSCE?"

Fifty-seven students (60%) responded to this question (Figure 5). The responses were categorised into three identifiable themes: Time constraints, Ambiguous questions and Questions too long.

Thirty-three of these students (58%) said that there was not enough time to answer the questions or complete the stations. "Time allocation unrealistic", "Time allocation at live stations was not fair" and "6 min is too short for patient counselling" were a few comments. Eleven of these students (19%) felt that some questions were ambiguous. Thirteen students (23%) said the questions were too long "The clinical stations were ambiguous" and"I felt rushed and confused" were a few of the comments.

"How the OSCE can be improved? Any recommendations?"

Sixty-six students (69%) responded to this question. Thirty-five of these students (53%) suggested that the time allocation should be increased and this suggestion ranged from 8–15 minutes per station. Five students (8%) suggested that the written stations should be a separate two-hour examination. Two students (3%) suggested that there should be more live stations and that these should be isolated from the written stations. Four students (6%) suggested that sweets should be provided at stations, or that students should bring lunch. Four students (6%) suggested that the OSCE should remain as it is, but the number of stations should be reduced. One student (2%) wanted two evidence-based stations (EBP SOO). Five students (8%) said that some of the longer written questions should be reduced to short answer questions. Five students (8%) found the sequencing of stations distracting and suggested that live stations be more isolated. Two students (3%) wanted a live station and more practical teaching for Palliative care, and one student (2%) requested feedback after the examination. One student (2%) suggested that calculators should be used and one student (2%) suggested a box instead of envelopes for the collection of scripts. "More practical teaching in Palliative Medicine is needed" "A live palliative medicine station would be an idea" and "We want feedback on our answers" were a few of the comments.

DISCUSSION

The response rate to the questionnaires was 95 out of a total student throughput of 126. This is a 75% response rate which is less than the 80% expected. The reason for this response rate is possibly due to the fact that the evaluations forms were completed immediately after the OSCE and some students may have chosen not to participate.

The results showed that the quality of the OSCE in terms of format (length of questions), structure (ambiguity of questions) and time management was not ideal and that certain improvements could be made. Approximately 10% of students felt that the written questions should be in a separate two-hour examination and the clinical stations should consist of real patients instead of role-players. Real patients would be possible at the procedural skills stations, but the "live" communication skills would be problematic because it would jeopardise the "standardised patient" concept. However, this could be overcome if external role-players were specifically trained for the OSCE. According to the literature, well trained Standardised Role players (SPs) can be used for communication skills stations, and contributes to the reliability of the examination by ensuring that all students are presented with the same challenge [5].

Time management of the OSCE was mentioned as a problem. Eighty percent of the students thought that the time allocation of 6 minutes per station was not sufficient and that more time was needed to complete some stations (Figure 2). This corresponded to similar findings in the study done by Khurseed et al. in 2007 [1]. Only 20 % of the students thought that the time allocation per station was adequate. Rafique and Rafique conducted a study in 2013, where they evaluated the students' feedback of the OSCE as one of the assessment methods used at Nishtar College in Multan, Pakistan [6]. The results from their study showed that students thought the time per station was insufficient and this concurs with the findings of this study. The problem of inadequate time per station was discussed at the sixth year review meeting and a decision was made to increase the OSCE time allocation to 7 minutes per station.

Most of the students (84%) thought that the OSCE content was aligned to what was taught during the rotation at the various sites, for both Palliative Medicine and Family Medicine. These perceptions can be compared to similar findings by Siddique in 2013, where research results showed that 53% of students agreed that the OSCE tasks were taught during clinical rotations [7]. This emphasises the importance of using a blue-print to plan the content of the OSCE.

Two students also mentioned that self-study was required and that some questions required more detail than what they were exposed to at the clinics. Only 16% of the students did not think that the OSCE content was adequately covered during the rotation. One student thought that the OSCE was not a good application of Family Medicine knowledge. These last comments could indicate that spiral learning is lost over the years and that students did not fully understand the concept of a 6th year student internship year.

The format of the OSCE in terms of the type of questions and the structuring of the questions at the clinical and written stations was generally accepted as good or fair (75%). However, 24 % of the students thought that certain questions were difficult to understand and that some Palliative Medicine questions were ambiguous. This ambiguity of questions correlates with the findings of Khurseed et al in 2007 [1]. Similar findings were confirmed in the study done by Siddiqui at the OSCE centre in 2010, where nearly 30% of students said that the OSCE stations were difficult to understand [7]. Thirteen students said that certain questions were too long, contained too much information to be able to read and complete in time. Other suggestions were that some written questions, e.g., the X-ray and ECG questions could be clinical or interactive stations.

The general consensus was that the OSCE was a comprehensive and fair assessment of what was learnt during the block. The majority of students thought the setting felt like a consulting room, especially for the clinical and interactive stations. This is reassuring for the Division, because it indicates that the objective of making the OSCE as real as possible was being met. These findings correlate with student perceptions internationally, at institutions such as King Saud University in Saudi Arabia. Raheel and Naeem conducted a study at this institution in Saudi Arabia, where they assessed students' perceptions of the OSCE. Their research showed that 52% of students thought that the exam was fair and 57% stated that it evaluated a wide variety of clinical skills [8].

The perceptions of UCT students generally correlate with the findings of similar studies conducted at other institutions.

Students made various suggestions as to how the OSCE could be improved. Time allocation was a problem and based on the students' recommendations to improve the OSCE, it was suggested that the time per station be increased. Another suggestion was that there should be more practical teaching in Palliative Medicine, and that a "live station" should be incorporated in the OSCE. This is a good suggestion and has been a topic of discussion within the division. Due to the paucity of permanent staff and resources, this has been put on hold, but it is a possibility for the future. It would not be realistic to get a "live" patient, but a role-player could be trained for a specific scenario. The use of Standardised patients (SPs) is recommended in the literature and these can either be staff members or lay persons with some form of acting or medical background [9]. Only six students made the suggestion that the written and clinical examination should be separated. This will not be addressed immediately, unless evaluation in the future demonstrates a problem. The ideal OSCE should consist of mostly clinical stations where procedural and communication skills are tested, and this is planned for the future evolvement of our OSCE. According to the literature, more recently evolved OSCE programmes also include assessment of professionalism, quality improvement and documentation [9]. The Division of Family Medicine has included the latter two aspects in the OSCE, but professionalism is assessed elsewhere. Students wanted immediate feedback on their answers. This is not always feasible, but the family physicians made a suggestion which could address this. These suggestions were discussed, and certain recommendations were made.

RECOMMENDATIONS

It was decided that the time management of the OSCE would be reviewed and the time per station would be increased to 7 minutes. The possibility of making the OSCE purely clinical, as well as the logistics of having another separate written examination (that may include Short-Answer Questions and computer-based MCQs), will be considered. A feedback session can be held after the examination, so that questions identified as being difficult by the majority of students, can be reviewed appropriately by adapting them for future use or removing them from the assessment.

CONCLUSION

The majority of students were happy with the structure and content of the OSCE, as well as the fact that it was aligned to what was taught during the clinical rotation. However, the majority of students complained that the time allocated per station was inadequate, as shown in the results. The positive comments are reassuring for the Division of Family Medicine and shows that objectives are by and large being met. The time constraints will be addressed as mentioned, by increasing the time allocated to 7 minutes per station. The results showed some correlation that UCT students' perceptions of the OSCE is similar to that of their international counterparts at other institutions, as evidenced by the literature. The key perceptions which showed some similarity was that the time allocation for OSCE stations was inadequate, and that the OSCE tasks were aligned to what was taught during the clinical rotations.

The understanding of spiral learning is "lost" amongst some students as some responses suggest that they do not expect to be examined on prior learning done during earlier years of study. This misconception should be addressed at orientation. The recommendations drawn from the study findings by UCT Family Physicians will be used to improve the OSCE as from 2014.

Dr. Nazlie Beckett

ACKNOWLEDGEMENTS

We would like to thank Dr. Liz Gwyther (Palliative Medicine, UCT), Prof. Richard Harding (King's College, London), Ms. Manisha Chavda (Course administrator) as well as all the Family Physicians and tutors within the Division for their valuable contribution towards the course. A special thanks to the class of 2012 final year medical students at UCT, for their willingness to participate in this research study. The study was supported by the University of Cape Town start-up grant.

CONFLICT OF INTEREST

Dr. Beckett is the convenor of the sixth year Family Medicine course and this may be seen as a possible conflict of interest.

REFERENCES

[1] Khurseed I, Usman Y, Usmaan J. Students' feedback of objectively structured clinical examination: a private medical college experience. J Pak Med Assoc 2007; 57(3): 148–150.
[2] Gupta P, Dewan P, Singh T. Objective Structured Clinical Examination (OSCE) Revisited. Indian Pediatr 2010; 47(11): 911–920.
[3] Bhatnager KR, Saoji VA, Banerjee AA. Objective Structured Clinical Examination for undergraduates: is it a feasible approach to standardized assessment in India. Indian J Ophthalmol 2011; 59(3): 211–214.
[4] Prislin MD, Fitzpatrick CF, Lie D, Giglio M, Radecki S, Lewis E. Use of an Objective Structured Clinical examination in evaluating student performance. Fam Med 1998; 30(5): 338–344.
[5] Boursicot K, Roberts T. How to set up an OSCE. Clinical Teacher 2005; 2(1): 16–20.
[6] Rafique S, Rafique H. Students' feedback on teaching and assessment at Nishtar Medical College, Multan. J Pak Med Assoc 2013; 63(9): 1205–1209.
[7] Siddiqui FG. Final year MBBS students' perception for Observed Structured Clinical Examination. J Coll Physicians Surg Pak 2013; 23(1): 20–24.
[8] Raheel H, Naeem N. Assessing the Objective Structured Clinical Examination: Saudi family medicine undergraduate medical students' perceptions of the tool. J Pak Med Assoc 2013; 63(10): 1281–1284.
[9] Casey PM, Goepfert AR, Espey EL, Hammoud MM, Kaczmarczyk JM, Katz NT, Neutens JJ, Nuthalapaty FS, Peskin E. To the point: reviews in medical education – the Objective Structured Clinical Examination. Am J Obstet Gynecol 2009; 200(1): 25–34.

SUPPLEMENTARY MATERIAL

PPH6000W Family Medicine OSCE Questionnaire

"What did you think of the structure of the OSCE (written stations vs. clinical stations)?"
"Was the time allocated fair/time management adequate for the OSCE stations?"
"Did the questions/OSCE stations cover the content of the block adequately (i.e., Family Medicine and Palliative Care)?"
"Was the format of the questions easy to follow?"
"What did you like about the OSCE?"
"What did you not like about the OSCE?"
"How the OSCE can be improved? Any recommendations?"

MEFANET 2013: THE CIRCLE OF LIFE

Jakub Gregor, Daniel Schwarz*, Martin Komenda, Lenka Šnajdrová
Institute of Biostatistics and Analyses at the Faculty of Medicine and the Faculty of Science of the Masaryk University, Brno, Czech Republic
** Corresponding author: schwarz@iba.muni.cz*

ARTICLE HISTORY
Available online 18 April 2014

KEYWORDS
MEFANET
medical informatics
e-learning
virtual patient
e-assessment

ABSTRACT — *Number seven is considered to be lucky and magic; it is even a "lucky number" in a mathematical concept that was defined in the 1950s. Although the degree of personal happiness and enchantment of participants in the 7th year of the MEFANET conference inevitably varied, the network of Czech and Slovak medical faculties has undoubtedly won favour with all of them.*

Like last year, the traditional two-day conference took place in the Hotel International in Brno (Czech Republic), which provided its premises on 26–27 November for the meeting of representatives of medical and health care faculties and other faculties that deal with modern methods of medical education and the use of information technologies in this field. Welcome of the participants and opening of the conference was given by Prof. Stanislav Štípek (1st Faculty of Medicine, Charles University in Prague), followed by a traditional "State of the Union" message, which was presented by Dr. Daniel Schwarz (Institute of Biostatistics and Analyses, Masaryk University). He focused on six fields and goals that MEFANET has attempted to achieve: sharing electronic teaching and learning materials; quality evaluation of digital educational resources (both items can be considered to be finished); use of e-assessment systems; extending the MEFANET platform into a comprehensive ICT infrastructure; expanding the network by attracting new institutions; and promoting the network while looking for crucial funding at the same time.

Invited speakers from abroad have always been an indispensable part of the plenary section of the MEFANET conference, and this year was not an exception. The first one was Prof. Panagiotis Bamidis of the Aristotle University in Thessaloniki. His initial compliment towards the unique Central European cooperation in the field of medical education was certainly not just a courtesy to conference organisers. The lecture itself, entitled "The Role of Big Data and Learning Analytics in Medical Education", focused mostly on final stages of the whole process of development and use of educational materials – an analysis on how users work with the publications, what they are interested in, and for how long. All such data can be assessed, providing a lot of inspiration and impulses for further development. These are frequently high-volume data, by far exceeding the scope and capabilities of regular databases; they are therefore referred to as "big data".

If there is a traditional source of invited speakers for the MEFANET conference, it is undoubtedly the United Kingdom, which was this time represented by Dr. Simon Wilkinson of the Newcastle University. His lecture dealt with another hot topic of the medical education, and that was e-assessment. He introduced the Rogö system and the "4P" concept (Purpose, People, Process, Performance), which should be followed during the whole process of development and use of electronic tests. He also pointed out some practical aspects of e-asssessment, e.g., how to elegantly solve problems of technical nature (having 300 students sitting at 300 PCs, it is very likely that at least one of the students forgets his personal access data, and that the operation system is down in at least one of the PCs), or that it is important to respect students with various disabilities.

After all, a separate section of lectures on the 2nd day of the conference confirmed the fact that e-assessment is a rewarding and heterogeneous topic. It included both theoretical lectures given by leading

Figure 1: Plenary session chairs (from left): Prof. Panagiotis Bamidis, Dr. Simon Wilkinson, Prof. Stanislav Štípek and Dr. Daniel Schwarz

Figure 2: Prof. Panagiotis Bamidis, Aristotle University in Thessaloniki

Figure 3: Dr. Simon Wilkinson, University of Nottingham

experts in this field from the 1st Faculty of Medicine, Charles University in Prague, and the Faculty of Medicine at Masaryk University, Brno, and featured practical contributions demonstrating the performance and specific problems. In any case, we can conclude that users' evaluation of the educational materials and electronic tests is a final step, which returns the whole development process to the beginning of its life cycle, leading to the creation of a new product which reflects experience from the previous stage. Therefore, the term "circle of life" has its meaning even in the medical education.

Dr. Adrian Raudaschl (Medikidz Ltd., UK) was another distinguished guest from abroad; most of the participants had seen him the previous year, when he had given his videoconference lecture. This time, he arrived to Brno in person in order to lead the workshop entitled Gamification of Medical Education. During the 75 minutes dedicated to the workshop, he guided the participants through the life cycle of software applications and games for medical education, and allowed non-professionals to take a closer look at the development, employment, and testing of application prototypes. Besides numerous

Figure 4: Conference audience

Figure 5: Workshop led by Dr. Adrian Raudaschl

demonstrations of medical applications, he also succeeded in participants' active involvement; after being separated into four groups, they suggested the basic design of four different applications, which might fill a gap in the market soon, at least according to the recent survey by App Store and Google Play.

The conference programme was very rich and extensive as usually; let us mention, for example, the section on clinical data safety and management, which has been an increasingly more recognised topic not only in education, but particularly in everyday hospital practice. Cyber-attacks have recently become more real and frequent than terrorist attacks; this can happen to anyone, requiring a quick reaction in the order of seconds. And what is most important, it is not a matter of "IT guys" only, but of all users connected to the Internet, although they might perceive some rules as bothering and pointless.

The impact of e-learning on a specific medical field is a traditional part of the MEFANET conference as well; this year, it was biophysics and medical informatics. Both of these areas, which are essential to the understanding of some aspects of medicine, are now integral parts of education of future physicians and health care professionals. Nevertheless, some messages were rather pessimistic, especially when addressing new students' knowledge of fundamentals of physics and generally their "enthusiasms" into this field.

The 7th year of the MEFANET conference again confirmed the rising involvement and activities of non-medical health disciplines. No less than two separate sections were reserved for them and the topic of education of nurses and other health care professionals trickled in other parts of the programme as well as in discussions. Lots of educational materials have already been created by teachers of non-medical health disciplines; however, it is obvious that they will have to go through a similar process as the entire MEFANET, such as ensuring the guarantee of content and comprehensive quality assessment, among others.

The section focused on legislative aspects of MEFANET activities, new policies of university publishers, and the "open access" principle was followed by a very rich and fruitful discussion. The discussion was opened by Prof. Stanislav Štech (Vice-rector of the Charles University in Prague), Petr Valo, MSc (Director of the Karolinum publishing house), Dr. Hana Dziková (Director of the Publishing House of the Palacký University in Olomouc), and Jakub Michálek, MSc (lawyer, Vice-president of the Czech Piracy Party). The participants pointed out the absence of coordination activities in the Czech Republic with respect to the development of uniform "open access" policies and attitudes. It is also evident that the conference organisers will have to reserve longer time for these issues in future, as they bring very attractive topics to be discussed in the MEFANET community.

After expressing thanks to all partners, chairs, lecturers, and participants, the conference was concluded by a public meeting of the MEFANET Coordinating Council. All persons involved expressed their satisfaction with this year's conference, as well as with the redirection from parallel sections to the "single track" design of the programme. A technical discussion was held on the issue of a recently launched MEFANET Journal (print: ISSN 1805-9163, online: ISSN 1805-9171), its focus and indexing in journal databases.

The tradition of MEFANET conferences will continue in 2014: the 8th meeting of Czech and Slovak medical faculties will be held on 26–27 November 2014 in Brno.

Jakub Gregor, Ph.D.

SUPPLEMENTARY MATERIAL

Looking back on the MEFANET 2012 conference
http://www.youtube.com/watch?v=JIr-pmzQWro

Looking back on the MEFANET 2013 conference
http://www.youtube.com/watch?v=lkxD1eQfSGM


8th international conference
of Czech and Slovak faculties of medicine,
focused on e-learning and medical informatics
in the education of medical disciplines
mefanet
2014
TECHNOLOGY-ENHANCED LEARNING
AND TEACHING IN ACUTE MEDICINE
www.mefanet.cz/conference
www.mefanet.cz
www.facebook.com/mefanet
www.youtube.com/MEFANETnetwork
26–27 NOVEMBER 2014
BRNO, CZECH REPUBLIC

MEFANET JOURNAL PROFILE

Aims and Scope

The journal is intended to present within a single forum all of the developments in the field of medical informatics, medical education, e-learning and thereby promote the synergism among these disciplines. The journal is the premier vehicle for disseminating information about MEdical FAculties NETwork, which covers all Czech and Slovak medical faculties.

The journal enables medical teachers and scientists to share and disseminate evidence demonstrating the actual practice in on-line education in medicine and healthcare sciences by focusing on:

- research in medical educational informatics and learning analytics
- applications of medical informatics into education
- design, usage and results of novel e-learning tools and innovative pedagogical methods in medical teaching and learning
- other interdisciplinary topics related to information and communication technology in medical education

In 2009–2012, MEFANET report was published as one volume per year and was printed in 1000 copies. Since 2013, MEFANET journal has been published biyearly.

Subjects of interest

- E-health and telemedicine
- E-learning
- Information science
- Innovative teaching methods
- Medical educational informatics and learning analytics
- Modeling and simulation
- Multimedia
- Social media pedagogy
- Evidence-based medicine in education

Indexing

MEFANET journal is indexed in:

- Bibliographia Medica Czechoslovaca
- Bibliographia Medica Slovaca
- Google Scholar

On-line access

All volumes are available in electronic version at http://mj.mefanet.cz

PUBLISHER

Facta Medica

The Facta Medica Ltd. publishing house, based in Brno, was founded in 2008 by Dr. Boris Skalka, Dr. Eliška Skalková, and Assoc. Prof. Zdeněk Susa. The publishing house was founded with the aim of focusing on the publication of specialized literature from the field of medicine and health care – both periodical and non-periodical, but also medicine-related literature of fact and that of fiction. Since 2009 the publishing house has been represented by B. Skalka and E. Skalková.

The scientific standards are guaranteed by the publishing house's Scientific Board, whose members are listed below:

- Prof. Josef Bednařík, MD, PhD, neurology
- Assoc. Prof. Igor Crha, MD, PhD, gynaecology and obstetrics
- Prof. Richard Češka, MD, PhD, internal medicine – metabolism
- Prof. Eva Češková, MD, PhD, psychiatry
- Prof. Petr Dítě, MD, PhD, gastroenterology
- Prof. Andrej Dukát, MD, PhD, internal medicine
- Prof. Jindřich Fínek, MD, PhD, oncology
- Prof. Petr Husa, MD, PhD, infectology
- Prof. Václav Monhart, MD, PhD, nephrology
- Prof. Marián Mokáň, MD, PhD, FRCP Edin diabetology
- Prof. Miroslav Penka, MD, PhD, haematology
- Prof. Miroslav Souček, MD, PhD, internal medicine
- Prof. Jindřich Špinar MD, PhD, FESC, cardiology
- Assoc. Prof. Petra Tesařová, MD, PhD, oncology

REVIEWERS

Papers published in the Mefanet Journal 2(1) were reviewed by:

Ioan Adrian Ciureanu
Milan Blaha
Stephen Randall Thomas
Michal Jurajda
Jaroslav Majerník
Jiří Mareš
Simon Wilkinson
Martin Vejražka

Editorial board and publisher greatly acknowledge reviewers' contribution to this Mefanet Journal issue.

esf european social fund in the czech republic
EUROPEAN UNION
MINISTRY OF EDUCATION, YOUTH AND SPORTS
OP Education for Competitivness
UNIVERSITAS MASARYKIANA BRUNENSIS
INVESTMENTS IN EDUCATION DEVELOPMENT

EDITORIAL BOARD

KEYWORDS INDEX

AUTHORS INDEX

AKUTNĚ.CZ®

NADAČNÍ FOND AKUTNĚ.CZ

WWW.AKUTNE.EU WWW.AKUTNE.CZ

MU IBA

UNIVERSITAS MASARYKIANA BRUNENSIS

FAMA Facta Medica