Study of the User Behaviour Caused by Automatic Recommendation Systems Call to Action

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Abstract. Diagnostics accuracy and usability of symptom checkers have been researched in several studies. Their ability to set a correct diagnosis especially in the urgent cases is questionable. There is one aspect of symptom checkers that has not been deeply studied yet. It is their ability to motivate patients to follow up after receiving a direct recommendation and to decrease a load on the health care professionals. The goal of this research is to study how patients behave after receiving a recommendation from a symptom checker and motivation of this behavior. We studied how patients react on the symptom checker recommendations and the motivation behind this behavior. In total we invited 3615 patients to have a symptom checker screening; 2374 of them agreed to run a symptom checker screening; 867 of them agreed to participate in the study. The proportion of the patients who agreed to have a symptom checker screening. So, we can clearly see that symptom checker screening doesn't result in a significant decrease of the load on healthcare professionals. This is supported by the quantitative study results. The patients emphasized the ease of use of the tool and clearness of the recommendations it gives. However, they perceived it as rather a second opinion tool or a tool that helps to prepare to the doctor's visit.

Keywords. symptom checker, user acceptance, follow-up rates

Introduction

The World Health Organization (WHO) stated in 2013 that the world was short of 7.2 million healthcare professionals of all disciplines. This number will likely increase to 12.9 million by 2035 [1]. Primary care is particularly [2] affected, with severe lack of health care professionals in most of the countries [3–5]

Large countries with remote areas face another problem: Transporting patients to the points of care.

This has several consequences for the healthcare systems. One of the main and most problematic issues are a reduced access to health care, growing inequity, long waiting times [6], increased load on the emergency services [7,8]. This all lead to the late diagnostics and not optimal treatment. Traditional doctors oriented clinical decision support systems could reduce a workload on the doctors. This was not enough to solve all the listed problems. Machine learning (ML) and Artificial Intelligence (AI) methods

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in data-driven decision support systems helped to reduce healthcare professionals workload, allowed more efficient management of clinical resources and help patients access medical services [9,10].

Online and point of care symptom checkers are becoming a tool that is supposed to be patient oriented and solve the problem of initial screening and help people in remote areas to have a first medical contact [11].
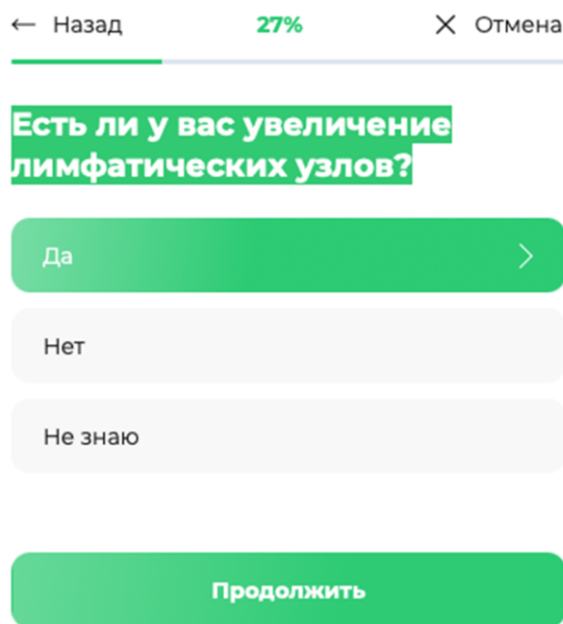
Diagnostics accuracy and usability of symptom checkers have been researched in several studies. Their ability to set a correct diagnosis especially in the urgent cases is questionable [12]. There is one aspect of symptom checkers that has not been deeply studied yet. It is their ability to motivate patients to follow up after receiving a direct recommendation and to decrease a load on the health care professionals.

The goal of this research is to study how patients behave after receiving a recommendation from a symptom checker and motivation of this behavior.

1. Methods

1.1. Symptom Checker

A symptom checker that is being studied is a general-purpose diagnostic symptom checker that is based on the Bayesian classifier. It askes multiple choice questions (figure 1), suggests 3 most probable diagnosis after a conversation (figure 2), and offers a call to action (figure 3) to follow up with a doctor or not. The average number of questions in one patient interaction was 11. There were 3 types of call for action messages: You need to see a doctor urgently (red), it would be good to see a doctor soon if you feel worse (yellow), there is no need to see a doctor now (green)

Figure 1. Question example. Translation from Russian: Do you have enlarged lymph nodes? Yes, No, Not Sure; Continue

99% вероятность	96% вероятность	84% вероятность
Острое респираторное заболевание (ОРЗ)	Хронический тонзиллит	Острый тонзиллит

Острое респираторное заболевание (ОРЗ)

Группа инфекционных заболеваний с преимущественным поражением верхних дыхательный путей и бронхов.

- У 9 из 10 человек с такими же симптомами было диагностировано это заболевание;

- диагностику и лечение проводит врач-терапевт;

- **внимание!** Симптомы заболеваний дыхательной системы могут быть характерны для COVID-19. При подозрении на коронавирусную инфекцию обратитесь по телефону горячей линии 8-800-2000-112. Узнать о бесконтактной сдаче анализа на COVID-19 вы можете на сайте сдайнакоронавирус.рф

Я подозреваю, что у меня острое респираторное заболевание (ОРЗ), что делать?

1. Соблюдать рекомендации

- Пить больше жидкости;

- Отказаться от курения;

- При отсутствии лихорадки или системных симптомов для ускорения выздоровления вернуться к привычному образу жизни.

2. Сдать анализы

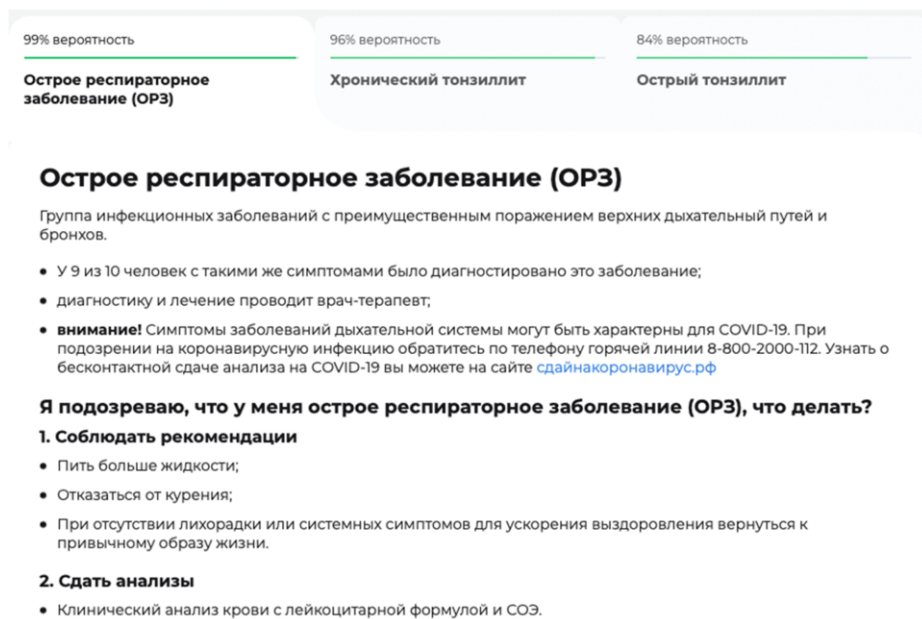- Клинический анализ крови с лейкоцитарной формулой и СОЭ.

Figure 2. Diagnosis suggestions

Translation from Russian:

Acute respiratory disease

A group of infectious diseases that mainly affects the upper respiratory tract and bronchi.

Nine out of 10 people with the same symptoms have been diagnosed with this disease.

Diagnosis and treatment are carried out by a general practitioner;

Warning! Respiratory system symptoms may be characteristic of COVID-19. If you suspect a coronavirus infection, call the hotline at 8-800-2000-112. To learn about noncontact testing for COVID-19, visit сдайнакоронавирус.рф

Результат оценки симптомов

Обратитесь к врачу в ближайшее время

Ваши симптомы могут потребовать внимания врача, запланируйте консультацию в ближайшие дни. Если вы чувствуете себя значительно хуже чем обычно, а симптомы длительно сохраняются или усиливаются - обратитесь к врачу сегодня.

Figure 3. Call to action. Translation from Russian: Result of symptom screening

It would be good to see your doctor soon.

Your symptoms may need your doctor's attention, schedule a consultation in the next few days. If you feel significantly worse than usual and your symptoms persist or get worse, see your doctor today.

1.2. Recommendations Follow Up

The first part of the study was dedicated to calculation of a follow-up rate.

The patients were offered to work with a symptom checker before a doctor's visit. Facilitators, who were not healthcare professionals supported patients with the symptom checker operation. The patients were motivated by a gift voucher that they could use for the medical services in the clinic.

A proportion of patients who accepted the offer was calculated by the research team. After the patients have completed a symptom checker session, we invited them to participate in the study.

Inclusion criteria were:
- Age > 18
- Purpose of visit: primary visit
- Completed a symptom checker session

Exclusion criteria were:
- Age < 18
- Secondary visit scheduled by a doctor

Those who had agreed were offered to sign a consent for that contained the purpose and the details of the study. They were also asked to fill in a short questionnaire that contained basic demographic information: age, gender, education and contact details.

After the consent form and a questionnaire were submitted to the research team, the patients were asked to provide the results of the symptom checker session.

The patients were asked if they would like to have a follow up visit with a doctor or not. We calculated the proportion of patients who wanted to have a follow up and those how didn't for the following groups of the patients:
- Green call to action (No need to see a doctor)
- Yellow call to action (Self-observation and may be see a doctor later)
- Red call to action (Urgently see a doctor)

The study was performed in a private outpatient clinic in March-April 2021. The study got the approval by the local ethics committee.

1.3. Motivation Study

For understanding the motivation to follow up or not on the symptom checker recommendations, we invited all the patients to take part in the interview. All the patients invited to interview were notified of the objectives of the study and of the purpose of the interviews in written.

The study was designed as a series of semi-structured interviews based on a topic guide, which was developed by the study team and reviewed by the local ethics committee.

Interviews had the following agenda:
1. Was the symptom checker user friendly and easy to use?
1.1. Did you understand the recommendations?
1.2. Did you understand the diagnosis that the symptom checker provided?
2. Did the symptom checker influence your decision to follow up with a doctor?
3. Why did you decide to follow up or not after a symptom checker session?

The guide included open questions to provide good understandings of the patients' opinion, without influencing from an interviewee. We applied a probing approach [13] during interviews to encourage patients to express openly.

Table 1. Demographic details of the study population

Gender	Average age	Age > 60	Education		
			Higher	Secondary	Below secondary
346 Males	42.6	106	98	238	10
521 Females	43.1	134	125	384	12
Total 867	42.9	240	223	622	22

The interviews were performed by two members of the research team. Each interviewee was in written assured of anonymity and confidentiality of the study participation. They were informed of their right to revoke personal data from the study at any time. The interview duration was 10 to 20 minutes and all of them provided sufficient information for the study. A combination of thematic analysis and a grounded theory approach was used to analyze the interviewees' responses [14,15].

2. Results

2.1. Recommendations Follow Up Results

In total, we invited 3615 patients to have a symptom checker screening; 2374 of them agreed to run a symptom checker screening; 867 of them agreed to participate in the study. The proportion of the patients who agreed to have a symptom checker screening. Table 2 contains the details of the patients' acceptance rates.

Table 2. Study population.

Patients approached	Agreed to the symptom checker screening	Agreed to participate in the study
3615	2374 (65,67%)	867 (23,98%)

Table 3 provides a classification of the study participants into groups.

Table 3. Distribution of the patients according to the call to action

Gender	Green	Yellow	Red
Male (346)	65 (18,79%)	213 (61,6 %)	68 (19,65%)
Female (521)	101 (19,38%)	341 (65,45%)	79 (15,16%)
Total (867)	166 (19,15%)	554 (63,9%)	147 (16,96%)

Table 4 presents follow up rates for each group of patients.

Table 4. Follow-up rates

Gender	Green	Yellow	Red
Male	46 (70,8%)	204 (95,8 %)	68 (100%)
Female	74 (73,3%)	329 (96,5%)	79 (100%)
Total	120 (72,3%)	545 (96,2%)	147 (100%)

2.2. Behavior Motivation

We have interviewed 48 patients, who agreed on this part of the study and signed a consent form.

The thematic analysis identified 4 core topics related to the patients' responses, namely: (1) usability, (2) intention to use, (3) trust, and (4) data protection. The first core topic highlighted the usability and clearness of the questions and recommendations. The second core topic demonstrated that the patients have strong wish to use the symptom-checker for screening. The core topic number 3 identified the issue of trust. The topic 4 identified personal data security and protection awareness. Table 5 present selected responses to support the obtained results.

Table 5. Selected answers

Core topic and Code	Selected responses
Usability Time	It doesn't take much time to do a screening [A1]
Usability clearness	The questions were clear to me, I could answer them easily [A2]
Usability Time	This tool can save my time [A3]
Intention to use Second opinion	I think this tool can be best used as a second opinion [A4]
Intention to use Second opinion	I can use it to better prepare to the doctor's questions [A5]
Intention to Use Second opinion	The portal allows to quickly update It can help me to be better informed on my health conditions [A6]
Intention to Use Second opinion	I still want to talk to a real doctor [A7]
Trust Explanation	The system explains the results clearly, so I can make an informed decision [A8]
Trust Explanation	I can see the logic behind the decision, so I can base my decision on what the system recommends [A9]
Trust User enthusiasm	The recommendations are clear, so I can rely on them when deciding to follow up [A10]
Data protection Privacy	It's good that no personal data is collected [A11]
Data protection Privacy	The session is anonymous, so I can trust the system [A12]

3. Discussion

As we can see from the follow up rate results, the urgent recommendations cause a 100% follow up rate. A red message always resulted in the doctor's visit. Yellow messages with a recommendation to visit a doctor soon if the health conditions do not improve also

resulted in almost a 100% follow up rate with actual number of 96,2%. The only recommendation that filtered some of the patients and prevented some of the not required visits was a green message with 72,3% follow up rate. So, we can clearly see that symptom checker screening doesn't result in a significant decrease of the load on healthcare professionals. This is supported by the quantitative study results. The patients emphasized the ease of use of the tool and clearness of the recommendations it gives. However, they perceived it as rather a second opinion tool or a tool that helps to prepare to the doctor's visit.

Our results add a discussion point to the efficiency of the symptom checker in terms of being able to decrease a load on the healthcare professionals or even replace them in some situations. We didn't observe any behavioral difference between males and females.

3.1. Limitations of the Study

In this study we did not assess the accuracy and other efficiency characteristics of the symptom checker. This will become a subject of a further study. The second limitation of the study is that we didn't research how the screenings affected the length of the actual doctor's visit, which will also become an objective of the further studies.

4. Conclusion

Our findings suggest that automatic symptom checkers don't significantly decrease a load on healthcare professionals, as they are mostly perceived as a second opinion tool.

References

[1]   Aluttis C, Bishaw T, Frank MW. The workforce for health in a globalized context – global shortages and international migration. Glob Health Action. 2014 Feb 13;7:23611. doi: 10.3402/gha.v7.23611. eCollection 2014.
[2]   Karimi-Shahanjarini A, Shakibazadeh E, Rashidian A, Hajimiri K, Glenton C, Noyes J, Lewin S, Laurant M, Colvin CJ. Barriers and facilitators to the implementation of doctor-nurse substitution strategies in primary care: a qualitative evidence synthesis. Cochrane Database Syst Rev. 2019 Apr 15; 4(4): CD010412. doi: 10.1002/14651858.CD010412.pub2.
[3]   Wu Q, Zhao L, Ye X-C. Shortage of healthcare professionals in China. BMJ. 2016; 354: i4860. doi:10.1136/BMJ.I4860.
[4]   Poppe A, Jirovsky E, Blacklock C, Laxmikanth P, Moosa S, de Maeseneer J, Kutalek R, Peersman W. Why sub-Saharan African health workers migrate to European countries that do not actively recruit: a qualitative study post-migration. Global Health Action. 2014; 7: 24071. doi:10.3402/GHA.V7.24071.
[5]   Zihindula G, John RA, Gumede DM, Gavin MR. A review on the contributions of NGOs in addressing the shortage of healthcare professionals in rural South Africa. Cogent Social Sciences, October 2019; 5(1). doi:10.1080/23311886.2019.1674100.
[6]   Griffith K, Evans L, Bor J. The affordable care act reduced socioeconomic disparities in health care access, Health Affairs. 2017; 36: 1503–1510. doi:10.1377/HLTHAFF.2017.0083/ASSET/ IMAGES/MEDIUM/2017.0083FIGEX1.EPS.GZ.GIF.
[7]   Djahel S, Smith N, Wang S, Murphy J. Reducing emergency services response time in smart cities: An advanced adaptive and fuzzy approach. 2015 IEEE 1st International Smart Cities Conference, ISC2 2015. doi:10.1109/ISC2.2015.7366151.
[8]   Stewart D, Lang E, Wang D, Innes G. Are emergency medical services offload delay patients at increased risk of adverse outcomes? Canadian Journal of Emergency Medicine. 2019; 21: 505–512. doi:10.1017/CEM.2018.478.

[9]   Battineni G, Sagaro GG, Chinatalapudi N, Amenta F. Applications of Machine Learning Predictive Models in the Chronic Disease Diagnosis. Journal of Personalized Medicine 2020; 10: Page 21. doi:10.3390/JPM10020021.

[10] Fraser H, Coiera E, Wong D. Safety of patient-facing digital symptom checkers, The Lancet. 2018; 392: 2263–2264. doi:10.1016/S0140-6736(18)32819-8.

[11] Baker A, Perov Y, Middleton K, Baxter J, Mullarkey D, Sangar D, Butt M, DoRosario A, Johri S. A Comparison of Artificial Intelligence and Human Doctors for the Purpose of Triage and Diagnosis. Front Artif Intell. 2020 Nov 30;3:543405. doi: 10.3389/frai.2020.543405. eCollection 2020.

[12] Ceney A, Tolond S, Glowinski A, Marks B, Swift S, Palser T. Accuracy of online symptom checkers and the potential impact on service utilization. PLOS ONE. 2021; 16 e0254088. doi:10.1371/JOURNAL.PONE.0254088.

[13] Eeg-Olofsson K, Johansson U-B, Linder E, Leksell J. Patients' and Health Care Professionals' Perceptions of the Potential of Using the Digital Diabetes Questionnaire to Prepare for Diabetes Care Meetings: Qualitative Focus Group Interview Study. J Med Internet Res. 2020 Aug 19;22(8):e17504. doi: 10.2196/17504.

[14] Marcellus L. The Grounded Theory Method and Maternal-Infant Research and Practice. Journal of Obstetric, Gynecologic & Neonatal Nursing. 2005; 34: 349–357. doi:10.1177/0884217505276053.

[15] Skeat J, Perry A. Grounded theory as a method for research in speech and language therapy. International Journal of Language and Communication Disorders. 01 March 2008; 43: 95–109. doi:10.1080/13682820701437245.