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COMPARATIVE ANALYSIS OF GLUCOMETERS ASSORTMENT ON THE UKRAINIAN PHARMACEUTICAL MARKET FOR THE DECADE (2011–2021)

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INFORMATION

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pharmaceutical market of Ukraine.

ABSTRACT

The aim of the work. Conducting a comparative analysis of glucometers and test strips assortment in Ukraine for decade to establish the specific dynamics of the glucometer market.
Materials and Methods. We used marketing, graphic, summarizing analyzes, comparison method and scientific and official sources about glucometers as well.
Results and Discussion. Based on a comparative analysis of the assortment of glucometers in Ukraine, a positive trend has been shown for decade (2011–2021), but import dependency. The number of offers of devices have increased by a factor of 1.8. Nine models which were on market in 2021 and 2011. This has indicated that part of the segment is stable. Manufacturers from Asian countries have leading positions in the supply glucoments, and they have increased their offers decade. Glucometers have became more functionality.
Conclusions. A wide assortment of glucometers allows patients with diabetes mellitus to choose the necessary device for self-monitoring.

Introduction. Despite the possibilities of modern medicine, there is a progression of complications of diabetes mellitus (DM), increasing disability and deteriorating quality of life of patients with diabetes [1, 2]. The main factors in the development and progression of complications of diabetes are chronic hyperglycemia and frequent episodes of hypoglycemia, so the control of blood glucose level is essential. The creation of effective ways of glycemic control has raised the care of patients with diabetes to a qualitatively new level [3].

To determine the level of glucose in the blood using electronic medical devices – glucometers, which allow you to effectively apply treatment regimens and achieve the desired results of therapy. Without means of glycemic control and self-control it is impossible to achieve compensation for diabetes. The presence of complications of diabetes not only improves the quality of life of the patient, but also relieves the health care system [4], so monitoring blood glucose by patients with portable devices is considered cost-effective [5].

Portable devices have significant advantages in use: reduction of time of the analysis of glucose in blood; reduction of testing errors; fast availability of results; autonomous and convenient tools; use of a small volume of blood sample for analysis; storage of the latest results in the memory of the device, affordable cost and ease of operation [6]. The first glucometer from Clark and Lyons was introduced in the 1960s [6], and in the mid-1980s the first domestic portable device for measuring blood glucose was released [7], after which, in the late 90s, foreign glucometers appeared in Ukraine. According to the analytical group Bridge, the market of glucometers is expected to grow in the period 2021–2028. This is due to the growing incidence of diabetes, increasing geriatric population, rising health care costs and technology development [8].

Today, a wide selection of glucometers is offered, but the study of the dynamics of the range of glucometers for a last years in Ukraine was not conducted. Therefore, it is important to study the dynamics of supply of glucometers in the domestic pharmaceutical market.

The aim of the work was to conduct a comparative analysis of the assortment of glucometers and test strips in Ukraine, with the definition of their characteristics, completing units and features of use, for the decade to establish the dynamics of the glucometers market.

Materials and Methods. The objects of the study were information from the State Register of Medical Equipment [9], offers of pharmacies and online stores which are available to Ukrainian consumers. For comparative analysis, we studied the technical characteristics, the principle of measurement, coding, calibration of glucometers, their additional functions, completing units and test strips for the relevant devices. Data from their previous studies [10, 11, 12] was used. Marketing, analytical, graphical, generalizing analyzes and comparison methods were used.

Results and Discussion. Generalized information about glucometers, which are presented on the pharmaceutical market of Ukraine in 2011 and 2021 provides in Table 1. In 2011 there were 24 models of glucometers, and 44 modes were in 2021. The result of

Table 1.
Glucometers on Ukrainian pharmaceutical market (2011–2021)

Manufacturer, country	Name of the glucometer	
	2011	2021
1	2	3
LLC Dopomoga-1, Ukraine	CARE-G	
Elta, Russia	Satellit Plus	
Taidoc, Taiwan	Glucofot Pus	
	Glucofot - Lux	
	Gamma model MINI	
Roche Diagnostics/ Roche Diabetes Care* Germany (1) United States America (2,3)	Accu Chek Active	Accu Chek Active
	Accu Chek Performa	Accu Chek Performa
		Accu-Chek Performa Nano
Life Scan, Switzerland	One Touch Select	One Touch Select Simple
	One Touch Ultra	OneTouch Ultra Plus Flex
	One Touch Ultra Easy	OneTouch Ultra Easy
Abbott, United States	Optium Xceed	Optium FreeStyle Neo
	FreeStyle Papillon Mini	
	Optium Omega	
Bionime, Taiwan	Rightest GM 110	Rightest GM 110
	Rightest GM 300	Rightest GM 300
	Rightest GM 550	Rightest GM 550
		Rightest ELSA
Int. Medical Equipment Diabetes Care, Germany	IME-DC	IME-DC
		IME-DC IDIA
ALLMedicus / All Medicus Co., Ltd. *, South Korea	Gluco Dr Slim (AGM 2300)	Gluco Dr. Auto (AGM-4000)
77 Elektronika Ltd, Hungary	SensoLite Nova Plus	SensoLite Nova Plus
	SensoLite Nova	
Acon Laboratories, Inc / Acon *, China	On Call Plus	On Call Extra
	On Call EZ	
MED TRUST, Austria (1) / MED TRUST*, China (4)	Wellion Calla Light	Wellion Calla Light
		Wellion Luna Duo
Bayer /Bayer Healthcare*, Switzerland	Contour TS	Contour Plus

Continuation of Table 1

1	2	3
ForaCare Suisse AG, Taiwan		Gamma Mini
		Gamma Diamond Voice
		Gamma Speaker
		Gamma PRIMA
Network Selects, China		Longevita Smart
i-sens, South Korea		CareSens N
Nipro, United States America		TRUEresult Twist
OK Biotech, Taiwan		Diacont
Infopia, South Korea		GluNeo
		GluNeo Lite
		Finetest Auto-coding premium
		Element
ARKRAY, Japan		SUPER GLUCOCARD II
GLANBER, China		Glanber LBM-01
SD Biosensor, South Korea		STANDARD GlucoNavii GDH
Beurer, Germany		Beurer BR-GL50
		Beurer BR-GL44
SD CodeFree, South Korea		SD CodeFree
Medisana, Germany		Medisana MediTouch
		Medisana MediTouch 2
General Life Biotechnology Co.Ltd., Taiwan		BeneCheck PLUS
NewMed GmbH, China		NewMed Neo
		NewMed VISIO
Contec Medical Systems Co., Ltd., China		CONTEC, BG01
TaiDoc, China		TaiDoc TD 4183

Note – * changed the name of the company for the study period.

comparative marketing analysis for decade has shown significant positive dynamics – increasing the number proposals almost twice (1.8). At the same time, 9 models of glucometers (20.5 % range in 2021) were available in 2011 too. This indicates the stability of the supply of companies, and in this case, they provide the pharmaceutical market with test strips for such devices. This is important for the patient, as it does not require changing the glucometer for a long time, which prevents additional financial costs for the patient.

The analysis of the glucometers showed its import dependence, both in 2011 and in 10 years.

In 2011, 37.5 % of the range was represented by manufacturers from Asia, a first part of the market (45.8 %) was represented by manufacturers from European companies which included one proposal Ukraine and Russia by each, and from the USA – 16.7 %. In 2021, Asian companies significantly increased their proposal of the range, which amounted to 63.6 % of the market, and European manufacturers reduced and provide 27.3 % of the range, while USA companies provide 9.1 %. There are no domestic proposals (Fig. 1).

Detailed analysis of the characteristics and features of glucometers was conducted (Table 2).

According to the *principle of operation*, almost all glucometers in 2011 and 2021 are electrochemical, except for the photometric device Accu Chek Active, which was on the Ukrainian market throughout the study period. Test strips for the Accu Chek Active photometric meter additionally have a strip for visual determination of blood glucose (without the use of the device). This option is important when the meter's battery runs out and there is no possibility to change it, or the device breaks down.

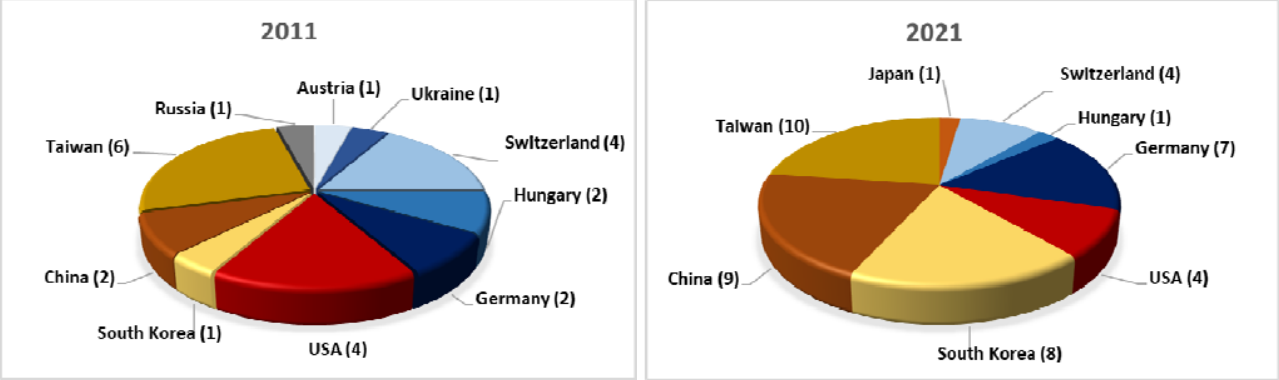

Figure 1. Segmentation of glucometers by country on the Ukrainian pharmaceutical market in 2011 and 2021.

Table 2
Technical characteristics and functions of glucometers

Technical characteristics / Functions	2011		2021		
	Number	%	Number	%	Dynamics
Assortment of glucometers (total)	**24**	100	**44**	100	
Principle of action					
- electrochemical	**23**	95.8	**43**	97.7	
- photo colorimetrical	**1**	4.2	**1**	2.3	
Device coding					
- manually	**7**	29.2	**2**	4.6	
- automatically	**14**	58.3	**17**	38.6	
- without code	**3**	12.5	**25**	56.8	
Calibration of test strips					
- on whole blood	**4**	16.7	**2**	4.6	
- on blood plasma	**20**	83.3	**42**	95.5	
Special signals					
- the expiration date of the test strips expires	**2**	8.4	**12**	27.3	
- warning of hypoglycemia	**2**	8.4	**10**	22.7	
- "alarm clock" function (reminder of the need for self-monitoring)	**3**	12.5	**17**	38.6	
- labeling of pre- and postprandial result	**3**	12.5	**27**	61.4	
Additional functiones					
- saving the results of the analysis	**22**	91.7	**41**	93.2	
- calculation of the average value of the analysis result	**7**	29.2	**9**	20.5	
- automatic detection of insufficient blood for analysis and the ability to add a drop of blood to the test strip	**7**	29.2	**9**	20.5	
- application of blood for analysis outside the device	**1**	4.2	**1**	2.3	
- acoustic mode	**2**	8.4	**9**	20.5	
- computer compatibility	**13**	54	**32**	72.7	
- measurement of other blood parameters (cholesterol, hemoglobin, uric acid, ketones)	**2**	8.4	**12**	27.3	

Note: / increased /decreased % compared to the previous year.

To prevent inaccurate results, all meters must *be coded*. The codeless device and the automatic method of coding using a code-strip are the most convenient, as they avoid the influence of the "human factor" on the accuracy of the results. In 2011 in Ukraine more than half (58.3 %) of glucometers are coded automatically, and in 2021 most glucometers are codeless (56.8 %), while the number of models with manual coding decreased.

According to the recommendations of the International Federation of Clinical Chemistry and Laboratory Medicine, devices for self-monitoring of blood glucose levels should be *calibrated* by blood plasma [14]. Almost all models of glucometers, during the study period, were calibrated by plasma, except for 4 glucometers in 2011, and 2 devices in 2021, which were calibrated by whole blood.

Based on the analysis of the characteristics and functions of glucometers, their features are established.

Analysis of the operating range of the devices showed, both in 2011 and in 2021, that in almost all glucometers *the operating temperature range* is mainly 10–40º C, and humidity – <85 (90) %. In 2021, the number of models with the largest range of glucose control (0.55 (0.6) – 33.3 (35) mmol/l) almost doubled compared to 2011. It was found that only a small number of glucometers have the largest range of adaptation to changes in hematocrit from 10 (15) to 65 (70) %.

Measurement with modern glucometers is very fast. Figure 2 shows the number of glucometers segmented by the time of analysis for 2011–2021. The device Element provides the fastest measurement (3 sec).

Many types of meters are equipped with special signals. In 2011, only glucometers of one company (Roche Diagnostics) have a special warning signal that the expiration date of test strips is coming to an end, and in 2021 there are meters from five companies (Roche Diabetes Care; Life Scan; Bionime; Int. Med; TaiDoc;) is provided with such a signal. Over the ten years, the number of models equipped with other signals has increased: *"hypoglycemia warning"* (after individual adjustment), *"alarm" function* (reminder of the need for self-monitoring), *marking pre- and postprandial test results,* which allows the patient not to remember these aspects of the analysis but take them into account for the correction of treatment (Table 2).

Almost all modern glucometers are provided with preservation *of results of the analysis with establishment of date and time* of it carrying out. The difference is in the number of stored results in the device memory. This allows you to compare them, control increases or decreases and take the necessary measures to stabilize blood glucose levels. In 2011, the largest number of results that can be stored is 550 (Rightest GM 550), and in 2021 this number is almost twice as much – 1000 (TaiDoc TD 4183) (Fig. 3).

Modern glucometers *automatically calculate the average result of glucose levels for a period* (7 spesial 90 days), through which you can indirectly calculate the degree of compensation for diabetes. In 2021, the percentage of glucometers that do not have this function has significantly decreased.

Patients praised the possibility of additional functions of glucometers, and they noted the usefulness of viewing the latest indicators of blood glucose levels and the function of reminder "alarm clock" [15].

Parts of glucometers have additional functions: *applying blood for analysis outside the device.* This function has only Accu Chek Active, which is available in both 2011 and 2021 years. This type of glucometers can use in the laboratories, at the doctor's visit and for screening.

Over a ten-year period, the number of *acoustic models* has increased. This is useful especially for patients with visual impairments.

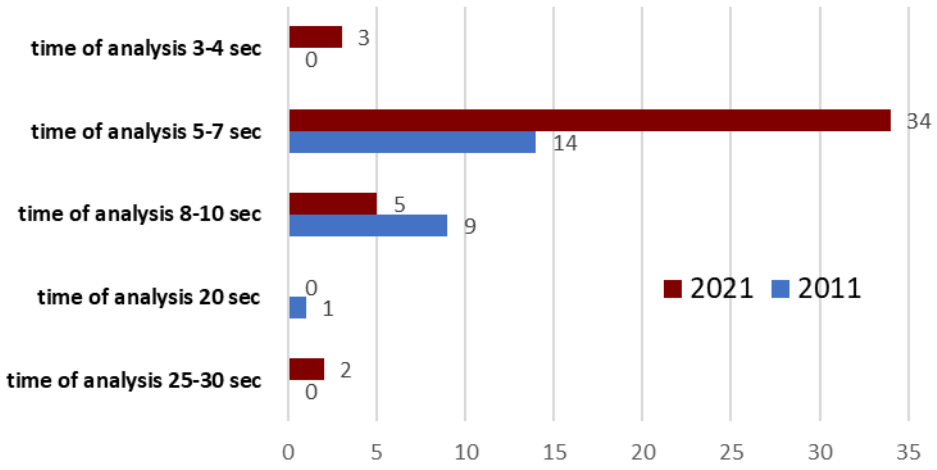

Figure 2. Segmentation of glucometers by the time of analysis for 2011 and 2021.

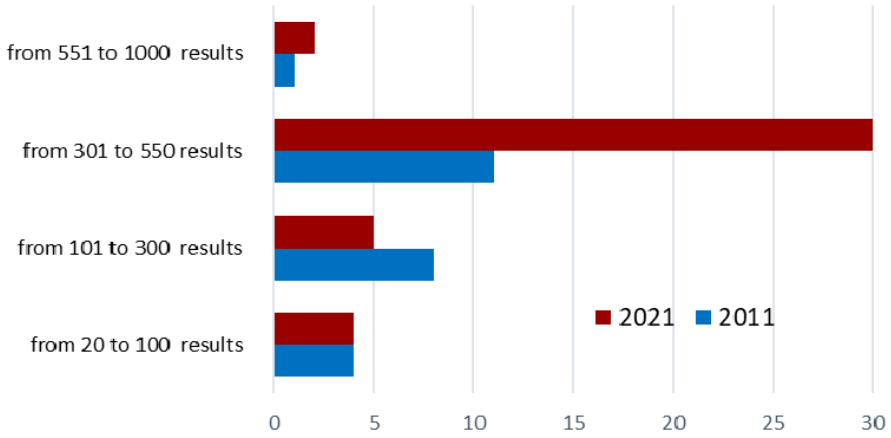

Figure 3. Segmentation of glucometers by the number saved analysis results (2021 and 2021).

The number of *computer-compatible* glucometers has increased over a ten-year period: in 2011 they were 54.0 % of the total range, and in 2021 – already 72.7 %. The transferring test results from the glucometer to the computer and quickly transmitting them to the doctor by electronic communications allows the doctor to monitor the patient's condition in real time and make decisions about adjusting treatment.

Manufacturers are expanding the functions of glucometers, and over a ten-year period, the number of glucometers that *measure other blood parameters* (cholesterol, hemoglobin, uric acid, ketones) has increased significantly. This is important for the timely correction of the patient's condition: colds, fever, kidney and liver disease; development of cardiovascular diseases.

In 2011 only 1 device which additionally measured ketones was on market, and in 2021 – 10 such devices and one meter (Wellion Calla Luna Duo) simultaneously with glucose measures cholesterol.

The ability to measure 3–4 indicators (glucose, cholesterol, hemoglobin, uric acid) with one device is provided in 2 glucometers (Glanber LBM-01, BeneCheck PLUS), but this requires additional appropriate test strips, which the device recognizes automatically.

For each type of glucometer "own" test strips are used (relevant manufacturer).

Glucometers are equipped with a device for piercing a finger with a needle thickness in the lancet from 28 G to 33 G. In 2021, the range of glucometers in Ukraine includes a multifunctional model of the meter "3 in 1" (measuring instrument, puncture tool, plug-in USB module / installed software) Beurer BR-GL 50, it does not require additional equipment with a lancet.

Conclusions. Based on a comparative analysis of the assortment of glucometers in Ukraine, a positive trend has been shown for decade (2011–2021). The number of offers of devices have increased by a factor of 1.8. Nine models which were on market in 2021 and 2011. This has indicated that part of the segment is stable. Manufacturers from Asian countries have leading positions in the supply glucoments, and they have increased their offers decade. Glucometers have became more functionality. The simplicity and ease of use of portable devices can significantly increase patients' commitment to regular self-monitoring, which can prevent complications of diabetes. A wide assortment of glucometers allows patients with diabetes mellitus to choose the necessary device for self-monitoring.

Key words: assortment; glucometer; pharmacy; diabetes mellitus; comparative analysis; pharmaceutical market of Ukraine

Conflicts of interest: authors have no conflict of interest to declare.

Конфлікт інтересів: відсутній.

ПОРІВНЯЛЬНИЙ АНАЛІЗ АСОРТИМЕНТУ ГЛЮКОМЕТРІВ НА ФАРМАЦЕВТИЧНОМУ РИНКУ УКРАЇНИ ЗА ДЕСЯТЕРІЧНИЙ ПЕРІОД (2011 – 2021 РР.)

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Мета роботи. Провести порівняльний аналіз асортименту глюкометрів і тест-смужок в Україні за десятирічний період для встановлення особливостей динаміки ринку глюкометрів.
Матеріали і методи. Використано наукові та офіційні джерела інформації щодо глюкометрів. Застосовували маркетинговий, аналітичний, графічний, узагальнювальний аналізи та метод порівняння.
Результати й обговорення. На підставі порівняльного аналізу асортименту глюкометрів в Україні показано позитивну динаміку за десятирічний період (2011 – 2021 рр.). Встановлено збільшення кількості пропозицій приладів в 1,8 раза, при цьому 9 моделей асортименту 2021 р. були наявні й у 2011 р., це свідчить, що поряд із розвитком і надходженням нових моделей частина сегмента залишається стабільною. Лідерами з поставок глюкометрів є виробники країн Азії, які збільшили свої пропозиції за десятирічний період. Встановлено, що в даному сегменті відбувається розвиток технічного оснащення глюкометрів і розширення їх функціоналу.
Висновки. Широкий асортимент глюкометрів дає змогу хворим на ЦД обрати необхідний прилад для самоконтролю, який повною мірою задовольнить їхні потреби.

Ключові слова: глюкометр; аптека; цукровий діабет; порівняльний аналіз; фармацевтичний ринок України.

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