Development of an educational research software with advisory role in the clinicobiochemical evaluation of amenorrhea

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ABSTRACT

Introduction: Amenorrhea is a symptom of a variety of disorders and dysfunctions. Historically, there have been many practical difficulties associated with the diagnosis of amenorrhea due to the complex nature of the ovaries, pituitary gland and hypothalamus.
Purpose: To develop a free, simple stand alone educational research software (ERS) to assist the education of clinicians and laboratorians (or undergraduate students) with regard to the clinicobiochemical evaluation of amenorrhea.
Materials and methods: The software was designed using: a) Microsoft Windows as operating system, b) C# .NET (4.0) as software component (plug-in), and c) C# (C Sharp) as (object-oriented) programming language. It can be distributed on Compact Disk (CD) and be run on any Personal Computer (PC) on Windows.
Results: The developed (ERS) -which we have called ERSA v.1.0 - does not require comprehensive skills and expertise in computers. Its educational benefits (common reasons for use) include activating motivation, stimulating recall of the prerequisite material, providing learning guidance and feedback (interactivity), usability outside timetabled course, and competency assessment.
Conclusions: The free ERSA v.1.0 could be a practical digital teaching tool for supporting the clinicobiochemical education. Future research should continue so as to evaluate and improve its accuracy, appropriateness, and usability by healthcare students or professionals.
Key words: Digital learning, biomedical informatics, hypothalamus, ovary, uterus.

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Received: 02.04.2014
Accepted: 18.05.2014
Progress in Health Sciences
Vol. 4(1) 2014 pp 83-87

INTRODUCTION

Amenorrhea is the absence or the abnormal cessation of menstrual bleeding. Physiological states of amenorrhoea are seen during pregnancy, lactation and menopause [1]. Pathological amenorrhea can be primary or secondary [2].

In particular, primary amenorrhea can be diagnosed if a patient has normal secondary sexual characteristics but no menarche by 16 years of age. If a patient has no secondary sexual characteristics and no menarche, primary amenorrhea can be diagnosed as early as 14 years of age [3]. Secondary amenorrhea is the absence of menses for three months in women with previously normal menstruation and for nine months in women with previous oligomenorrhea.

Secondary amenorrhea is more common than primary amenorrhea [3].

The prevalence of amenorrhea not due to pregnancy, lactation or menopause is approximately 3% to 4% [2]. With regard to the impact of amenorrhoea at individual and societal levels it has been shown that patients with untreated secondary amenorrhea are at higher risk in developing major depressive and/or anxiety disorder [4]. The long term effects of prolonged amenorrhoea include the reduction of bone mineral density and infertility [1].

Major risk factors that could increase the risk of amenorrhea include family history (inherited predisposition for the problem), eating disorders (anorexia), and athletic overtraining [1-3].

Historically, there have been many practical difficulties associated with the diagnosis of amenorrhea (which is a symptom of a variety of disorders and dysfunctions) due to the complex nature of the ovaries, pituitary and hypothalamus. [5].

In recent years, however, laboratory testing provides patient-specific information necessary for the prevention, diagnosis, and treatment of amenorrhea; evidence-based medicine and clinical pathways rely on laboratory tests. One of most valuable tools that medical laboratory educators usually use to support their teaching is the computer. To our knowledge, no previous study has focused on the design of a computer program for the differential diagnosis of amenorrhea with user-friendly characteristics as a tool for educational research purposes. The aim of this study was to develop a free, simple stand alone educational research software (ERS) to assist clinicians and laboratorians (or undergraduate students) during the process of familiarizing with amenorrhea.

MATERIALS AND METHODS

System Design

The design of the system was initially done on paper with all the relevant stages and data processing outlined clearly. The mathematical algorithms were detailed in simple English language for easy of programming [6].

Implementation

The minimum hardware requirements for the (ERS) is a Pentium 4 processor (Intel) or equivalent and 1 GB of random-access memory. The required operating system is Windows XP Service Pack SP 2 or later (Microsoft), and the required software component (plug-in) is C# .NET (4.0). Other computer requirements are: color graphics screen; hard disk drive; mouse; and CD ROM drive.

Development

Clinicobiochemical data for amenorrhea were collected from a clinical biochemistry textbook [7] and further evaluated from Internet biomedical databases. Control commands were added using C# (C Sharp), an object-oriented programming language developed by Microsoft. The developed software can be distributed from one Personal Computer (PC) to another using a flash drive, a compact disk, or any portable medium.

Testing

Software testing was performed so as to determine and minimize faults that failed on execution. Before the (ERS) was released, we did several in-house tests, defect fixes and design updates. Then, we released the (ERS) for evaluation by users who were informed of its trial status. During this phase, users provided needful feedback and gave us a better understanding of how they were using the (ERS). Once in-house testing and evaluation from users (which represent internal and external views of the (ERS) respectively) was finished, we released (ERS) for educational research use.

RESULTS

The development of the software-which we have called ERSA (Educational Research Software for Amenorrhea) v.1.0- doesn't demand special skills and expertise in computers. When the user logs into the system, a default page becomes visible with data in Greek or English language (Figure 1).

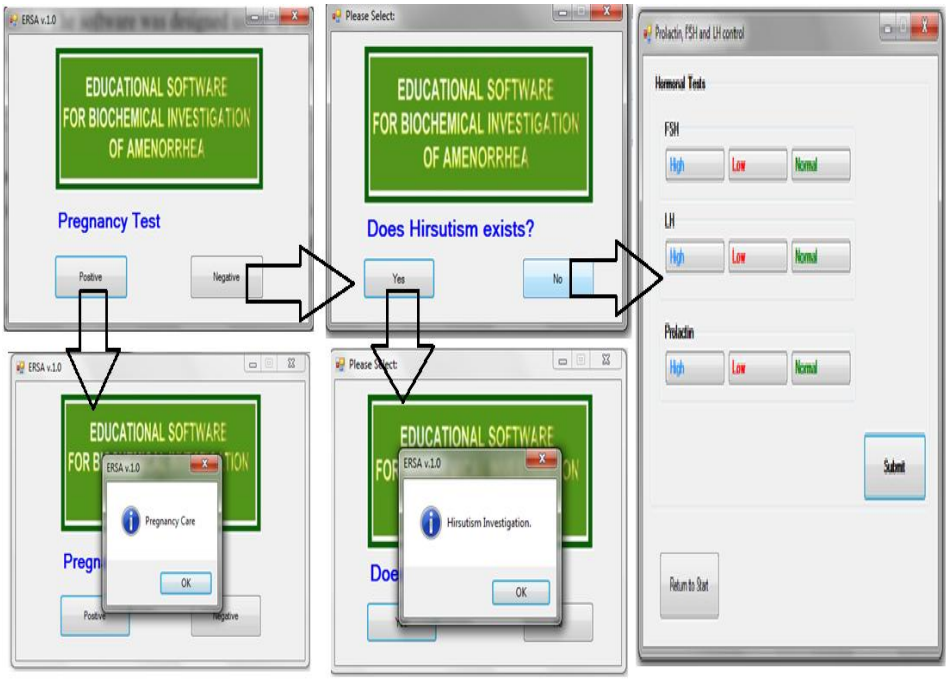

Figure 1. An example-illustration of the screen from the ERS. When the user selects a button, the program performs a specific action.

The quantitative determination of hormones (FSH : follicle-stimulating hormone, LH: luteinizing hormone, and prolactin) plays an important role in the clinicobiochemical evaluation of amenorrhea. However, the reference range values may vary between different laboratories due to different equipment and different methods or standardization of the analysis. This variation does not affect the diagnostic algorithm that we used [7]; the hormonal levels of the patient have been divided into three groups («high», «normal », and «low ») without the need from the user to «enter» the reference range and the individual patient's values into the system (Figure 2, 3).

After selecting the hormonal levels for FSH, LH, and prolactin (hormonal profile) the user clicks on the "submit" button, and the possible diagnosis and/or other tests that may be recommended are displayed on the computer monitor (Figure 2, 3).

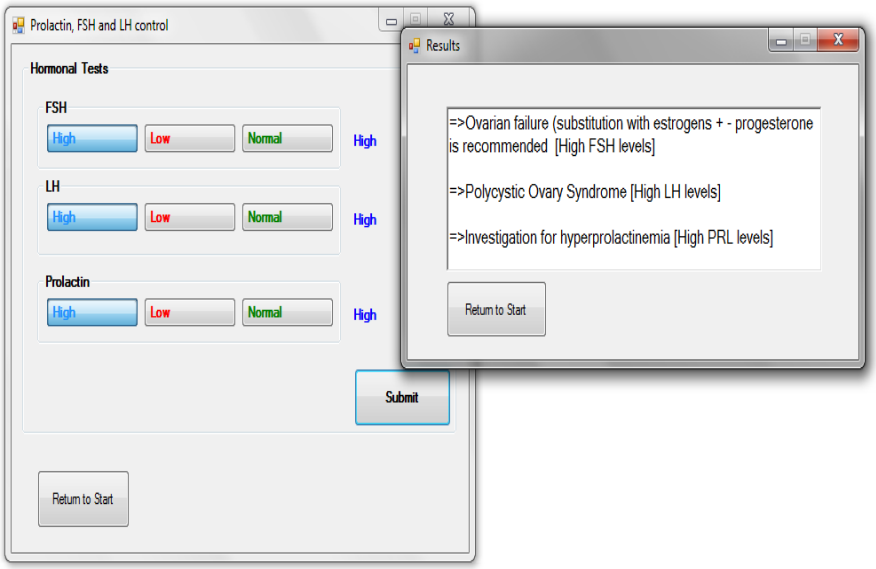

Figure 2. An illustration of the screen from the ERS that appears when the levels of FSH, LH, and prolactin have been selected (high levels). As results, the system provides the most common causes for amenorrhea or additional tests that might be necessary.

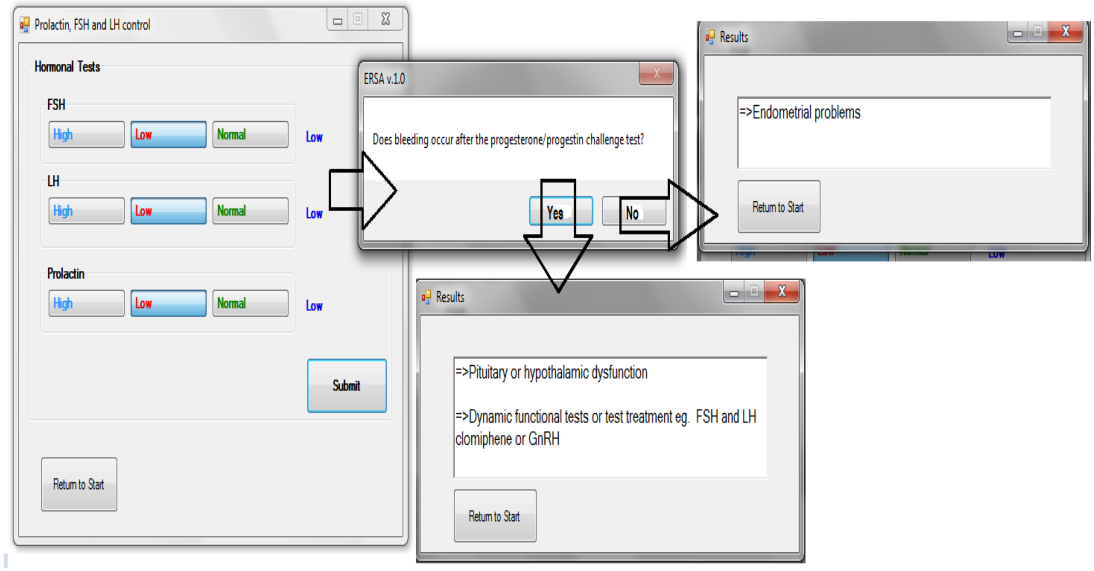

Figure 3. An illustration of the screen from the ERS that appears when the levels of FSH, LH, and prolactin have been selected (low levels). As results, the system provides the most common causes for amenorrhea or additional tests that might be necessary.

DISCUSSION

Computer-based learning has many advantages for the learner as it can take place at the time and location best suited to her/his needs. In contrast to traditional lecture-oriented, mass broadcasting of information, computers (with multimedia capabilities and presentational benefits) can support personalized one-on-one education, delivering material appropriate for learners' needs and interests, and thus promote active and self-directed learning [8,9]. By placing the student in simulated clinical situations, or in a simulated examination, an educational software can exercise the student's decision-making capabilities in a non-clinical environment. Moreover, well-constructed computer-based learning can be enjoyable and engaging, maintaining the interest of the student [8]. With regard to our study, the exploratory and discovery digital learning through analyzing the potential pathological states (and/or the clinicobochemical tests that may be recommended) for the diagnosis of amenorrhea could have a role in undergraduate or professional healthcare education [6]. It is widely accepted that digital technology with user-friendly screen elements could motivate learners and assist them in retaining and recalling the information; especially when the software contain interactive exercises with the appropriate feedback [10]. Moreover, it can improve data-handling abilities and clinical problem-solving skills [11]. In particular, the developed (open access, free) computer software was designed and tested so as enhance the traditional teaching methods of supervised instruction and textbook instruction since these methods have substantial drawbacks (reliance on memorization rather than problem solving), and provide help in performing educational research aimed at improving clinicobiochemical education [12].

CONCLUSIONS

In conclusion, the (free) ERSA v.1.0 has been developed to support the learning process regarding the clinicobiochemical evaluation of amenorrhea, and it could be useful for the education of undergraduate students or healthcare professionals (as a tool and not as a substitute for the doctor's diagnosis or a healthcare student's medical thought). Future work is warranted so as to evaluate and evolve its characteristics both from a technical and from a pedagogical point of view.

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