

Mobile Application to Determine the Severity of Salmonellosis Disease

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Abstract. The paper deals with studying the use of mobile devices for diagnosing in medicine, working out the element of medical students' electronic teaching and applying the mobile app in learning infectious diseases, namely, salmonellosis. The amount of people infected with this disease have been increasing year by year. The complexity of curing the moderate and serious diseases depends on the timeliness of determining the patient's condition. The authors have statistically researched how four indices of clinical blood test that affect the course of disease are significant. Three mean values of each of the four indices of clinical blood test were shown, which correspond to the three levels of severity of the disease. The application for mobile devices that enables the urgent and accurate determination of the salmonellosis disease severity without extra time and financial expenditures has been worked out. It can be used by students in the academic process, by doctors while rendering the first aid to patients, as well as for the independent disease course control by a patient himself / herself.

Keywords: Mobile App, Salmonellosis, Concordance Correlation Coefficient, Sign Test, Android, Kotlin.

1 Introduction

Today there are more than 325 thousand mHealth apps in the sphere of medicine. Most of them are free of charge. Research2Guidance prognosticates that the most prospective tendency of mHealth in the nearest 5 years will be elaboration of apps for distant monitoring and consulting [1]. In Ukraine the new edition of the technical regulation that is worked out according to the EU Medical Device Directive has been mandatory since July 1, 2015.

We have analyzed the modern state of incidence of salmonellosis, an intestinal infection, in the world. People all over the world suffer from this disease. About 94 million cases of salmonellosis are detected annually [2]. In the European countries where the incidence amounts to 23,4 cases per 100 thousand people the disease has a considerable influence on the population health [3]. The main task of curing the disease is early determination of its severity degree. This topic is studied by scientists all over the world [1-3], the patient's condition and products that cause the disease are

analyzed, the formulae for clinical blood test are suggested, the statistical analysis of data about the disease at a particular period is conducted, but no source contains the reference to an app or calculator that is used by students or practitioners to urgently determine the degree of the disease severity. Such an app is especially topical while the ambulance service and rendering the first aid by family physicians are involved in the medical reform which starts on January 1, 2018. For the first time we have created the app for the Android which will help to quickly determine intoxication indices and disease severity without a personal computer and at any place. The app is basically aimed at the automatization of calculating intoxication indices to shorten time and determine the patient's condition more accurately. The basic requirements for the application are the possibility to put in data, to calculate intoxication indices and to determine the patient's condition, the modern design of the app, the convenient use.

2 The Basis for Mobile App Creation

Creating the mobile app has relied on the integrated development environment (IDE) for the platform Android – Android Studio. This program is free of charge, it is licensed by Apache 2.0. Android Studio is based on IntelliJ IDEA Community Edition that is supported by the company JetBrains. The applications for the operation system Android can be made in many programming languages [4-6]. The most popular language to develop on the platform Android is Java now [5]. But while creating the application we have used the programming language Kotlin [6]. The use of the programming language has been determined by the fact that it is the most modern and the easiest one to write programs. Kotlin can be compiled in two variations: bytecode JVM and JavaScript. All the Java-frameworks and libraries can be also used. Kotlin may be converted into Java and just the other way round. This programming language is null-safe. The important advantages of Android Studio are the represented collection of typical interface elements and the visual editor for their combination that provides the convenient preview of the targeted application, code highlighting, analysis and detection of errors, integration with the control system.

3 Statistic Preparation of Data to Create the App

It should be noted that the salmonellosis disease falls into three degrees of the clinical course. The criteria for the degree of salmonellosis severity comprise the height of fever and its duration, stool frequency and volume and duration of diarrhea.

The mild severity degree is characterized with low grade fever, watery stool up to 5 times a day, duration of diarrhea for 1-3 days. The temperature of 38-39° C for 4 days and the stool up to 10 times a day for about a week indicate the moderate degree of severity. The evident intoxication, the temperature that rises to 39° C and higher for five or even more days and profuse stool more than 10 times with the duration for more than a week are characteristic of the serious degree of severity. In order that the severity of the gastrointestinal salmonellosis should be accurately diagnosed, we have used for the first time the integrative indicators of endogenous intoxication the deter-

mination of which does not involve extra expenditures, apart from the conventional analyses – clinical blood test [7]. It has been found out what indices reflect the degree of disease severity most objectively. For this purpose, the concordance correlation criterion has been applied: we have dealt with the most widespread variants to determine the sequence of the importance of indices investigated in case records to evaluate the hypotheses of different levels of importance of four indices: the index of shift of leucocytes (ISL), the leucocytic intoxication index (LII), hematological index of intoxication (HII), the index of intoxication (II). Their analysis has presupposed the ranking number for every index. We have used the concordance correlation coefficient for the case of tied ranks (the same values of ranks in evaluation of the same hypothesis).

$$W = S / \left(\frac{1}{12} m^2 (n^3 - n) - m \sum_{i=1}^m T_i \right), \quad T_i = \frac{1}{12} \sum_{j=1}^{l_i} (t_j^3 - t_j),$$

where S - the sum of ranks, m - the number of hypotheses, n - the number of indices, T_i - the number of connections (types of the repeated elements) in evaluations of the i^{th} hypothesis, t_i - the number of elements in the l^{th} connection for the i^{th} hypothesis (the number of repeated elements). Then we have set the task to find out what indices influence the accurate diagnosis. As a result of the research, it has been identified on the basis of expert rating that the most significant qualitative properties are ISL and LII [7].

4 Key Moments in Creating the Application

Then, based on the results obtained, a mobile application was created to quickly determine the severity of the disease for salmonellosis, which can be found by reference <http://play.google.com/store/apps/details?id=com.kam123.ua>

The application for the operating system Android is a set of classes and forms. Every form is an object of the class Activity, the interconnection between them is realized by the object of the class Intent. The first form is for data input by the user. The main designated purpose of the first form is getting the necessary information from the user. The user puts in the data about the clinical blood test that are necessary to determine the severity of salmonellosis disease. The second one reflects the general theoretical data about each intoxication index. The third form demonstrates the results of calculations and the information about the obtained degree of disease severity. The object of the class Intent is employed to change the form. The additional elements EditText are essential for data input, and the button “Calculate” initiates the call of another form and puts down the results of calculations into static variables in the class Result. After that the results are available in the form in which the answer is output. The variables that have the static modifier are global variables. When the class objects are initialized the copies of a static variable are not made. All the samples of the class make common use of one static variable. It is not necessary to create an object of the class to get access to the static variable. The event processor is not obligatory to simulate pressing the button. The attribute OnClickListener specially elaborated for Android has been used. It is the modern approach to programming on Android that makes the

elaboration easier and shortens the number of lines in the code. The class Formula has been created for calculations. It stores static functions which compute intoxication indices and determine the disease severity. It allows to apply formulae from any part of the program.

The calculations are made in the following way:

```
val LII_v = Formula.LII(M, Y, St, Se, Pl, Ly, Mo, E)
```

```
val HPI_v = Formula.HII(LII_v, Cesr, Cl)
```

```
val ISL_v = Formula.ISL (E, B, St + Se, Mo, Ly)
```

```
val II_v = Formula.II(LII_v, Lc, ESR)
```

```
val res = Formula.result(LII_v, HPI_v, ISL_v, PI_v, T, K)
```

The results are written into global variables of the class Result. Then the form with the results opens by means of the method startActivity:`val intent = Intent(this, ResultActivity::class.java)` startActivity(intent). Then we turn to variables of the class Result which are output on the form Result Activity. To start working with the application one should put in correct data and press the button “Calculate”. After pressing the button “Calculate” the check is carried out whether all the columns are filled in. If one of the columns is not filled in, the warning will appear, and they will be filled in with zeros. After all the data are put in the program computes the result.

Appendix

For the first time the mathematical model of calculating the degree of gastrointestinal salmonellosis severity has been elaborated. The application for the urgent and accurate determination of the disease severity degree has been created that can be used by medical students in studying, by medical staff for making a diagnosis and rendering the emergency care, infection disease doctors at different stages of patients’ treatment and, finally, in the independent disease course control by a patient himself / herself. The severity of salmonellosis disease is determined quickly and without economic expenditures, besides objective indicators are additionally regarded.

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