SECTION 4. PREVENTIVE MEDICINE

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4.1 Implementation and application of information and communication system with a feedback function for improval of quality of medical care in patients with type 2 diabetes at the primary level during COVID-19 pandemic

Quality in of health care is considered as a multidimensional concept, which includes a dynamic continuous process of providing medical service to patients by health care institutions, in particular, by primary health care centers (PHC), aiming to meet the medical needs of the population. High-quality medical care also involves effective, safe and rational use of resources, as per medical standards, as well as reducing costs in the health care system [332-333].

The COVID-19 pandemic caused severe medical and socio-economic challenges worldwide, which required fast adaptation of health care, in particular primary care, focusing on the quality of medical care (QMC) [334]. Increasing in use of medical information and communication systems (ICS) amidst of quarantine restrictions may help to improve interaction between provider of medical service and patients, to ensure remote monitoring of the health status in population and disease prevention, creating additional incentives and motives to comply with recommendations of the attending physician. It may also reduce the burden on providers of primary health care service [335-337].

Chronic diseases are among the most important public health issues, creating a global burden caused by high morbidity, disability and premature mortality. Diabetes mellitus (DM) ranks second in the structure of chronic diseases. Analysis of International Epidemiological Studies shows a continuous annual increase in people with diabetes, which causes social and economic costs for both developed and developing countries. The global increase in the prevalence of diabetes is mainly due to the aging of the population, as well as impact of behavioral risk factors on diseases` development (keeping unhealthy diet, low level of physical activity, tobacco and alcohol) [338, 339].

According to the International Diabetes Federation, in 2021, 537 million patients with diabetes were diagnosed. In European countries, this indicator was 61 million people. It is predicted that the number of patients with DM will increase by 46% in general and by 13% in European countries by 2045 [340]. In Ukraine, the number of patients with diabetes is also increasing every year and makes up about 1 million 300 thousand people. However, total number of undiagnosed patients is 2-3 times higher [341].

As per the updated recommendations of the American Diabetes Association, to optimize the management of patients with diabetes mellitus, modern approaches, methods and technologies of dynamic monitoring and treatment are needed, which will improve medical care and contribute to strengthening the health in population, by implementing behavioral mechanisms for active involvement of patients to constant monitoring/self-monitoring of glycemic status. Also, an important role in improvement of QMC in patients with diabetes is attributed to the impact on socioeconomic determinants of health (healthy food, physical activity, quitting bad habits, social support), as they hold an important role in achieving disease control, affect the risk of short- and long-term complications` occurrence and patient mortality [342-344].

For DM patients, the issue of optimization of medical services due to modern effective information and communication medical technologies based on behavioral theory, in emergency conditions, in particular during COVID-19 pandemic, is becoming more and more relevant. After all, in quarantine restrictions and the burden on primary care, qualitatively developed medical digital tools help to create additional stimuli for constant self-monitoring of glycemic status in patients, contribute to increasing their compliance with doctor's recommendations [345-347].

Thus, in order to solve the above-mentioned issues of preventing short- and long-term complications in patients with type 2 diabetes, as well as providing additional information and actively involving them in continuous self-monitoring of their own health, we developed and implemented an automated ICS "Remote medical service in management of QMC system at the primary level" with a feedback that allows to conduct dynamic monitoring of the patient`s health remotely.

The results of ICS introduction among the studied cohort of patients with type 2 diabetes were evaluated according to the following indicators of QMC: control of glycemia and glycated hemoglobin (HbA1c), control of blood pressure (BP), frequency of hypoglycemia and/or ketoacidosis state occurrence, diet therapy, adequate insulin therapy and /or taking hypoglycemic drugs (regular medication, dose correction based on glycemic control and HbA1c level), keeping healthy lifestyle, frequency of family doctor appointments, timely examination, number of hospitalizations per year due to diabetes and/or hypertension, number of ambulance calls [338].

The aim. To assess the effectiveness of implementation of a remote medical service with a feedback to involve patients with type 2 diabetes in dynamic self-monitoring of their health state and disease prevention during the COVID-19 pandemic, as well as to calculate the potential for saving budget funds at the level of institutions of health care in Sumy.

Materials and methods. 96 residents of Sumy, aged 18 to 70, with diabetes and who gave their consent for processing and using their personal data participated in the cohort prospective medical and sociological study. In six months of 2020, the remote dynamic bilateral monitoring and treatment algorithm using ICS "Remote medical service in management of QMC system at the primary level" was implemented within the studied cohort (Certificate of copyright registration No. 84380 dated 15.01.2019). Then indicators of quality of providing medical care in patients with type 2 diabetes and level of motivation of the studied group of patients for self-monitoring of glycemia level were analyzed. The methods of information collection used during the research are surveys, that include a closed questionnaire developed for medical and sociological research, as well as copying from the primary accounting records "Medical card of an outpatient" (file No. 025/o). The questionnaires were reviewed and approved by the Academic Council of the Educational and Scientific Medical Institute of Sumy State University. The research involved a systematic approach, bibliosemantic, comparative and statistical analyses, and logical generalization. Google Forms and the Microsoft Excel 2010 program for Windows, processing and statistical analysis of the received

data was used to carry out: descriptive statistics, calculation of the error of the relative value (m).

The medico-sociological survey concerned identification of patients' awareness of the disease and prevention of its complications, regularity of diagnostics and treatment measures, awareness of their responsibility for their health and importance of their active involvement in preventing the influence of modified risk factors.

Thus, 96 questionnaires from Sumy residents aged from 18 to 69 years (including 58 women (60.42%); 38 men (39.58%) were examined.

Patients aged 18-29 made up 1.04%; 30-39 years old - 5.21%; 40-49 years old - 9.38%; 50-59 years old - 28.13%; 60-69 years old - 56.25%.

The analysis of the continuous monitoring outcome showed improval in QMC indicators and respondents' health status during the period of ICS implementation at the level of primary health care.

The percentage of patients who monitor blood pressure regularly, compared to the data before implementation (43.8±3.58%), increased by +32.3% and made 76.1±3.08% of respondents. Before the introduction of ICS feedback, only 22.9±3.03% of respondents indicated measuring blood pressure twice a day and 20.8±2.93% - once a day; and after the introduction, 31.3±3 .35% of respondents indicated that they control their blood pressure twice a day and 44.8±3.59% – once a day. A decrease of -24.5% in the share of patients who measure blood pressure only once a week or less was noticed - before the ICS implementation, the share of such patients equaled 29.2±2.86%, after implementation it went 8.8±1.47%. The data received from the repeated audit on control/self-control in respondents are shown in the Table 1.

Table 1.

Results of a survey in respondents with type 2 DM regarding the frequency of blood pressure control (in %)

No.	Indexes	Patients` data and their health state monitoring, %		Difference, %	Level of significance, p
		Before implementation	After implementation		
1	2	3	4	5	6
1	2 times a day	22.9±3.03	31.3±3.35	+8.3	<0.001
2	Once a day	20.8±2.93	44.8±3.59	+24	<0.001
3	2 times a week	21.9±2.93	12.0±2.34	-10.9	<0.001
4	Once per week	13.5±3.03	5.7±1.68	-15.1	<0.001
5	Once per month	15.6±2.69	3.1±1.26	-9.4	<0.001

The analysis of a quality indicator as the frequency of control/self-control of glycemia showed that specific weight of patients who regularly control the level of glycemia increased by +35.4% and made 60.4±2.93% of respondents, comparing to 2018 - 29,2±2.69%. Before implementation of ICS, only 8.3±1.99% of respondents mentioned controlling blood glucose every day, and 16.7±2.69% - two or three times a week. After implementation, the share of these respondents increased to 20.8±2.93% and 39.6±3.53%, respectively. It is noteworthy a significant decrease in a specific gravity of patients (-41.7%) who mentioned monitor/self-monitor of glycemia as once a month or less: before ICS implementation, this indicator was 52.1±2.32% of people, and after - 10 .5±1.47%. The data obtained from the re-audit on control/self-control of glycemia in respondents are shown in the Table 2.

The data obtained at the time of the repeated survey on the level of glycemia and blood pressure showed that percent of respondents who had a target blood pressure

level (≥ 140/90 mmHg) increased to 63.5±3.60% after ICS implementation (+25%). The survey found that only 11.5±2.20% of people had a satisfactory level of diabetes compensation (fasting blood glucose in the range of 4.4-6.7 mmol/l) before ICS implementation, and a repeated survey demonstrated the percentage of respondents in this group increasing to 40.6±3.37% (+29.1%).

Table 2.

Results of a survey in respondents with type 2 DM regarding the frequency of glycemic control/self-monitoring (in %)

No.	Indexes	Patients` data and their health state monitoring, %		Difference, %	Level of significance, p
		Before implementation	After implementation		
1	2	3	4	5	6
1	Everyday	8.3±1.99	20.8±2.93	+12,5	<0,001
2	2-3 times a week	16.7±2.69	39.6±3.53	+22,9	<0,001
3	Once a week	22.9±3.03	29.2±3.28	+6,3	<0,001
4	Once a month	47.9±3.61	8.9±2.05	-39,1	<0,001
5	Once per 3 months	2.1±1.03	1.6±0.89	-0,5	<0,001
6	1 раз в 6 місяців, не контролюють	2.08±1.03	-	-2,1	<0,001

The number of emergency medical care (EMC) calls decreased by -12.5%. During the initial survey, 32.3±3.40% of respondents mentioned calling EMC, and during the second survey the rate was 19.8±2.88%. The study of the effectiveness of ICS implementation at the level of the primary care institution showed a decrease from 58.3±3.56% to 44.2±3.58% in respondents (by -14.1%) who required inpatient treatment of diabetes and/or its complications.

The incidence of hypoglycemia and/or ketoacidosis conditions decreased by -4.2%. During the initial survey, 6.3±1.75% of respondents noted the occurrence of such conditions during the year, and during the second survey – only 2.1±1.03% of respondents mentioned the same.

Patients tended to visit medical institutions more frequently for prophylaxis. The specific weight of patients who visited their family doctor two or more times during the studied period increased from 72.9±3.58% to 90.6±2.88% (+17.7%), and specific weight of patients, who visited a doctor once a year decreased from 14.6±5.09% to 9.4±3.06% (by -5.2%); the number of patients who never visited a doctor for preventive purposes decreased by -8.3%.

The positive effect of reminders (done with ICS) on frequency of medication by patients is significant. Compared to the survey before the implementation of ICS, during which 79.2±2.93% of respondents mentioned regular medication with drugs prescribed, this indicator increased by +12.5% and equaled 91.7±1.99%. The obtained results of repeated medical and sociological research are presented in the Table 3.

When comparing and analyzing information on the frequency of HbA1c level measurement among the studied group of patients with type 2 diabetes, it was found that during 2017-2018, only 9.4±2.98% of patients were examined once every 3-4 months, 21, 9±4.22% of patients were examined twice a year, and 40.6±5.01% at least once a year. The share of patients with missing data for this period was 28.1±4.59%. Therefore, based on the obtained data, it can be concluded that only 31.3% of people had an adequate level of glycemic control (testing for HbA1c level at least once every 3-6 months), and 68.7% of people had no appropriate level of glycemic control.

The positive impact of additional information and periodic reminders (done by ICS) on the motivation of the studied group to control the level of glycemia is noticed. During six months of ICS implementation, all of them were examined for HbA1c once or twice: 42.7±5.05% of people were examined twice, i.e. once every 3 months (+33.4% increase), and 57.3±5 .05% of people were examined once every 5-6 months (increase of the indicator +35.4%).

Table 3.

Evaluation of indicators of the effectiveness of ICS implementation according to the data from repeated survey in respondents with type 2 diabetes (in %)

No	Indexes	Patients` data and their health state monitoring, %		Difference, %	Level of significance, p
		Before implementation	After implementation		
1	2	3	4	5	6
1	Occurrence of hypoglycemia and/or ketoacidosis	6.3±1.75	2.1±1.03	-4.2	<0.001
2	Calling EMC	32.3±3.40	19.8±2.88	-12.5	<0.001
3	Had inpatient treatment during the year: ● once ● 2 times ● 3-4 times	58.4±3.56 ● 43.8±3.5 ● 6.3±1.75 ● 8.3±1.44	44.3±3.58 ● 39.1±3.52 ● 3.7±1.35 ● 1.6±0.89	-14.1 ● -4.7 ● -2.6 ● -6.8	<0.001
4	Visited a medical institution 2 or more times a year	72.9±3.58	90.6±2.88	+17.7	0.014
5	Visited a medical institution once a year	14.6±5.09	9.4±3.06	-5.2	<0.001
6	Did not attend medical institution at all during year	8.3± 3.99	-	-8.3	<0.001

Continuation of the Table 3.

1	2	3	4	5	6
7	Have blood pressure ≤140/90 mmHg. during the survey	38.5±3.56	63.5±3.37	+25.0	<0.001
8	The level of fasting blood glucose is 4.4-6.7 mmol/l at the time of the survey	11.5±2.20	40.6±3.37	+29.2	0.034
9	Regularly take medication (treatment for DM and AH)	79.2±2.93	91.7±1.99	+12.5	<0.001
10	Take medication irregularly (treatment for DM and AH)	20.8±2.93	8.3±1.99	-12.5	<0.001

The specific gravity of patients with a target level of HbA1c (<7%) increased by +19.8% (before implementation only among 10.4±3.12% of people, and after implementation – in 30.2±4.69% target level of the indicator is detectable); the specific weight of patients whose HbA1c level is in the range >7% - <8% increased from 18.8±3.98% to 44.8±5.08% (by +26%). The proportion of patients with an unsatisfactory level of diabetes control (HbA1c >8%) during the study period decreased from 42.7±5.05% to 25.0±4.42% (by -17.7%). It should be mentined that before the study conduction, it was not possible to assess the degree of glycemic control in28.1±4.59% of patients, because they did not test the HbA1c level during the year, yet after the study, the level of awareness about the importance of glycemic status control improved in patients, making them pass the test to control (Table 4).

Table 4.

Comparison of HbA1c level according to the results of the last test before and after the ICS implementation (in %)

No.	Indexes	Patients` data and their health state monitoring, %		Difference, %	Level of significance, p
		Before implementation	After implementation		
1	2	3	4	5	6
1	<7 %	10.4±3.12	30.2±4.69	+19.8	<0.001
2	>7 % - <8 %	18.8±3.98	44.8±5.08	+26.0	<0.001
3	>8 %	42.7±5.05	25.0±4.42	-17.7	<0.001
4	Data unavailable	28.1±4.59	-	-28.1	<0.001

Thus, the obtained results regarding reduction of the number of EMC calls, number of hospital admissions also provide an opportunity to evaluate economic efficiency of the ICS implementation and potential for saving budget funds at the level of primary health care according to the following indicators: cost savings at the level of research and levels of health care facilities in Sumy.

The potential for saving budget funds (in 2020 prices) was calculated. During the calculations, the following data from the Main Department of Statistics of Sumy Region were used: cost per one day of inpatient treatment in endocrinology department equaled UAH 421.00; average length inpatient treatment in a hospital makes 10.2 bed/days.

Accordingly, the cost savings (E_{inp}) as a result of reducing the need for inpatient treatment amounted to:

$$E_{inp} = 421{,}0 \times 10{,}2 \times 14 = 60\ 118{,}8 \text{ (UAH)}.$$

The number of EMC calls decreased by 12.5% among the studied group of patients as a result of implementation of measures to optimize QMC at the primary care level (12 patients). The average cost of one urgent/emergency medical care team departure was UAH 381.33. Accordingly, cost savings (E_{EMC}) amounted to:

$$E_{EMC} = 381,33 \times 12 = 4\ 576 \text{ (UAH)}.$$

The total amount of savings at the level of health care institutions of Sumy, on the basis of which the research was conducted, equaled:

$$E_{inp} + E_{EMC} = 60\ 118,8 + 4\ 576 = 64\ 694,8 \text{ (UAH)}.$$

Provided application of the developed ICS to optimize the QmC system at the primary level in all patients with type 2 diabetes under dynamic observation in primary care institutions in Sumy, projected budget savings will make:

- due to a decrease in the need for inpatient treatment by 14.1% (1,110 patients):

$$E_{inp} = 421,0 \times 10,2 \times 1110 = 4\ 766\ 562 \text{ (UAH)}.$$

- due to a 13.5% decrease in calls for emergency medical teams (1,064 cases):

$$E_{EMC} = 1064 \times 381,33 = 405\ 735,1 \text{ (грн)}.$$

Therefore, the projected saving of budget funds for Sumy city will be about UAH 5,172,297.1.

The data obtained during our research demonstrate positive impact of the developed and implemented ICS on health of the population and level of prevention of chronic diseases, in particular type 2 diabetes, on creation of conditions and additional stimuli for ensuring the responsible attitude of patients to comply with doctor's appointments and control state of health. This positively impacts patients' awareness of effect of modified risk factors on their health as well. It has been proven that amidst COVID-19 pandemic and quarantine restrictions, in order to optimize QMC and prevent development of short- and long-term complications of diabetes, it is advisable to introduce an algorithm of dynamic monitoring of patients health condition, which involves their active participation, feedback from the doctor and additional information. The expediency and effectiveness of ICS implementation is confirmed by positive impact on medical and economic indicators of quality.