

## The use of digital technologies in the diagnosis of tumor diseases at the pre-medical stage

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### Abstract

**Aim.** To improve the effectiveness of tumors and risk factors detection in reducing time costs at the pre-medical stage using a robotic complex.

**Methods.** To achieve this goal, the previously created robotic complex with a program for self-questioning, taking into account gender, has been improved. A portable USB microscope was built into the complex's housing to transmit images of pathological changes of visible localizations to the touch screen. The survey and examinations were conducted by clinical residents and students of the "case-control" type in 1638 patients at the Novgorod Regional Clinical Oncological Dispensary (in 2019–2021) as part of the Doors Open Days. The average age of patients was  $54.6 \pm 8.9$  years, including 703 men and 935 women. Descriptive statistics methods of Statistica 6.0 software were used. Qualitative characteristics showed as absolute number and the relative value in percentage (%). The differences were considered statistically significant at  $p \leq 0.05$ .

**Results.** The use of the complex allowed us to suspect cancer risk factors in  $9.03 \pm 1.3\%$  patients, of which  $31.08 \pm 1.8\%$ , or  $2.8 \pm 2.1\%$  ( $p = 0.017$ ) of the total patients with the further examination was able to confirm oncology-related findings. Patients complained of discomfort in the stomach (59 people) underwent a breath test built into the program of the complex, according to the results of which helicobacteriosis was detected in 29 patients. In 17 patients with fibrogastrosocopy, intestinal metaplasia was subsequently established, in 4 — gastric ulcers, 3 of which had malignancy.

**Conclusion.** The use of a robotic complex-2 saves the time of a doctor of a "lean" polyclinic and improves the effectiveness of identifying cancer risk factors and early-stage cancer.

**Keywords:** robotic complex, survey with illustrations, physiological parameters, USB microscope, breath test, recommendations.

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**Background.** With the large number of patients, mass screening, and time limit, the doctor is unable to perform a complete survey of the systems. As a result, paucisymptomatic tumors remain unnoticed, and this leads to a high incidence of advanced cases and mortality from malignant tumors [1]. Thus, there is a need to create and introduce digital technologies that expand the possibilities of interviewing and increase "oncological alertness" and the efficiency of work in the primary care stage. An interactive system is available for collecting data from the population in the format of a mass sociological survey [2]; however, it is not for medical purposes [3].

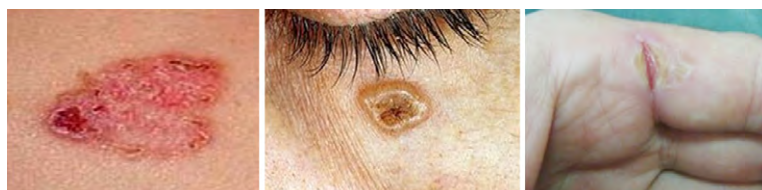
**This study aimed** to increase the efficiency of detecting tumor diseases and risk factors while re-

ducing costs and queues in the clinic at the pre-medical stage by using a robotic complex (RC).

**Materials and methods.** RC efficiency was investigated based on the created system survey program with illustrations and touch screen, but its body and program have been modified (RC-2). RC-2 additionally comprises simple diagnostic methods, such as a fingertip pulse oximetry to determine pulse, oxygen levels, and hemoglobin, and a non-invasive glucometer with a tonometer to assess the patient's current physiological state and cancer risk factors [4, 5]. An important set of RC-2 contains a magnifying digital diagnostics (including a portable USB microscope with LEDs) of focal changes in visual localizations (skin and oral cavity) with transmission to the screen, He-



**Fig. 1.** Touch screen: a, keyboard for filling in the passport data; b, questions with illustrations of pigmented tumors



**Fig. 2.** Precancerous changes and basal cell cancers

lik-scan® for determining the “respiratory urease test” for *Helicobacter pylori* (the main cause of stomach diseases) [6, 7], a computer program for assessing the examination results, formation of recommendations for further approach, and their transfer to the doctor for an appointment.

The RC survey program was performed on a touch screen, taking into account gender and specific factors. First, passport data were filled in (Fig. 1, a). Then, questions are shown on the main localizations with illustrations of melanoma and non-melanoma tumors (Fig. 1, b) and precancerous skin conditions (Fig. 2) and on the risk factors for the development of oncological diseases and other conditions of organs and systems (i.e., the state of the thyroid and mammary glands, presence of enlarged lymph nodes, lifestyles, and habits).

Examples of questions are presented below.

1. Do you have any (ulcer, crack, or other) formations on your skin?

a) Yes, I have. It began to change shape, color, or size.

b) Yes, a tumor appeared, spreading over the skin, in places with raised edges, other changes, sometimes itching.

c) Yes, there is an ulcer on the skin that does not heal for more than 3–4 weeks.

d) Yes, there is a lesion in the form of a skin-colored plaque with a depression in the center and raised shiny edges.

e) Yes, I have, but I do not know how to estimate it.

f) Yes, there are several signs.

g) No, nothing.

2. Do you have a pigment spot(s) on the face,



**Fig. 3.** Pigmented tumors (under the magnification of the screen, without coloring)

back, neck, including the nail bed (without bruising) or other places?

a) Yes. b) No. c) I do not know.

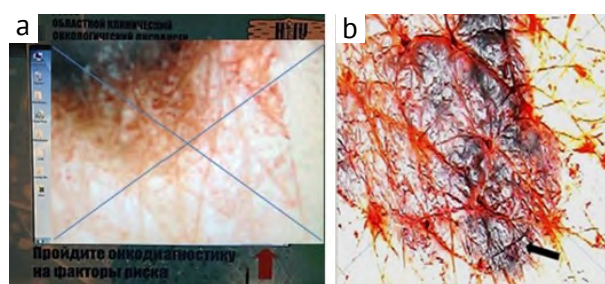
Considering the extremely high level of advanced oral cavity cancer cases, we have created a portable USB microscope with LED into a flexible hose entering from the side of the RC body to transmit pathological changes in visible localizations (skin and oral cavity) to the monitor. Suspicious segments can be enlarged on the screen and photographed (Fig. 3) [8].

To diagnose early forms of melanomas (horizontal phase), the structure of a pigmented nevus after picro-fuchsin staining was analyzed under a USB microscope  $\times 100$  with digital transformation of the image on a TV screen. After 8 min, the stain penetrates the reticular papillary layer of the skin (fuchsin stains bright red the collagen fibers in the form of diamonds, and picric imparts a yellow color to other tissue structures, which become randomly or asymmetrically located during

**Table 1.** Survey results with illustrations and chromomicroscopy

| Localization and risk groups  | Number of patients with suspected pathology | Precancerous changes and melanoma-prone nevi | Malignant tumors |
|-------------------------------|---------------------------------------------|----------------------------------------------|------------------|
| Skin                          | 16                                          | 8                                            | 8                |
| Oral cavity                   | 11                                          | 9                                            | 2                |
| Lymph nodes                   | 19                                          | 19                                           | —                |
| Thyroid gland                 | 44                                          | 43                                           | 1                |
| Mammary gland                 | 58                                          | 56                                           | 2                |
| Risk groups (DM, HD, and Hb)* | 64                                          | —                                            | —                |
| Total                         | 212                                         | 135 (8.2%)                                   | 13 (0.79%)       |

Note: \*DM, diabetes mellitus; HD, hypertensive disease; <Hb, low hemoglobin level: —, cancer risk groups for breast cancer, colon cancer, etc.

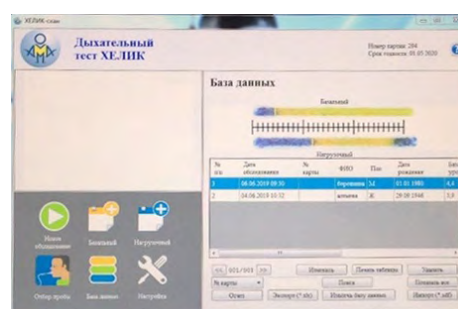


**Fig. 4.** Examination results for oncological pathology: a, simple nevus, the fibers form a relatively uniform diamond-shaped network; b, superficially spreading melanoma, its collagen fibers are chaotic, with asymmetrically located globules, and angioneogenesis formation (arrow)

malignancy). To evaluate the lesion, two lines were drawn in segments from the screen corners [9, 10].

**Results and discussion.** The survey and expert examinations were performed by clinical residents in 1638 patients who visited the Novgorod Regional Clinical Oncology Center (2019–2021) during the Doors Open Days and regional exhibitions. The use of the RC allowed them to suspect tumors of the skin, oral cavity, thyroid and mammary glands, and lymph node enlargement in 148 (9.03%  $\pm$  1.3%) patients. The oncological pathology was confirmed in 46 of them (31.08%  $\pm$  1.8% and in all respondents (2.8%  $\pm$  2.1%;  $p = 0.017$ ) with further examination; melanoma was established in three patients (Fig. 4), basal cell carcinoma in five, oral cancer in two, thyroid cancer in one, and breast cancer in two patients. In addition, eight patients were diagnosed with melanoma-prone nevi (Table 1). The time for the survey and USB microscopy in the presence of suspicious pigmented lesions ranged from 13 to 20 min (on average,  $18 \pm 4.5$  min).

Even with the slightest complaints related to the stomach and other digestive organs, 59 patients underwent a sensitive “breath test” based on the Helik-Scan® built into the RC panel. Two “breath tests” were performed on an empty stomach for 6 min each, before (basal test) and after (with car-



**Fig. 5.** Patient P. 42 years old: upper band, the basal test turned blue up to 4.9 units; lower band, after loading, 10.8 units

bamide loading) taking carbamide. The blue bar on the screen increased significantly in comparison with the basal test in proportion to the percentage of ammonia in the exhaled air (Fig. 5). According to the results of the color change in the “breathing tubes,” helicobacteriosis was higher than 10 units with load, and the fixation on one touch screen was revealed in 29 (49.15%  $\pm$  1.9%) patients.

The online program reflected the change in the length of sample 2 on the screen in accordance with the stomach infection with *H. pylori*. Color change in “breathing tubes” >10 units with load was revealed in 29 (49.15%  $\pm$  1.9%) patients. In 17 (28.8%  $\pm$  1.7%;  $p = 0.017$ ) patients who had fibrogastroscopy, metaplasia was subsequently established in the small intestine (MP-1) and colonic (MP-2) types, four patients had gastric ulcer, and three of them had malignancy.

Thus, the use of the RC and RC-2 at the pre-medical stage, taking into account the methods of targeted survey with illustrations by screening patients who seek medical help, proved its efficiency and reduced the time for systemic survey and general examination of the patient by an average of  $18 \pm 4.5$  min.

In the future, the survey–examination is planned to be conducted in polyclinics of the

general medical network by a specially trained nurse-consultant or midwife in the examination room, who will help answer difficult questions to the patient, and conduct additional examinations. All examination results of the complex program via the local Internet system and recommendations for further approach should be sent to the attending physician of the “lean polyclinic.”

## CONCLUSIONS

1. Robotic examination for primary diagnostics of risk factors and early forms of cancer of the main localizations is relatively simple and affordable for each patient with the participation of a specially trained paramedical worker.

2. The introduction of the RC-2 will save the time of each doctor in a “lean” polyclinic and increases the efficiency of identifying cancer risk factors and early forms of malignant neoplasms; thus, prevention and treatment are more successful and less expensive.

**Author contributions.** Ch.V.G. was the work supervisor, set the terms of reference for the RC program, collected and formed the information. V.V.R. was the work supervisor and created the work design. P.K.G. organized the Doors Open Days, collected the information, processed the results, and wrote the paper. A.I.G. generated the program and provided design support.

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**Conflict of interest.** The authors declare no conflict of interest.

## REFERENCES

1. *Zlokachestvennye novoobrazovaniya v Rossii v 2019 godu (zabolevaemost i smertnost)*. (Malignant neoplasms in Russia in 2019 (morbidity and mortality).) Ed. by A.D. Kaprin, V.V. Starinsky, A.O. Shakhzadovoy. M.: MNIOI im. P.A. Gercena — filial FGBU “NMIC radiologii” MinzdravaRossii. 2020; 252 p. (In Russ.)

2. Dartau L.A., Mizernitsky Yu.L., Stefanyuk A.R. *Zdorov'e cheloveka i kachestvo zhizni: problemy i osobennosti upravleniya*. (Human health and quality of life: problems and features of management.) M.: SINTEG. 2009; 400 p. (In Russ.)

3. Kushnir V.A., Katilov A.V., Magdebura S.A. *Metodika obsledovaniya patsientov s nevusami i melanomoy kozhi. Voenno-meditsinskiy klinicheskiy tsentr Tsentral'no-go regiona (g. Vinnitsa)*. (Methods of examination of patients with nevi and melanoma of the skin. Military Medical Clinical Center of the Central region (Vinnitsia).) M.: N.I. Pirogov Medical University. 2015; 52–54. (In Russ.)

4. Paches A.I. *Opukholi golovy i shei*. (Tumors of the head and neck.) M.: Practical medicine. 2013; 416 p. (In Russ.)

5. Semiglazov V.F., Semiglazov V.V. *Rak molochnoj zhelezy*. (Breast cancer.) M.: MK LLC. 2014; 264–266. (In Russ.)

6. Besova N.S., Byakhov M.Yu., Gorbunova V.A., Davydov M.I., Davydov M.M., Karseladze A.I., Kolobaev I.V., Kuvshinov Yu.P., Malikhova O.A., Nered S.N., Stilidi I.S., Turkin I.N., Tryakin A.A. *Klinicheskie rekomendatsii po diagnostike i lecheniyu bol'nykh rakom zheludka*. (Clinical recommendations for the diagnosis and treatment of patients with stomach cancer.) M. 2018; 40 p. (In Russ.)

7. Gantsev Sh.H., Starinsky V.S., Rakhmatullina I.R., Kudryashova L.N., Sultanov R.C., Sakaeva D.D. *Ambulatorno-poliklinicheskaya onkologiya. Rukovodstvo dlya vrachey*. (Ambulance-polyclinic oncology. A guide for the doctors.) 2<sup>nd</sup> izd. M.: GEOTAR-Media. 2014; 448 p. (In Russ.)

8. Cherenkov V.G., Pasevich K.G., Gulkov I.V., Kostylev A.V., Kabirotov V.A., Aubakirov R.A. Preliminary results of the creation of a robotic complex in the organization of primary diagnostics of risk factors and early forms of cancer. *Rossiyskiy onkologicheskiy zhurnal*. 2018; 23 (3–6): 176–179. (In Russ.) DOI: 10.18821/1028-9984-2018-23-3-6-176-179.

9. Cherenkov V.G., Pasevich K.G., Gulkov I.V., Prysiashnyuk S.L. Non-randomized study of a new usb chromomicroscopic method for the diagnosis of superficial spreading melanomas. *Farmateka*. 2020; 27 (11): 42–45. (In Russ.) DOI: 10.18565/pharmateca.2020.11.42-45.

10. Pasevich K.G., Cherenkov V.G., Gudkov I.V., Ris M.E., Naumenko E.S. *A method for diagnosing melanoma of superficial spread*. Patent for invention RF No. 2716811. Bulletin issued at 16.03.2020. (In Russ.)