Application of artificial intelligence in digitizing the process of screening studies - Overview

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Abstract:
In addition to reviewing the literature sources on the subject, the review discusses the possibility of applying automated systems as a basis for developing and implementing innovative software solutions for data analysis from screening studies, which will assist medical professionals, students and teachers in the early detection of various diseases and conditions. The integration of telemedicine technologies for remote patient consultation and monitoring can improve access to health care, especially in regions with a lack of medical care. The benefits of integrating artificial intelligence and its combination with telemedicine are: a more efficient screening process, earlier detection of diseases, better quality of patient care, increasing the quality of life of patients, increased qualification of medical professionals, possibility of remote consultation and data verification. Prioritizing and predicting the urgency of emergency medical care is a key factor in integrating AI software solutions in combination with telemedicine.
Keywords: visual screening, health screening practices, AI in health screening, bulgarian healthcare data, AI tools for prevention, AI tools for screening

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INTRODUCTION

The paramount importance of screening examinations in early diagnosis of diseases was proven more than 80 ago despite the lack of definitive evidence of their first application – whether it was for establishing mental illness in the US army(1, 2), evidence of syphilis with Wassermann test (3, 4), or blood and urine glucose tests which have been administered since the turn of the last century(5, 6).

At the beginning of 1950s United States Commission of Chronic Illness defined screening as "identifying the presence of a disease while it is still in the preclinical stage" or as "check for disease while there are still no symptoms" (7).

Screening tests can identify diseases at a very early stage, and hence the chance of successful treatment increases significantly (8).

Naturally, the following questions arise, "Does earlier treatment improve prognosis?", "How valid and repeatable is the screening test?","What is the outcome of the screening service?". Although they might seem very general, these questions are still looking for an answer today (9).

Morabia and Zhang (10) have conducted an in-depth study and found that in the post-World War II period the factors, such as the advent of cheap and non-invasive tests, advances in easily applicable dosage forms, as well as easier access to health care, are powerful incentives for the mass implementation of screening. Based on an analysis conducted on large data sets for the United States and Canada, they have concluded that the evaluation of the impact of screening on human health is evolving very slowly. It is recommended that evaluation methods be adapted, upgrading from simple questionnaires to case-control studies and randomized trials (11).

EXPOSITION

The main differences between medical examination and medical screening are:

7. Purpose for medical examination visit - for the vast majority of patients, they see a doctor after they have already had a complaint or distinct symptoms, and medical screenings are done regularly over a period of time or on a campaign basis.
8. Medical screening, by definition, has to meet medical standards and the time it takes to be performed, exceeds substantially the time of a targeted screening test, or in other words, in screening campaigns much more people can be analysed per unit of time.
9. In many places around the world, screening tests are carried out by nurses, even health workers.

Since the number of specialists who can perform screening examinations compared to general practitioners and specialist physicians, as well as the time for a screening process is much less than a standard physical examination, this makes screening examinations very significant in building the right preventive medicine methodology.

In Bulgaria, it is not uncommon for screening examinations to be performed by doctors with a specialty. Why does this happen?

According to the **NIS (National Institute of Statistics)** data for the period 2010-2022 (Table 1), while the total number of physicians increased from 27903 to 29599 96 (+6.08%), a drastic decline was observed in internal medicine specialists (-36.34%), followed by general practitioners (-18.14%), or 854 in absolute value. The population in the Republic of Bulgaria, again according to **NIS** data, is nearly 6.5 million (12).

According to the World Health Organization methodology, the minimum number of medical professionals, including physicians, nurses and physician assistants for providing medical care is 2.3/1000 population (13). Official data published in The World Factbook (14)indicates that Bulgaria in 2018 has a sufficient number of medical professionals per capita - 4.2/1000 which puts it in the top 20 in the world. According to data from the same source on the number of hospital beds per capita (7.5/1000) as of 2017, we are among the top 10 countries in the world (15). Against this privileged background, however, according to the generally accepted infant mortality rate methodology, by 2024 we rank an unenviable 149th out of 262 countries. This coefficient is most often used as a measure of health system quality (16).The situation is similar for the Life expectancy at birth factor, which provides an overall assessment of the quality of life in a given country - we are ranked 118 there (17).

The combination of unsatisfactory quality of life and the top ranks in bad habits such as high alcohol consumption, overweight population (25% as of 2016), high number of smokers 39% of the population leads to growing awareness of the most disturbing trends - despite the absence of natural disasters, terrorist attacks or war we rank **seventh** in order of highest mortality rate in the world or 14.2/1000 people.

It stands to reason that we should turn to artificial intelligence (AI) for solving some of the problems.The application of AI in the fight against bad habits is not new. For instance, there are already many digital applications in the world aiding to quit or reduce harmful addictions. The more important ones are:

- **QuitSure** uses AI to personalize a smoking cessation plan for each individual user (18).
- **Kwit** uses gamification and cognitive behavioural therapy techniques to help people stop smoking (19).
- **RehabBuddy** is an app that helps people recover from alcohol abuse (20)
- **I Am Sober** is an app that helps people track their sobriety (21).
- **Noom** is a weight loss app that uses AI to customize a weight loss plan for each individual user (22).

A major problem is the timely detection and avoidance of medical errors. Researchers at the Mayo Clinic in Rochester, Minnesota have found that medication errors cause 1 in 131 outpatient and 1 in 854 inpatient deaths (23) More recent studies have shown that medical errors can be reduced by targeted staff training and continuous audits (24). However, this is much more effective if AI is used to analyse and evaluate the applied methodology and propose solutions (25).

Even higher hopes are placed on the application of AI within the overall screening process. There are already many applications for early cancer detection - e.g. DeepMind has developed an AI system that can detect breast cancer with very high accuracy and IBM Watson for Oncology is an AI system that analyses medical records, images and other data to help diagnose cancer. Diabetes screening uses Google DeepMind, an AI system that can predict the risk of developing diabetes with 95% accuracy. A good example of application in cardiovascular disease screening is CardioAI. It is an AI platform that analyzes images from echo-cardiograms and can detect signs of heart failure. Using BlueDot for infectious disease screening, the spread of infectious diseases can be tracked,and using IBM Watson can help to analyse genetic data for detecting signs of infectious diseases.

CONCLUSION

Despite the availability of many different applications and platforms for analysing medical examination and screening data, the main problem remains their digitization.Currently, the screening tests are not clearly regulated, the data from the screening tests are mostly not digitized and consequently cannot be analyzed using AI.

With adopting effective and reliable methodology (unified visualization of results and their export in a standardized way), digitalization of existing equipment and legal facilitation of screening tests, we will have a prerequisite for high quality and individualized preventive medicine with large scope and rapid results.

With seamless integration of the processes, we will have the opportunity to supercharge pre-hospital and hospital care in the country, while laying the groundwork for analytical telemedicine.

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Table 1. Number of doctors by areas of specialization for the period 2010-2022.

Medical specialties	**2010**	**2012**	**2014**	**2016**	**2018**	**2020**	**2021**	**2022**	**Rate differential**
Internal medicine	1428	1408	1241	1065	967	935	948	909	**-36,34%**
Cardiology	1303	1391	1518	1636	1747	1850	1843	1870	43,51%
Pneumology and phthisiology	620	598	598	627	612	601	596	602	**-2,90%**
Pediatrics	1665	1669	1717	1738	1735	1412	1408	1438	**-13,63%**
Surgery	1554	1618	1568	1606	1576	1517	1538	1508	**-2,96%**
Orthopaedic Trauma Specialists	795	893	912	966	965	1001	1020	1024	28,81%
Urology	404	454	520	510	515	511	522	543	34,41%
Infectious Diseases	224	225	230	211	205	233	248	237	5,80%
Obstetrics and gynaecology	1654	1688	1743	1751	1742	1766	1756	1756	6,17%
Ophthalmology	883	869	901	952	991	1055	1019	1012	14,61%
Otorhinolaryngology	662	678	703	692	695	689	684	678	2,42%
Neurology	1399	1448	1417	1463	1474	1455	1437	1433	2,43%
Psychiatry	706	691	701	686	695	681	675	656	**-7,08%**
Cutaneous and venereal diseases	502	483	476	485	479	452	447	459	**-8,57%**
Radiology	865	851	859	900	923	948	974	1007	16,42%
Physiotherapy and rehabilitation	518	531	576	613	638	654	658	694	33,98%
Laboratory physicians	611	615	636	624	628	640	645	640	4,75%
General practitioners	4708	4592	4481	4344	4199	4015	3945	3854	**-18,14%**
Other specialties	7314	7547	7872	8337	8756	9177	9115	9156	25,18%
Unallocated[1]	88	100	105	112	125	125	126	123	39,77%
Total	**27903**	**28349**	**28774**	**29318**	**29667**	**29717**	**29604**	**29599**	**6,08%**