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Original article

The usability of IT systems in document management, using the example of the *ADPIECare Dorothea documentation and nurse support system*

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Abstract:

Background: in 2016 an IT system was developed at MUL for the documentation of nursing practice. Preparing nursing students for the implementation of eHealth solutions under simulated conditions is crucially important for achieving digital competencies necessary for the health care systems in the future. Scientific evidence demonstrates that the use of an IT system in clinical practice shortens the time required for preparation of documentation, increases the safety of clinical decisions and provides data for analysis and for creation of predictive models for the purposes of HB HTA.

Methods: The system was created by cooperation of an interprofessional team at the Medical University of Łódź. The ADPIECare system was implemented in 2016 at 3 universities in Poland, and in 2017 a study of its usability was conducted using a questionnaire made available by *Healthcare Information and Management Systems Society* "Defining and Testing EMR Usability MASTER V2 Final" on 78 nurses — students of MA in Nursing at Medical University of Łódź.

Findings: Over 50% of the surveyed nurses have indicated the usability of the system for the "effectiveness of documentation" variable. The same group of respondents have confirmed that a positive attitude towards patient care planning with the use of the assessed system. In the opinions of the examined parties positive opinions predominated, such as e.g.: "the system is intuitive," "the system facilitates work," "all patient assessments are in one place," "the time needed for data entry would be shortened."

Keywords: IT; ICNP™; nursing documentation; care plans, usability;

1. Introduction

Electronic IT systems should collect all appropriate normalised data generated by health care employees, such as nurses and doctors, in order to improve the quality and effectiveness of services provided to the patients [1]. Unfortunately currently

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electronic medical records (EMR) include standard medical data through discharge summary reports, with standard nursing data rarely taken into account, and thus may not be used to study the independent contribution of nursing to health care outcomes [2]. Thus the use of nursing terminology in the project, which will enable not only the planning of care, but also obtaining medical history and describing the health care status of the patient [3], thus enabling the unification of care, its standardisation [4], [5] and will also enable the assessment of the causes of sentinel events, which constitute a hazard to the patient, with their occurrence related to the competencies of medical employees (analyses of sentinel events noted during the use of IT systems are also performed). Providing appropriate care requires the measurement of outcomes [6]. What's more, the types of outcomes that the nurses are required to measure and which they manage are inextricably linked with the definition of nursing itself: "… care, promotion and optimisation of health and skills, preventing diseases and injuries, alleviating suffering through diagnosing and treating human reactions and advocacy in care over people, families, communities and populations" [7], [8]. An increasing number of scientific contributions indicate that the digitisation of nursing care provides a measurable value for the patient and for the system [9], [10]. Studies also indicate the importance of digitisation to improve the processes of care [9], [11]. Electronic medical records improve the quality of health care [12]. Research indicates that advantages related to the use of systems by far outweigh the inconveniences [13]. It is important to make the best use of available computer systems to improve care [11]. Frequently the support of IT systems results in improvement of clinical practice [14]. Analyses and studies demonstrate that the use of new technologies results in a significant reduction of errors [15], [16]. An improvement of the decision making process occurs [12], [17], [18]. Research indicates a significant translation of new technologies to improvement of effectiveness and efficacy of health care [12], [15], [19]. It was proven that the quality of predictive models has improved when nursing data (in addition to medical data) was taken into account [20], [21]. An important expectation for the digitisation process, in addition to improvement of quality and communication between doctors and nurses, is a decrease of health care system costs [22]. The knowledge of how to accurately document the patient's status may literally mean life or death. Some of the most frequent medical documentation errors may prove catastrophic. The source literature indicates nine main types as most common, which include:

1) Sloppy or illegible handwriting
2) Missing date, hour and signature on the medical entry

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3) Lack of documentation for omitted medications and/or treatments
4) Incomplete or missing documentation
5) Adding entries later
6) Documenting subjective data
7) Not questioning incomprehensible orders
8) Using inappropriate abbreviations
9) Entering information into a wrong chart.

Incorrectly maintained documentation may expose a medical facility to legal claims and to uncontrolled abuse. One of the most famous cases in the history of medicine which resulted in regulating the number of working hours of resident physicians is a case study concerning lack of access to clinical documentation. Experiences indicate that implementation of medical information systems frequently encounters many difficulties [23], [24]. Strategic goals indicated for the year 2030 in "Policy paper" include, among others, goal 3. Implementation of instruments which raise the quality of provided health services and the efficiency of the health care system, which assumes, among others, the improvement of systems for collecting and managing of medical information, among others by implementing e-health projects [25]. This is repeated in the "Healthy future" policy. Whereas the "Strategic frameworks of the development of the health care system for the years 2021–2027, with a perspective up to 2030" document indicates that one of the policies is the Development of digital services in the health care system; Goal 1.2 [Quality] Improvement of safety and clinical efficacy of health services; development of mechanisms for paying for quality by the payer [26]. Quality has its dimensions in patient safety. A measurement of safety in the form of sentinel events used in the United Kingdom, which was created based on assessment of 3375 reports (2010–2013) shows that 120 reports concern e-Health services. They were presented in the following categories: human-computer interface (33%); work flow and communication (24%); contents (quality) of clinical data (23%); internal principles, procedures and organisational culture (6%); human factor (6%); external factors (1%); and measurement and monitoring of the system (1%). As much has 33% are events which concern the usability of the system. Usability of a system is a feature that depends mainly on user interface and on clarity of documentation; operability —concerns the user freely using all functions of the application, as opposed to the remaining attributes, where simple operation is required (the ISO 9126 standard) [27]. In accordance with the next standard ISO 9241-11 usability depends on effectiveness, efficiency and satisfaction [28]. These features depend on the user's environment and on user's emotions when achieving the established

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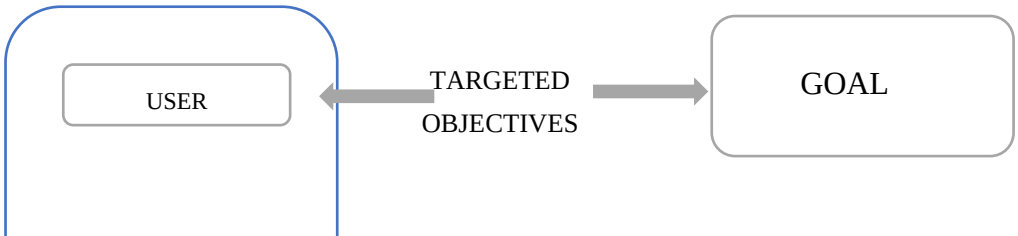
goals: effectiveness — is the accuracy and completeness with which users achieve specified goals; efficiency — is the relationship between precision and performance of the task and the resources used to achieve this goal; satisfaction – is the positive emotion of the users which results from accepting the operation of the system. Usability results from user's feelings and thoughts after interacting with an IT system. Emotional state of a person has a key impact on the results of their work and on their willingness to use the system again. Usability refers not only to websites, software or electronic services, but to all electronic devices and interactive systems with which we are in contact. Additionally it should be emphasised that usability, which describes the ease of use of a system does not overlap with the term functionality, which is responsible for its capabilities and the amount of available options [29]. Jakob Nielsen has defined *usability* as a collection of 5 elements [30]:

- *learnability* — how easy is it to perform simple tasks when in first contact with the product
- *efficiency* — how fast users already acquainted with the system are able to use the product
- *memorability* — ease of recall of product use after a longer break
- *errors* — how frequently are they made and how easily users can recover from them
- *satisfaction* — how pleasant the product is to use. In order to assess the usability of the system at least 5 users are needed. As claimed by Nielsen, this serves the development of the system, instead of spending resources on unnecessary tests which result in the same effect [30].

The figure below presents the method of achieving the application's usability. It is based on ISO 9241-11 standard and it applies to interactive cycle of product improvement.

In the column on the left side a user was presented, their task, tool they are using and their environment. Whereas on the opposite side, in the upper right corner the goals of the user are provided, which they implement through their actions with satisfaction and in an effective and efficient manner (the area of usability). The entire process can also fail. The user will not achieve the intended goal, which will result in dissatisfaction and feeling of frustration [28], [31].



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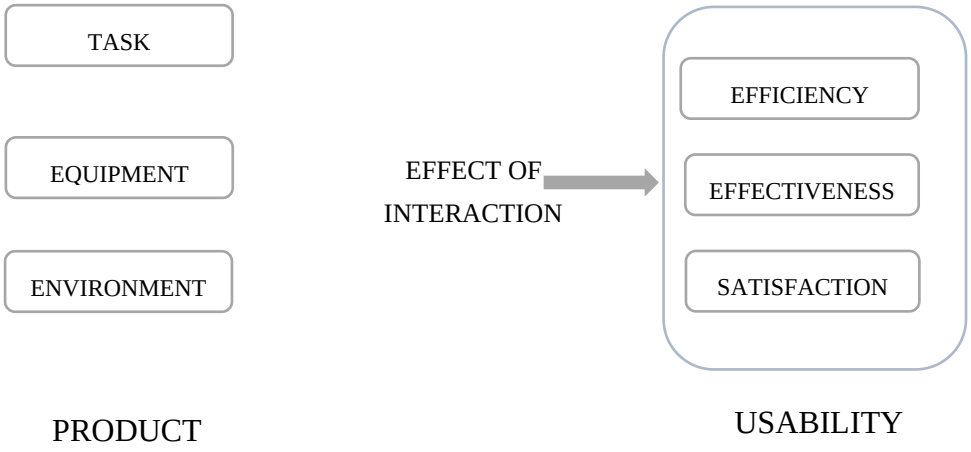

Figure 1. Achieving usability in an interactive product improvement cycle
source: Prepared by M. Kusiak 2020

System usability is of key importance in the context of nurse work. Medical care in a hospital is performed mainly by nurses and includes processes intended to improve patient's health status, including in particular before and after a medical intervention. Nurses visit patients 157 times during a twelve hours shift [32], they are responsible for the daily monitoring and managing of health care provided to patients [33]. A nursing role includes immediate detection and intervention when the patient's clinical condition changes [34], [35]. Nurses form a supervision system used for early detection of complications and problems with the patient and have the best possibility of initiating actions which minimise negative patient outcomes [36]. Studies confirm significant engagement of nurses as advocates for high quality, patient focused care and cost-effective health care [37]. In the source literature the time spent by nurses on performing activities related to intermediate care (documenting, administering) ranges from 22% [38] to 43.2% [39]. Digitisation of processes performed by nurses reduces work load and enables increasing the time of providing patients with direct care [16], [40], [41]. This is demonstrated by studies which show that electronic records shorten the documentation time by more than 50%; the share of nursing time dedicated to documentation amounted to 15.8%, 10.6% on paper and 5.2% on computer [42]. The time saved by digitisation is a measurable benefit for the patient and for the system [9], [43]. It should be noted that until 2030 Europe may have a shortage of over 4 millions of medical personnel [44]. All over Europe the discrepancy between the demand for health care and the availability of personnel and other resources is growing, just as the awareness that digital transformation is of key importance to fill this gap. Nurses, devoting a significant part of their time to administrative works need more time

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for care which provides patient value. In 2012 studies were conducted in which it was examined how new nurses assess their knowledge and skills in clinical conditions, compared to the perception of the same skills by nurse managers. They have demonstrated gaps in 13 out of 28 areas of knowledge and skills deemed to be key for the effectiveness of electronic healthcare records (EHR). Almost 90% of new/beginning nurses and 75% of nurse managers participated in EHR training at their work sites, but only 20% of new/beginning nurses and only 7% of nurse managers have stated that EHR was part of their training programme in nursing school. Over 60% of nurse managers have agreed that starting nurses need more than 2 months in order to be competent with EHR use [45]. Providing students with EMR training programme under simulated conditions, where they can train various scenarios and become skilled in safe, supervised environment is key for the digitisation process. This process is understood as increasing safe decision-making based on actual, unequivocal and undeniable data. Most of medical errors do not occur as a result of incompetence or recklessness of nurses and other medical personnel. They occur because of defective systems and fragmented processes. The main culprit is defective documentation [46]. Appropriate and accurate documentation is necessary in order to avoid various types of errors in making clinical decisions by a doctor or a nurse, and to help to avoid deaths of patients and the medical facility's liability. In this place EMR comes to aid. Effective training of nursing students in EMR may play a significant role [47].

Characteristic of the ADPIECare Dorothea IT System

"The main goal for the creation of the system was to prepare an application which supports the collection and documentation of nursing work (of both community nurses and nurses working in hospitals) and also helps in care plan creation decision-making. The system may operate in two modes (production and teaching). The application collects a wide range of data about the patient (basic reporting and contact details as well as medical history chart) and about the course of their clinical treatment. The system logics enables the collection of data in the form of subsequent assessments of patient state in order to compare their current condition with their condition from previous assessment. On this basis the system prepares and suggests diagnoses, on the basis of which care plans to be implemented are created in order to achieve the goal of patient health improvement. Additionally reports and trend diagrams are generated, which show whether the implemented care plan provided the desired effect. The task of the system is to enable maintaining documentation of nursing care from the moment of patient's admission to the hospital to the moment of discharge. The system possesses mechanisms which enable coordination of work between multiple nurses, and also supports the education of students, who may have a nurse as a tutor.

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For this purpose, records of "virtual" patients are created, over whom the student is caring, and the nurse supervises the education process and assesses decisions made by the student. An additional advantage of the system is the fact that it has implemented ICNP (general terminology of nursing practice) and HOBIC (terminology used to assess patient outcomes) terminology sets." Mariusz Sawko, director of the CIT at the Medical University in Łódź. The manner of work performed by nurses, e.g., in patient education is based on the nursing process shown on the figure

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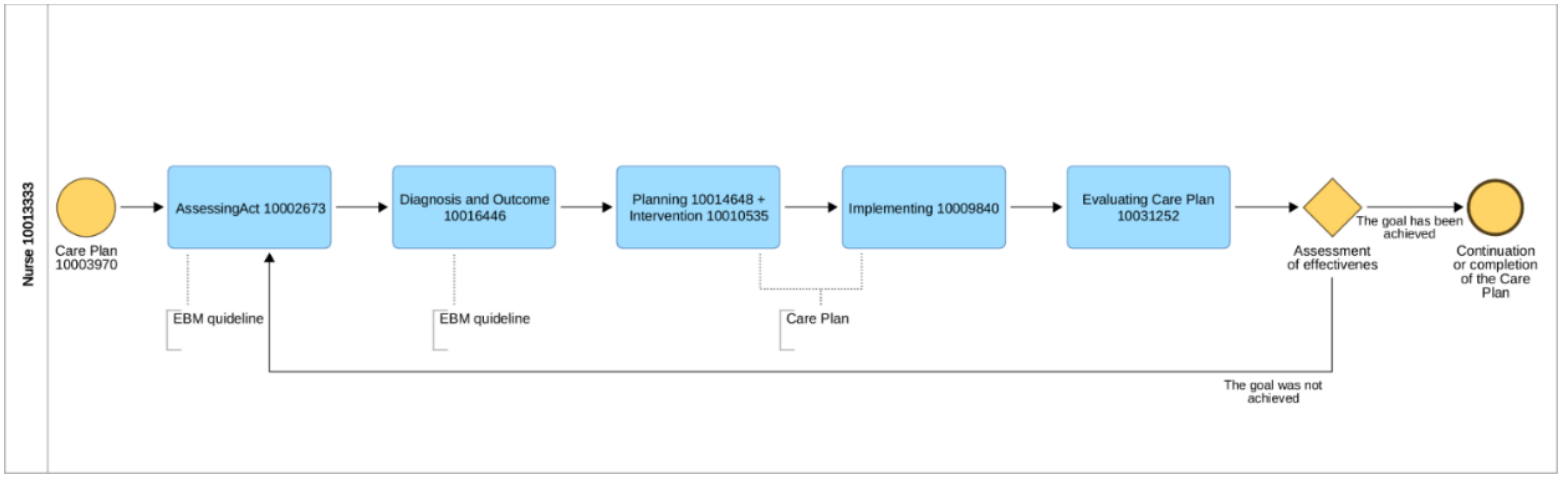

Figure 2. *The BMN clinical path — the nursing process in client/patient education, source: BPMN ed. Kamiński M., Kilańska D., Lipiński C., Librowska B., Szydłowska-Pawlak P., Dział Rozwoju Systemów Opieki Zdrowotnej (Department of Health Care Development Systems), ADONIS, UMED 2020 (for AOTMIT 2020)*

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The application reflects all the process elements using the ICNP™ reference terminology. The first stage is the assessment of patient knowledge (Assessing Knowledge Of Disease — 10030639), then the Diagnosis And Outcome (10016446), Care Planning (10035915) Implementing (10009840) and afterwards Evaluating (10007066), at the last stage showing the result in the form of a final diagnosis. In 2001 work was commenced on the implementation of terminology recommended by the international nursing community and the UN, World Health Organisation — *International Classification for Nursing Practice — ICNP™*. The terminology contains terms necessary to describe nurse's work, which are combined into blocks in accordance with the ISO 18104:2003 standard [48]. The United Nations recommends the use of ICNP terminology to gather statistics in nursing [49]. ICNP reflects the boundaries of nursing practice, and thus overlaps with other health terminologies such as *SNOMED CT*, simultaneously exceeding their scope. It is more comprehensive and more detailed than Classification for Clinical Practice and has higher international use since it is based on the *OWL* ontology. Thus, when planning IT solutions, the aforementioned recommendations should be used. In 2011 based on the terminology a recommendation by the Nursing eHealth Council of The Center Healthcare Information Systems Ministry of Health and *ICN* Accredited Centre of *ICNP* MUL was created, establishing the scope of data for nursing documentation and the use of structured nursing practice terminology. In 2015 the Minister for Health has accepted the Recommendation of 11 September 2013 [50]. As a result, works commenced on transposition of the Recommendation to technical language of *HL 7 CDA*[1] — an interoperability technical standard. This standard enables the exchange of data between units that provide care. The document was published in Polish National Implementation (PIK) and became a benchmark for the creation of IT systems for nursing documentation [49], [51].

The undertaken implementation actions have resulted in the **"ADPIECare Dorothea documentation and nurse support system"** which is at the same time the first Polish system enabling documentation of nursing work and teaching with the use of the international ICNP terminology.

The acronym ADPIECare reflects the care process shown on Figure 2. - **A**ssessment/**D**iagnosis/**P**lanning/**I**nterventions/**E**valuation **Care**. The works were commenced on 7 March 2016 and ended on 8 August 2016 r. The scope of IT works is presented in *Appendix 1*.

[1] *HL 7* (Health Level Seven) *CDA* (Clinical Dokumentation). Health Level Seven or *HL7* refers to a set of international standards for transmission of administrative and clinical data between applications used by various service providers.

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The ADPIECare system is an expert system which supports the work of an operator by suggesting diagnoses and activities. It does not make any decisions for the operator.

The functionality of the nursing works documentation system is a user panel which contains a special education module.

In the education module the system presents the patient documentation (maintained by students). This allows the student's tutor to track the assessments of patient's state proposed by the students, the decisions and interventions they make. It also enables communication between the student and the tutor, as shown on the drawing below.

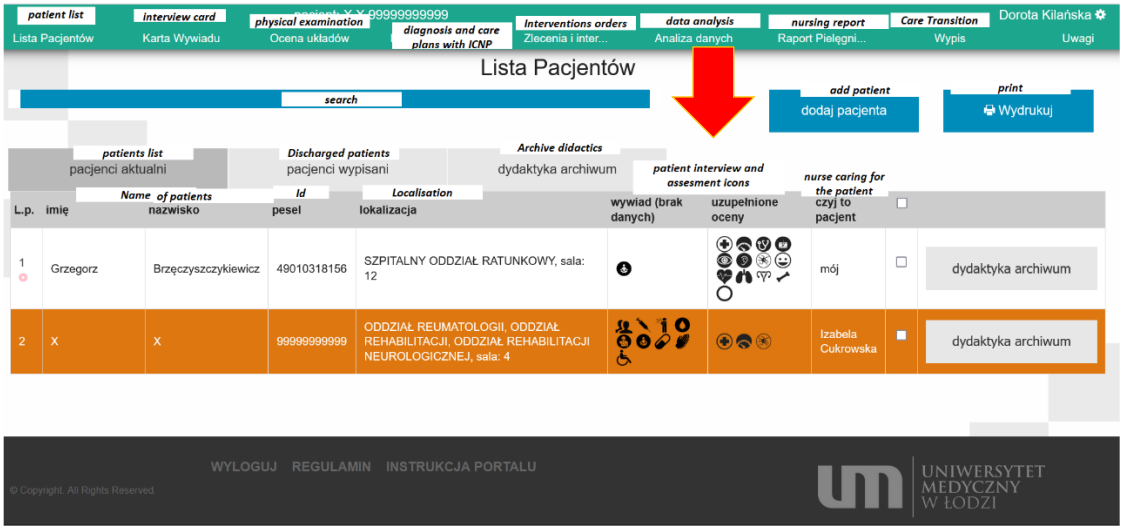

Figure 3. The ADPIECare „Dorothea" system's user panel, source: https://pielegniarki.umed.pl/lista_pacjentow.html

The system enables the creation of ad-hoc websites which provide support services.

The list of patients displays a registry of patients entered into the system. For a given user (employee or student) only the list of these patients who were assigned to them from an administrative level is displayed. The list is divided into categories (current patients, discharged patients and a registry of teaching documentation). Moreover, it enables rapid and quick searching for a patient based on their personal data or their location in the hospital (by selecting a ward). On the list, in addition to the basic data, one can also see (in the form of graphic icons) information concerning the data missing on the patient's medical history chart, and also a list of assessments of systems which were already performed for the patient. If at a given time an intervention is planned for the patient in question (an activity

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resulting from the care plan), the patient is highlighted on the list above by an exclamation mark displayed next to their data record. An "Individual Nursing Care Chart" is assigned to each patient, based on the eHealth Council Recommendation, in which the required elements of a physical examination are listed, including:

1) Medical history chart, which is filled out when entering a new patient into the system. It has a series of specific fields placed in subject groups. The data are filled out with the use of terms from the ICNP terminology standard. On their basis the system suggests to the operator the proposed diagnoses for the patient. The medical history chart may be printed after it is filled out. The data collected in the medical history chart include, among others:

- Personal data (personal and contact information) of the patient
- Personal data (personal and contact information) of the patient's guardian
- Ward data (data concerning the ward at which the patient is located)
- Contact with the patient
- A list of the patient's diseases
- Physical parameters, such as, among others, height, weight
- Vital parameters, such as, among others, temperature, heart rate, BP (may only be entered when the medical history is filled out for the first time, afterwards the aforementioned data may only be entered from the level of subsequent assessments of the patient's condition)
- Pain assessments
- Information concerning:

o blood
o allergies
o lifestyle
o medications taken
o pastoral care
o compensatory, corrective and vascular equipment.

In subsequent stages of the work on interoperability of data in the application the medical history was mapped to a reference terminology (the terms found in the classification were compared to the terms from the terminology), and the results of the work were published, demonstrating the ability to use the dictionary in all elements of patients' description in the application [3].

Another element of the nursing care process in the application are patient assessments. From the level of this module the employee enters data concerning the assessment of the patient's health status, using the terminology implemented in the

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system, which allows the indication of the patient's symptoms, problems and assessment using standardised care quality indicators C-HOBIC [52]. Based on the rules established in the administration panel (standardised care plans were prepared in subsequent stages of operation) the system may prompt certain interventions or suggest diagnoses which result from the data entered in the subsequent assessment sheets. The rules are flexible and enable advanced inferences, also based on the working notes of the employees. All assessments have version control, which enables showing subsequent assessments over time. This enables the operator to monitor the changes to the patient's health status on an ongoing basis. For the description of the assessments standardised ICNP terminology and previously listed nursing care quality indicators recommended by the International Council of Nurses should be used. The indicators were prepared through an analysis of millions of patient records by the Registered Nurse's Association of Ontario, in a project financed by the Minister for Health in Ontario (Canada). This system was called C-HOBIC [52]. The ADPIECare system contains 10 recommended indicators and enables the following assessments:

1) Assessment of patient's parameters (e.g., height, weight, BMI etc.)
2) Assessment of patient's vital signs (e.g., temperature, heart rate, BP etc.)
3) Assessment of patient's skin condition (e.g., skin hygiene, skin disorders, injuries, bedsores etc.)
4) Assessment of patient's eyesight
5) Assessment of patient's hearing
6) Assessment of smell
7) Assessment of taste
8) Assessment of patient's activity (ADL activity scale from C-HOBIC)
9) Assessment of nervous system and cognitive functions (e.g., establishing mood, fainting, vertigo, balance disorders, epileptic seizures etc.)
10) Assessment of behaviour and emotional reactions of the patient
11) Assessment of the cardiac system
12) Assessment of the respiratory system (e.g., shortness of breath, cough etc.)
13) Assessment of the gastrointestinal tract (e.g., assessment of weight, tongue condition, appetite, thirst etc.)
14) Assessment of the urogenital system (e.g., type of urine, swelling etc.)
15) Assessment of the musculoskeletal system (e.g., breaks, dislocations, anomalies, joints etc.) (Figure 4).

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The person working with the application may move the screen down in order to select the system assessed in the patient, or use an extended panel to move to the assessed system on Figure 4.

Figure 4. Iconography of physical examination in ADPIECare "Dorothea" using ICNP™ — print screen, source: https://pielegniarki.umed.pl/oceny.html

The next module is the "Diagnoses and care plans" module, which supports the operator in developing a care plan for the patient by selecting from the diagnoses suggested by the system based on the patient's health status assessments entered in the system. Every diagnosis selected by the operator becomes a separate care plan, for which the operator may plan next interventions (activities) at specific times and with the use of a device necessary to perform the activity in question. After a diagnosis selection decision is made, a care plan is created, supplementing it with proposed nursing interventions or with the option of searching for interventions in the entire terminology. Creating interventions and establishing their frequency (realisation, execution and commencement time) is another system functionality. To each care plan a text description may be added. The care plan ends with an evaluation by selecting a diagnosis: positive, negative or a diagnosis from a risk group, which are appropriately grouped in the International Classification for Nursing Practice — ICNP. The information documented by the nurse is used to create a nursing report, in which the last record of patient activity is visible, enabling the continuation of care at another place.

Moreover, the application supports the user by enabling selection from finished care plans of those plans which are adequate to the assessment conducted. The

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student/nurse may choose from among the proposed interventions the ones that are possible and for the performance of which no competencies are unavailable. The system monitors and shows the impending interventions using an "Alert" icon. The possibility of adding interventions to the diagnosis is shown by an arrow on the figure below. Every care plan is finished with evaluation (assessment of the plan), consisting of making a final diagnosis from the categories of: positive, negative, or risk. Evaluation is a result of the care plan implemented in practice and the final diagnosis is used for continuation of care — the creation of another plan, which is adopted by the nurse to the patient's current situation. The system provides support in establishing the care plan with its ICNP terminology standardised care plans. The application contains care plan standards which were established in cooperation with students and nurses who participated in care plan planning training courses using the ADPIECare system. An example care plan view, showing a set of terms concerning the intervention which the nurse may adapt to the patient's health status is shown on the figure below (Figure 5).

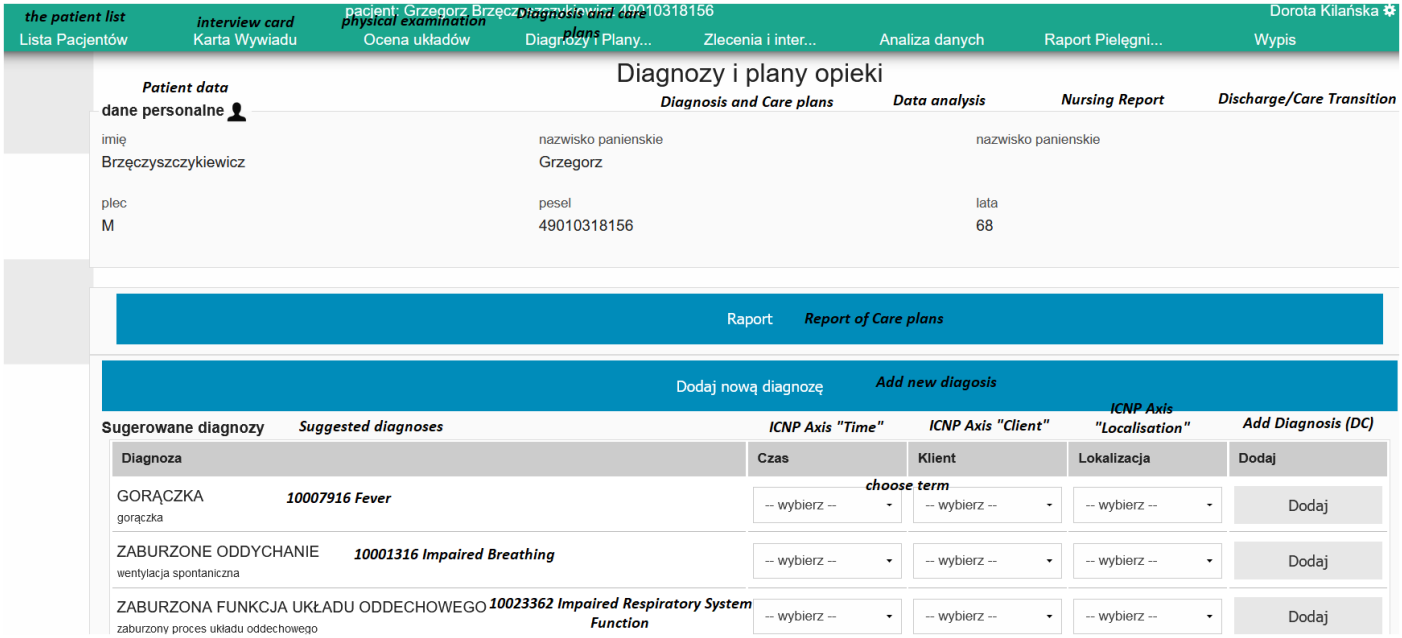

Figure 5. An example set of diagnoses for a patient enabling establishing the time, location of the problem, source: https://pielegniarki.umed.pl/diagnozy.html

When working with the application (2017–2021) the users (students and nurses participating in the training) have prepared care plans for 577 diagnoses. Figure 6 shows the diagnoses selected by students from the range of over 100 care plans for a given diagnosis. Nursing diagnoses have value for predictive models which demonstrate the risk to health and life of the patient, regardless of medical data.

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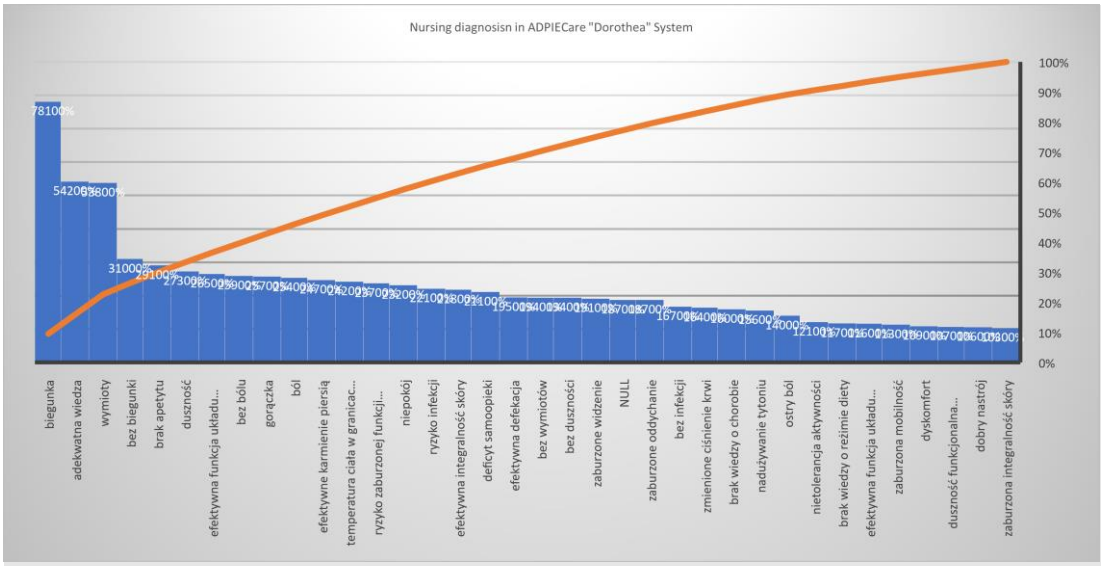

Figure 6. The most frequently selected nursing diagnoses assessing patients in ADPIECare "Dorothea" made by students in the years 2017–2021 from a range exceeding 100 care plans for a given diagnosis

The next module in the user panel is "Data analysis" — a module which enables the analysis of the changes to the patient's health status over time, based on the assessments entered into the system. The system enables the creation of dynamic reports based on a single variable or on multiple variables. Based on the numeric data or from the C-HOBC assessment scale the system natively generates linear or star (radar, spider) chart, as shown on Figure 7.

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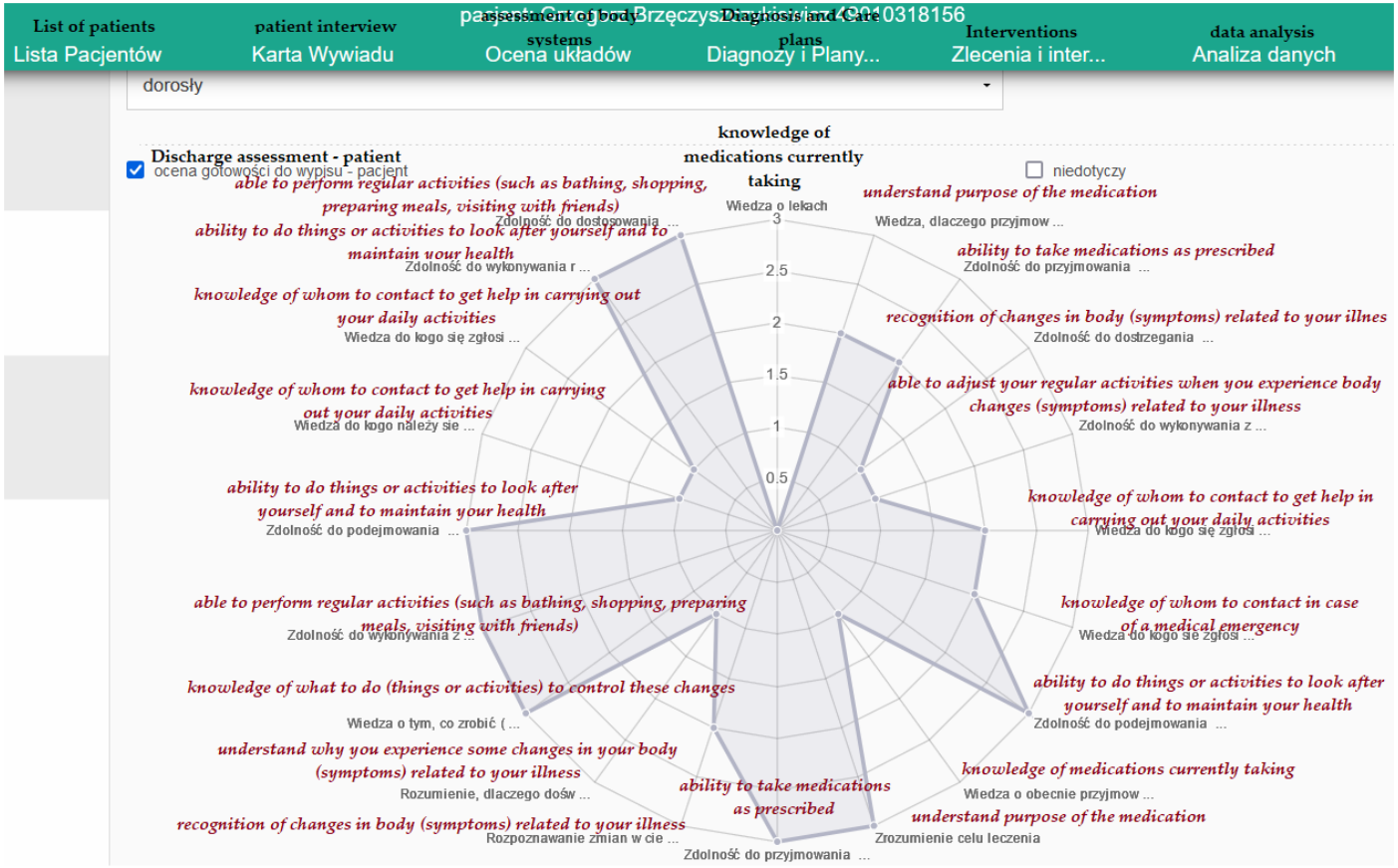

Figure 7. Assessment of the patient's health competences with the use of C-HOBIC, source: https://pieleg-niarki.umed.pl/wypis.html [53]

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Statistical analysis

A discharge chart is a module which enables the assessment of the readiness of the patient for discharge (checking their knowledge concerning the medication they are taking or their illnesses) based on the C-HOBIC tool. The discharge report may be printed from the system in order to be handed to a patient and included in the patient's medical documentation. The possibility of printing out ensures continuity and safety of care to the patient and the carers.

The goal of this study is to establish the usability of the "ADPIECare Dorothea" original application used for the management of documentation.

2. Materials and Methods

The study was conducted at the Medical University in Łódź among the users of the ADPIECare "Dorothea" application, which were 78 nurses studying for MA in nursing. The study was performed during seminars of the "European Nursing" course. The study group were nursing students of the second year of the master's programme in Nursing, the Health Sciences Department. The eligibility criterion for a given group to participate in the study were previously completed classes, during which students have received instructions on the use of ADPIECare Application and the principles of planning of care using the ICNP reference terminology. The courses were conducted under the supervision of the software's author, using computers which allow working with the application. At the first stage, the design of the tool and the sequence for filling out data were presented. The composition of the ICNP nursing classification used in the tool was explained and the C-HOBIC indicators referring to the results of the nursing care quality for the needs of assessment of self-management of care by the patients and preparation of interim care plans were discussed. After initial discussions of the principles of work the students were divided into groups. Then they received a case description, based on which they filled out individual elements of electronic documentation: a medical history chart, assessment of systems and prepared a care plan, composed of an initial diagnosis resulting from the assessment along with the interventions. At the final stage, the students' task was to conduct evaluation by indicating a final diagnosis/result of care in the plan using ICNP terminology. In the first step, students performed an assessment, then they made a diagnosis, selected an intervention, and in the last step of the process they conducted evaluation for the case description prepared for the examination.

The medical history chart is the basic element of the electronic documentation system, which is the foundation of patient assessment. Filling it out enables work in

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subsequent steps in the application. A key resource are the body systems, according to which the assessment chart was created. The students had a task of indicating, in a specially prepared form, the elements they have identified for assessment in the system in question. Thus, we understand the "system" to mean elements of assessment concerning, for example: the respiratory system, the circulatory system, the gastrointestinal system etc.

The care plan concerned the selection of diagnoses which meet the patient's health status and selecting appropriate interventions intended to meet the patient's needs, that is, achieving a positive diagnosis during the evaluation of the care process. After the courses were finished, students were requested to fill out a survey questionnaire assessing the usability of the system. The study was conducted in the period of November-December 2019. The survey questionnaire was sent by electronic communication to a group of students participating in the research process. To create the survey questionnaire Google Forms were used, where variables specified in a standardised *Defining and Testing EMR Usability MASTER V2 Final Healthcare Information and Management Systems Society* (*HIMSS)* tool were entered [29]. Afterwards the tool was made available to the students on the Facebook social networking site in a group of 2nd year students which participated in the study. The students have created a private group for the year, which enabled using this form of communication, with Facebook Messenger used as the group's communicator for consultation. The tested group was larger than the group recommended by system usability researchers, who indicate that an assessment by 5 users is a sufficient number [30].

3. Results

The survey of nurses' opinions on the usability of IT systems was commenced by checking when the "ADPIECare Dorothea" application was used for the first time (Figure 8). As the received answers show, the majority of people had contact with the application during the first year of the master's programme. Only a small number of respondents have encountered this tool during their education on the second year of undergraduate studies. As the existing situation demonstrates, students did not encounter the application during the remaining years (Figure 8).

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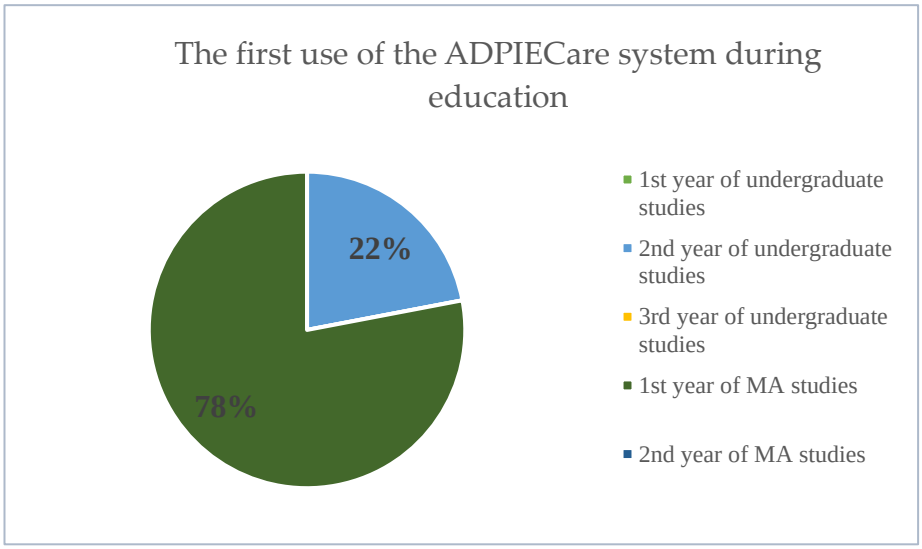

Figure 8. Experience in the work with ADPIECare system application by the surveyed users during undergraduate (BSN) and MA studies (MZ).

The results of the research indicate that most users who are in contact with the application for documenting medical events have used them 2 to 5 times, which constitutes 70% of all research subjects. A smaller group, constituting 26% of the subjects, was the group of respondents who have used the application only once. Only 4% of the surveyed persons have entered information in the application from 5 to 10 times (Figure 9).

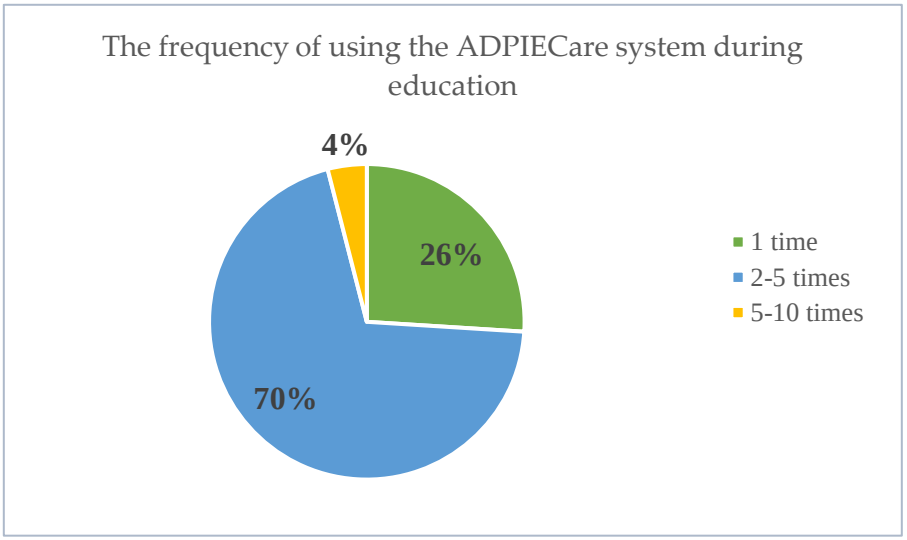

Figure 9. Frequency of the ADPIECare system use during training conducted for the purpose of testing the system's usability

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The study demonstrates severe differences in the frequency of use of the application during testing. Only a few users could demonstrate the highest number of attempts, however there was not a single person who did not operate the system on their own (Figure 10).

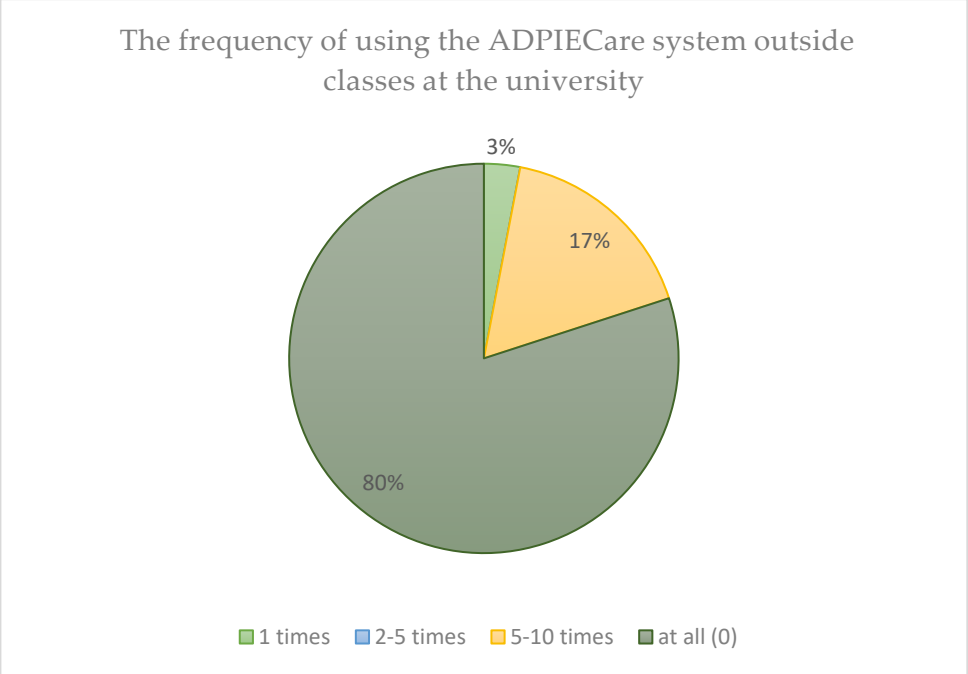

Figure 10. Frequency of application's use outside of the training conducted in order to assess the usability of the ADPIECare "Dorothea" system

As the answers on figure 10 demonstrate, as much as 80% of the respondents did not have any contact with the application outside of the training course. Much less people, only 17% used the tool for their own purposes from 5 to 10 times, 3% of people used it only once (Figure 11).

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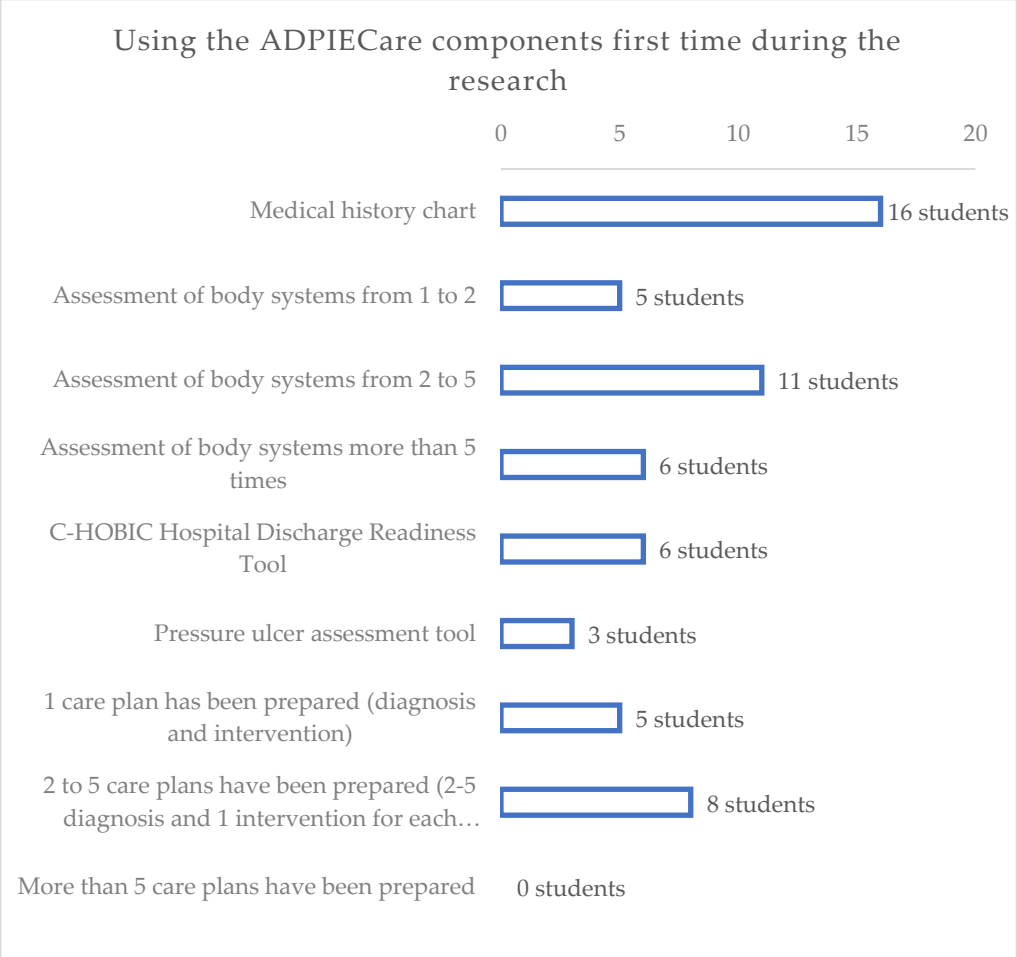

Figure 11. The use of individual components of the ADPIECare system by the surveyed students

Another cross-section of information about the surveyed persons concerns the goal of the use of application during its first use. The data presented on figure above demonstrate that the user most frequently filled out the medical history chart. "Assessment of body systems from 1 to 2" was filled out by 5 persons. At the "Assessment of body systems from 2 to 5" this value increased twofold. 6 persons filled out filled out both "Assessment of body systems more than 5 times" and "discharge readiness scale". "Pressure ulcers" were filled out by 3 persons. Care plans using diagnoses and interventions were filled out by the following number of persons: "1 care plan" — 5 persons, "2 to 5 care plans" — 8 persons. The time consumed by the use of the application when preparing a care plan was analysed. The answers of the respondents enable establishing that most frequently preparing a care plan for a single patient takes from 21 to 40 minutes. Slightly fewer (seven) respondents fill out a care plan in a time interval of 11 to 20 minutes. The most experienced persons only need 10 minutes. An analysis of the chart

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shows that the least numerous group consists of people who marked an answer of 41 to 60 minutes (Figure 12).

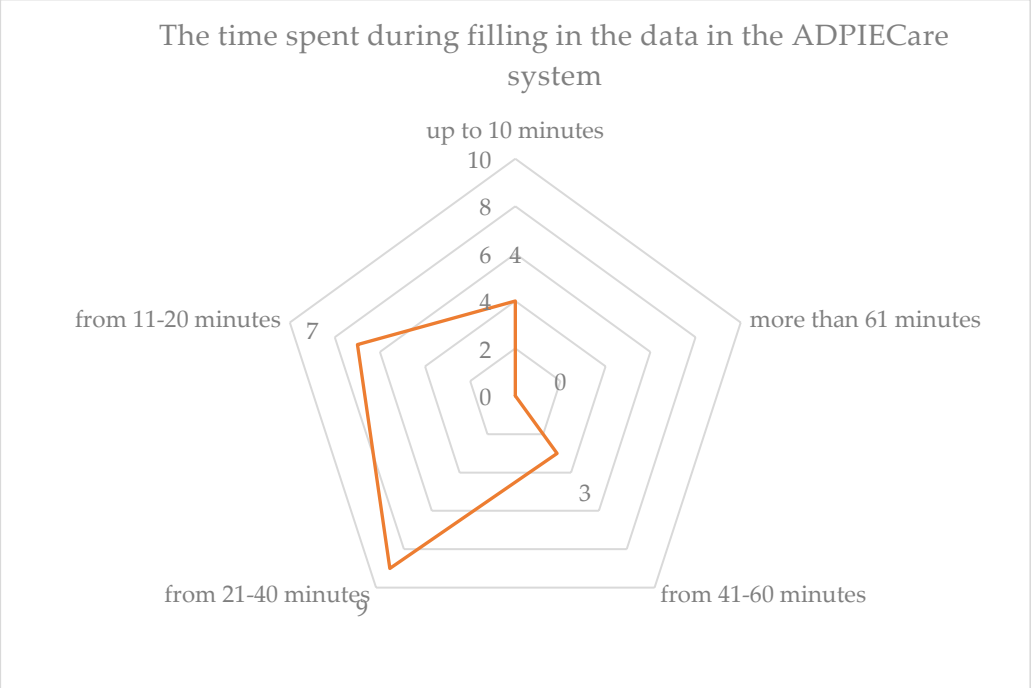

Figure 12. Time consumed by documenting the patient's care plan

The assessment of the user interface (system had a clear, easy to understand and ordered appearance of the screen) of the ADPIECare system was shown on the Figure 13. Answers “definitely agree” and “mostly agree” amounted to a total of 70%. This demonstrates that most of the surveyed persons have considered the application screen to be clear, easy to understand and ordered. There were 26% respondents who selected the convenient option of “I don't know”. And only 4% have expressed their disapproval by selecting the answer “mostly disagree”. None of the nurses have selected the answer “definitely disagree”.

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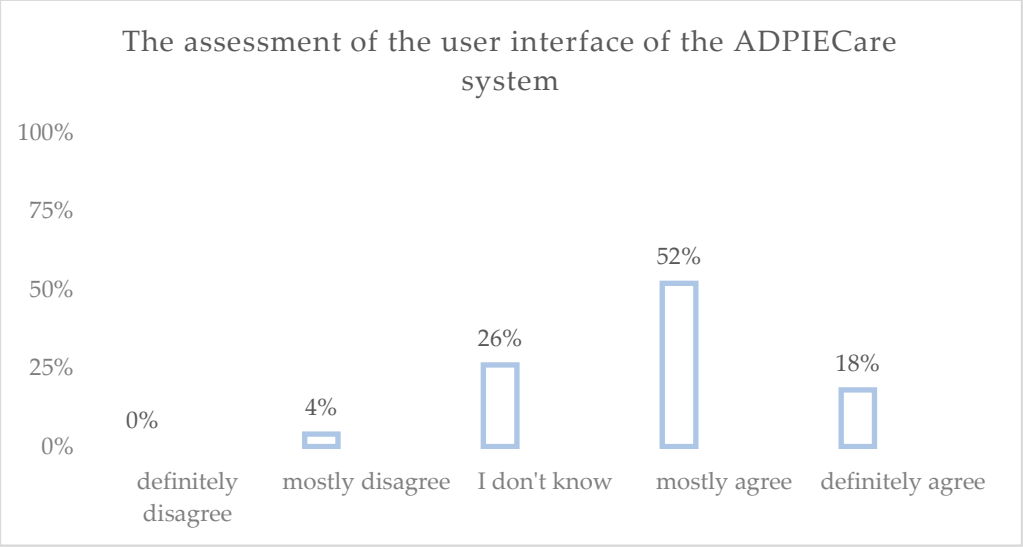

Figure 13. Characteristics of the ADPIECare system user interface

The largest number, as many as 44% of the respondents have selected the answer "definitively agree" concerning the correct saving of entered changes. In case of nurses which declared their opinion as "mostly agree" the share is 30%. Only 17% had no opinion. The remaining 9% have selected the answer "mostly disagree". Again, nobody selected the answer "strongly disagree".

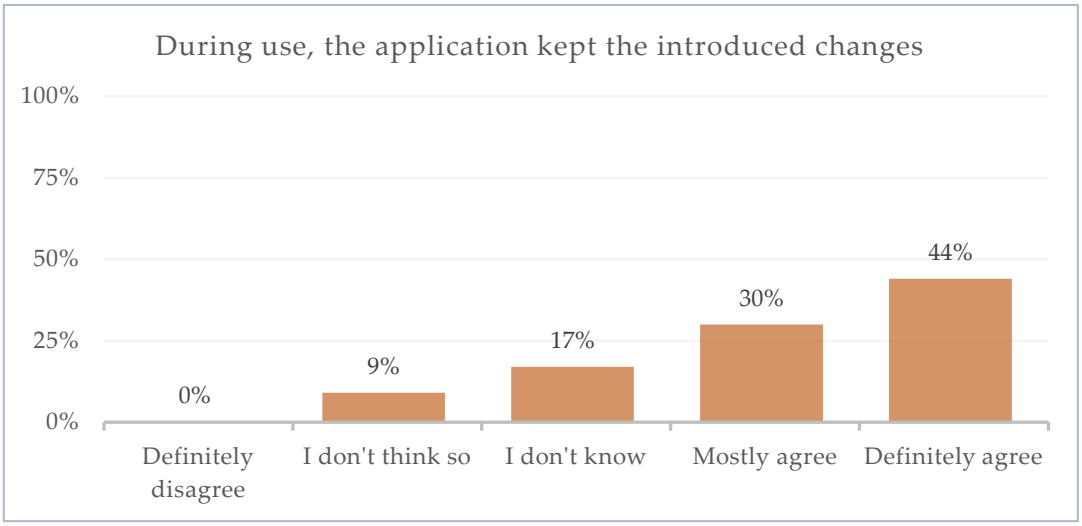

Figure 14. The behaviour of introduced data during the use of the ADPIECare system by the respondents

According to the diagram 35% of the respondents think that the program definitely minimises the number of steps necessary to perform a task. The answer "mostly agree" was chosen by 13%. A lack of opinion was expressed by 30% of the examined parties. The remaining 22% decided on a "definitely disagree" answer (Figure 15).

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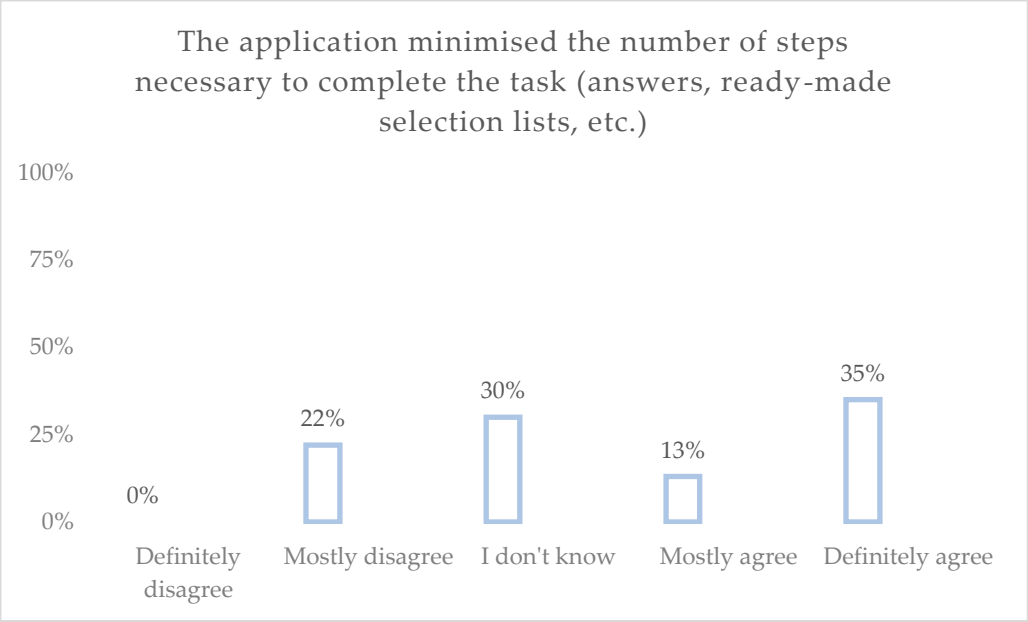

Figure 15. Minimisation of the number of steps in the application

The information presented on the screens were given the highest assessment by 39% persons. Only 8% less of the surveyed persons have answered "mostly agree" to the question. 28% of the surveyed had no opinion. Only 4% have expressed their opinion as "mostly disagree" (Figure 16).

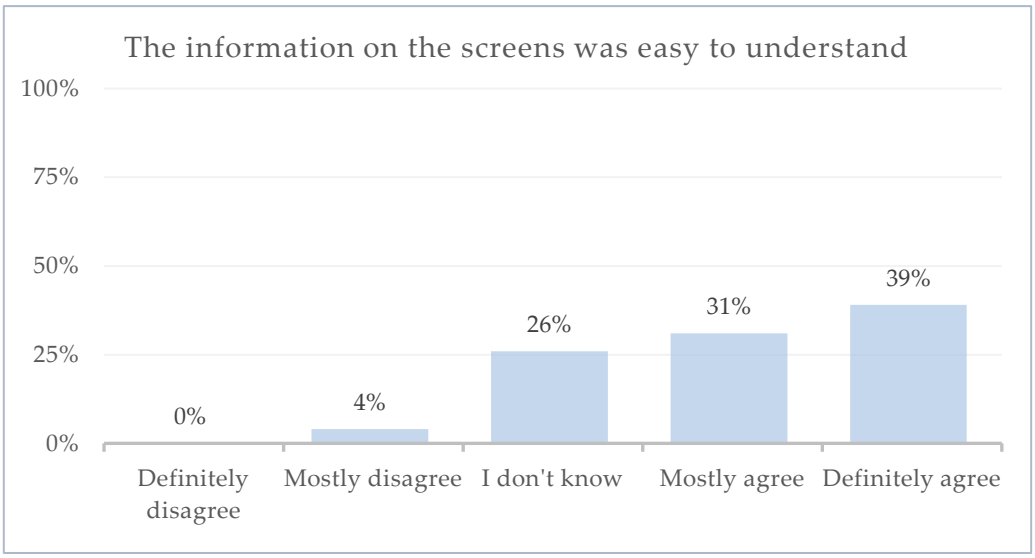

Figure 16. Opinion of the surveyed users about the legibility of the ADPIECare system

Most of the research subjects have agreed with the assumption that the information necessary to perform the task in question were grouped on a single screen. Only 19% had no opinion in the matter. None of the nurses have selected the answer "mostly disagree" and "definitely disagree". By analysing the results, it can

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be easily established that the functions of the application are correctly placed, which shortens the amount of time necessary to perform the requested instruction (Figure 17).

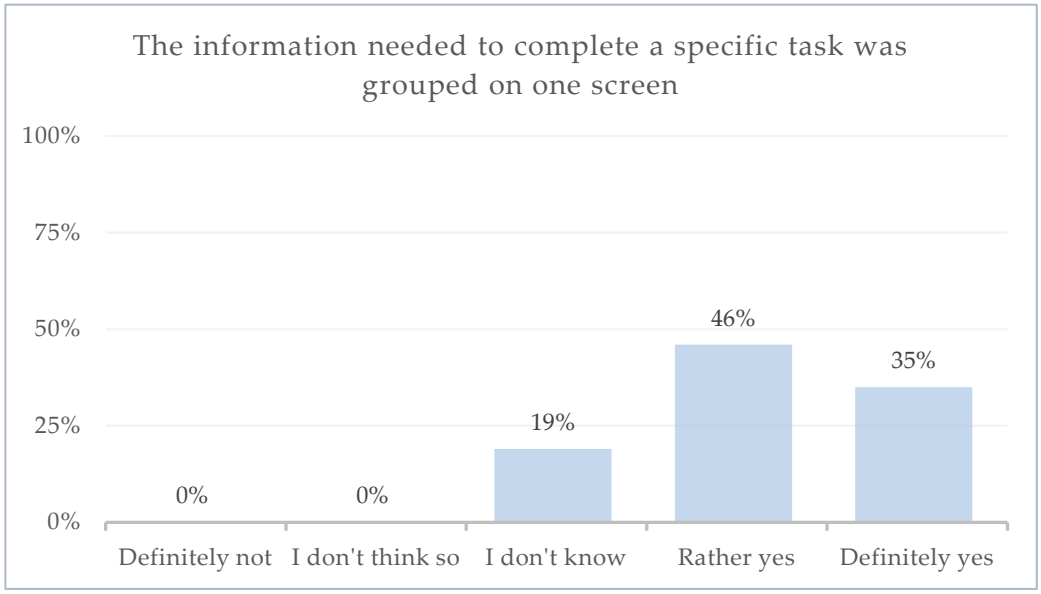

Figure 17. Structure of the ADPIECare Dorothea system in the opinion of its users

As presented by the chart below the selection lists in the application were legible for most of the surveyed. The remaining 1/3 of the surveyed have marked the answer "I don't know". The answer "mostly disagree" and "definitively disagree" was not selected by anyone (Figure 18).

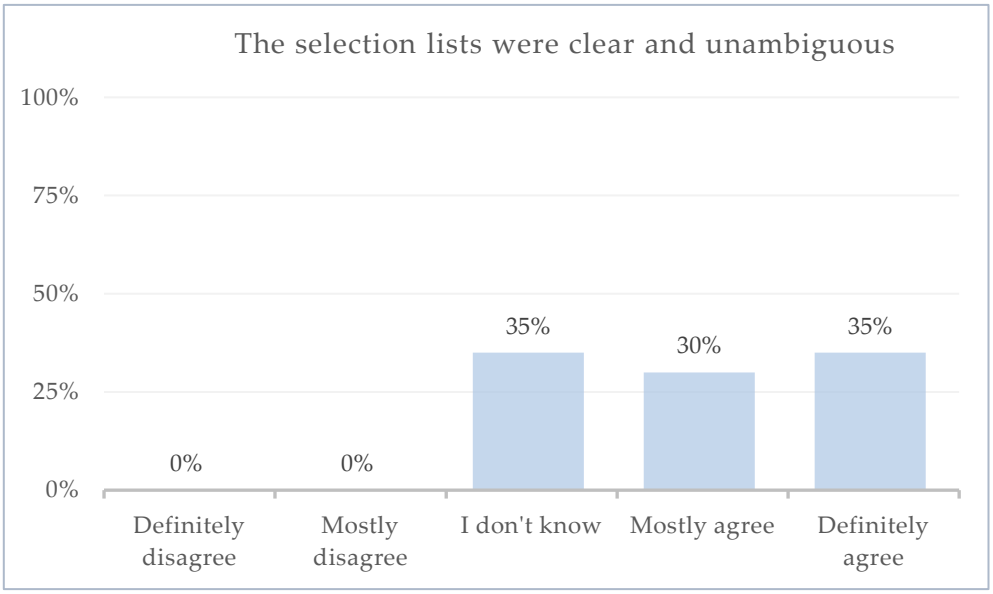

Figure 18. The legibility of the selection lists according to the users of the ADPIECare system

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The nurses have assessed the effectiveness of the clinical documentation tools as follows: “definitely agree” — 34%, “mostly agree” — 22%, “I don't know” — 44%, “mostly disagree” — 0%, “definitely disagree” — 0% (Figure 19).

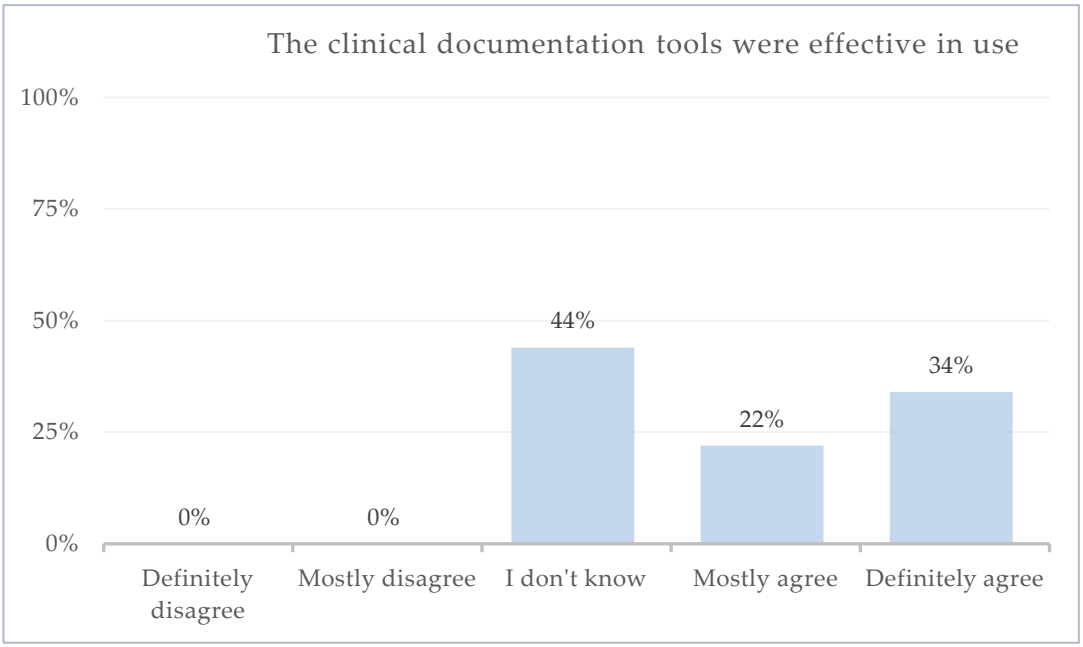

Figure 19. Effectiveness of documenting of clinical data in the ADPIECare system as assessed by the surveyed users

The largest portion, as much as 48% of the surveyed have selected the “I don't know” answer. In case of persons selecting the answer “mostly agree” and “definitely agree” this share combined also amounted to 48%. A small part of the studied group, 4% has deemed the alerts mostly not to appear at appropriate moments. Nobody selected the answer “strongly disagree” (Figure 20).

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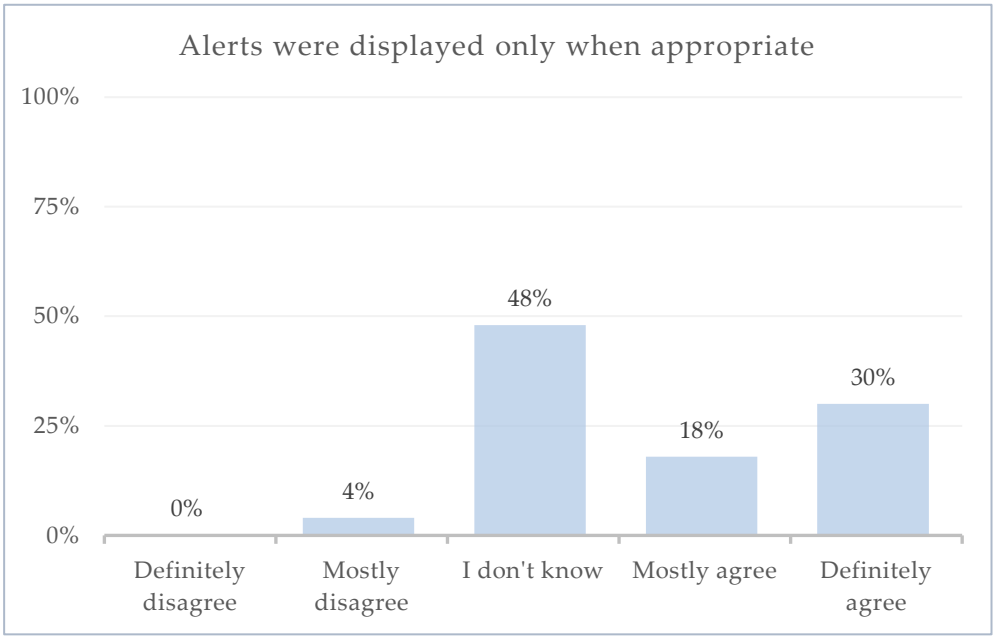

Figure 20. Assessment of the correctness of the alerts displayed in the ADPIEC-are system

The majority, as many as 52% of the respondents agree that the data after being entered once could be used multiple times. A subsequent 22% have confirmed the assumption by marking "mostly agree". 26% did not have an opinion. The remaining 4% disagreed (Figure 21).

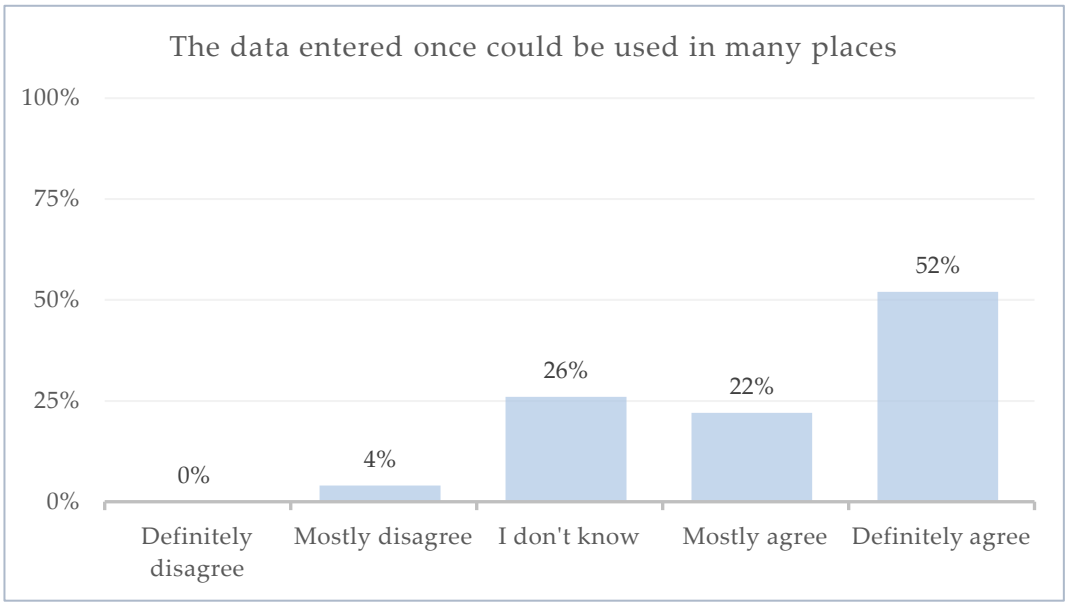

Figure 21. Universality of the entered data in the opinion of the surveyed users of the ADPIECare system

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Based on the answers of the respondents it may be established that the elements which created the most difficulties when working with the application were: "selection of diagnoses" (15 persons), "selection of interventions" (14 persons) and "planning the work pattern" (15 persons). The same result (7 persons) was given both to the answer "assessment of systems" and to "using tools to assess the patient's health status". Slightly less, 6 persons had problems with preparing a discharge readiness assessment. The simplest to fill out proved to be the interview card.

When analysing the chart, the "medical history chart" proved to be the simplest to use, marked by 16 persons. Next places were, in order, "assessment of systems" (marked by 14 persons) and "using chart, tools to assess the health status" (Figure 22).

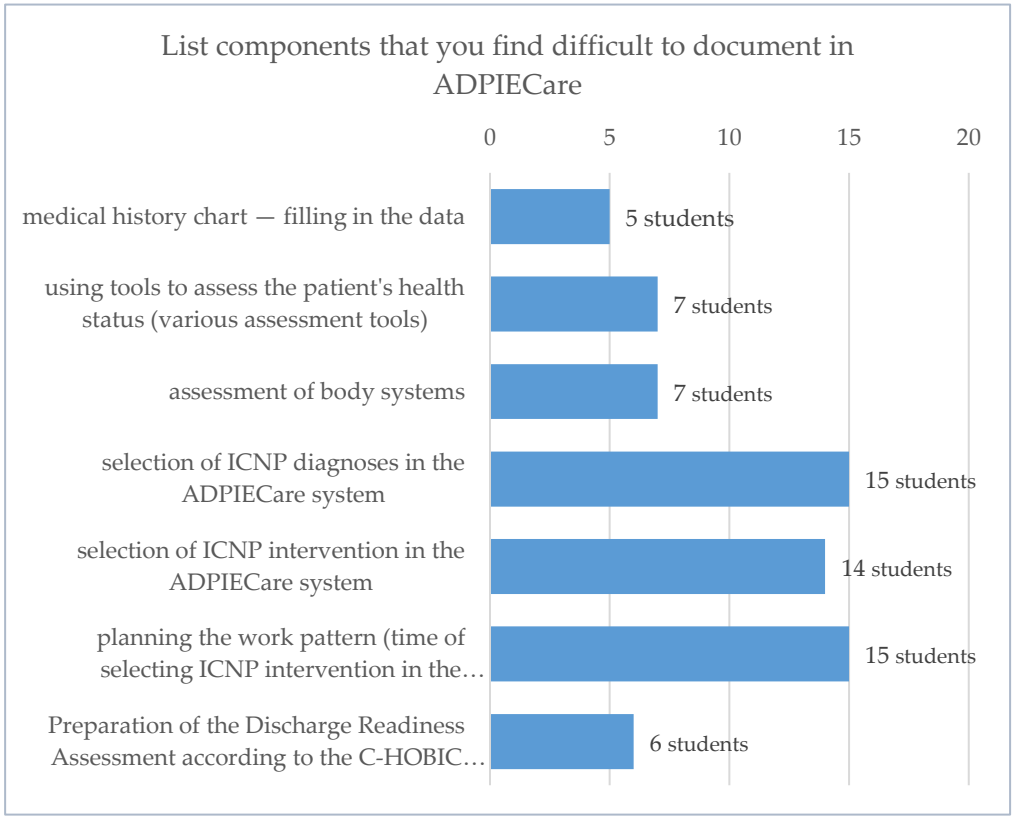

Figure 22. Factors that cause problems in the documentation of data in the ADPIECare system in the opinion of the surveyed users of the system

There were only 8 persons for whom "assessment of systems" was easy to use, 6 persons who selected the answer "preparation of discharge readiness assessment" and 5 persons chose the "selection of intervention" answer. The lowest score was obtained by the "planning the work pattern" answer (Figure 23).

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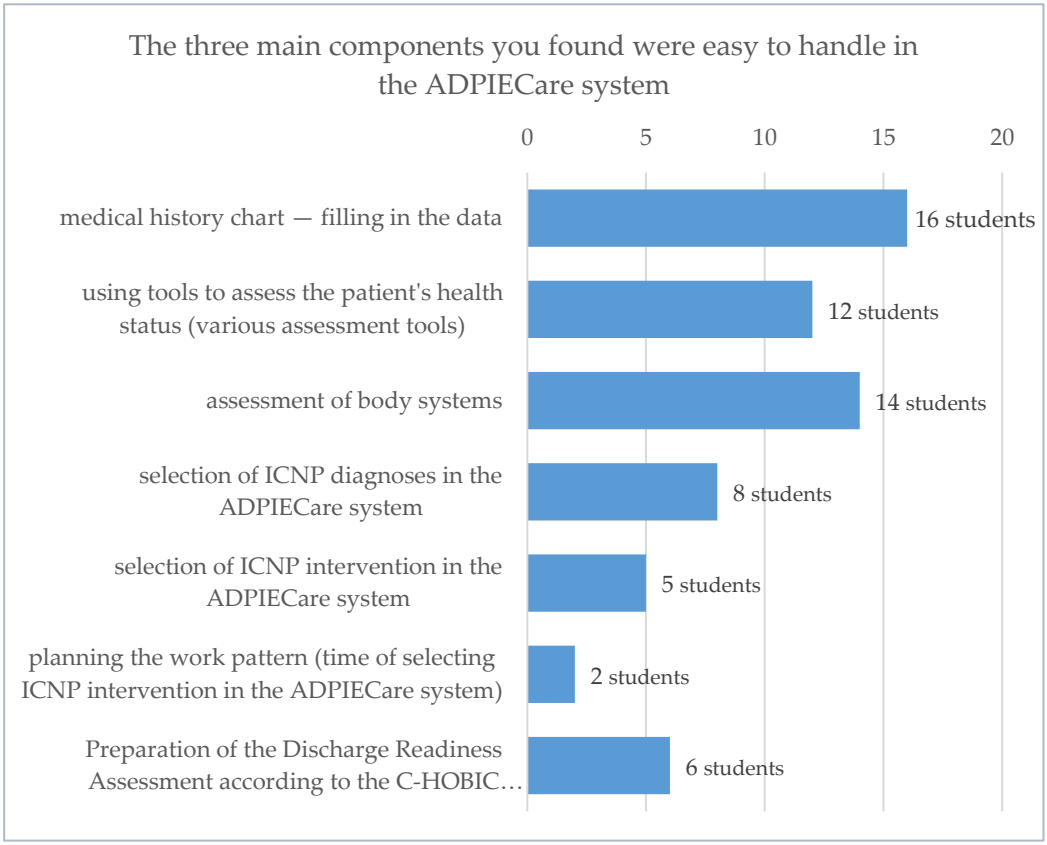

Figure 23. Factors indicated by the surveyed users of the system as easy to use, source: Own work based on research results

Despite little experience with the ADPIECare Dorothea application, over half the respondents had a positive attitude towards the planning of patient care with the use of the application. 30% were reluctant towards the introduction of the system. Only 9% did not have an opinion in the matter, while 4% were hesitating and stipulated acceptance on the condition that changes are made to the category of selecting of diagnoses and interventions.

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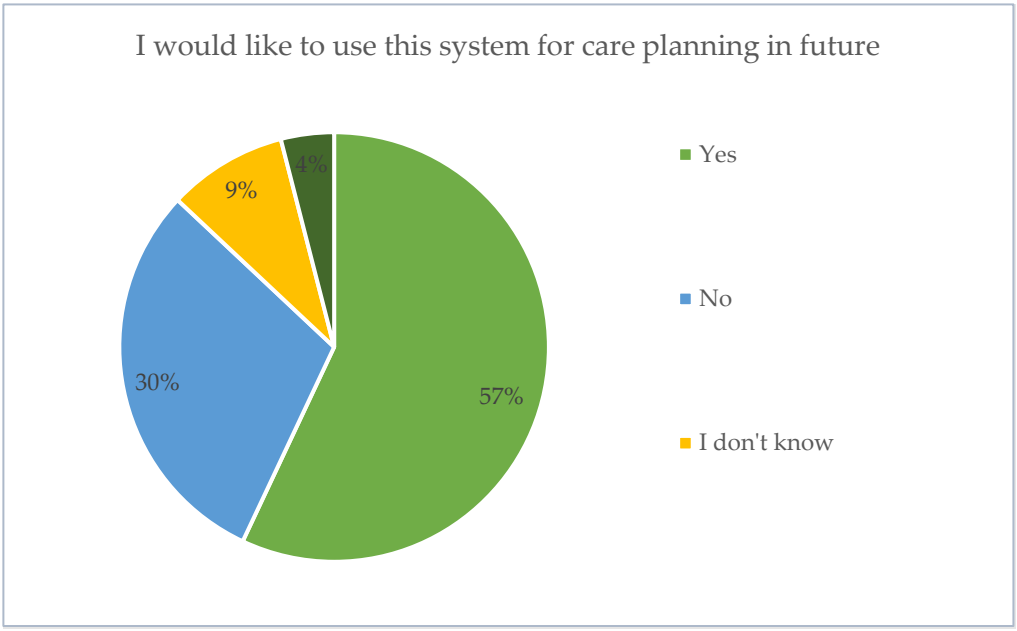

Figure 22. Attitude of the respondents to the implementation of the application for patient care planning

The last question in the questionnaire was an open question. It allowed us to thoroughly learn the opinions of the nurses about the application, and also the justification of their choice in item 17. A significant majority of the answers concerned positive comments. An opinion survey is always related with disapproval of the surveyed parties, which was also reflected in this case. A small number of persons were cautious and have no opinion concerning the IT tool (Table 1).

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Table 1. Responses of the surveyed to question 18 from the survey

positive answers	neutral answers	negative answers
the application is intuitive	no opinion	too much time
the application facilitates work	application has both advantages and disad-vantages	too much filling out
all patient assessments can be found in a single location	I don't know	anxiety about server or computer freezing and in-sufficient number of com-puters at the ward
the time needed to input data would be shortened, even though so detailed assess-ment of individual systems is not necessary		I don't need this in the daily work
yes, if the option of selecting diagnoses and interventions in the system is improved		the software narrows the manner of formulating of diagnoses and interven-tions, sometimes it is diffi-cult to adapt the proposed description to the actual problem
everything is legible and comprehensible		I prefer paper documenta-tion
the application is state-of-the-art		
it facilitates the collection of necessary data		
rapid collection of data about the patient		
the software would facilitate and accelerate care planning and would group patient in-formation		
yes, if this will have a posi-tive impact on better wages		

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3.2. Analysis of the used services

4. Discussion

The presented study and the conducted surveys were inspired by current trends of digital transformation in health care. The e-Health revolution uses IT and telecommunications technologies for the development of the medical sector in Poland, and also in other European Union countries [54]. The selection of the studied group was not accidental. Most of the surveyed persons were second year students, who were being prepared during their education to work in a digitised world. Additionally, they are characterised by young age, short work experience, and a fresh approach to the currently introduced standards of modern nursing care.

The nature of information and communication services fosters the dissemination of knowledge by separating data from the physical location of the problem. Geographical boundaries are ceasing to exist and allow the integration of distant societies, which has a positive impact on the general availability of knowledge for everyone [55]. It is important to approach the issue of electronic documentation and information in a comprehensive and interdisciplinary manner [56].

Another study also demonstrates that nurses do not yet have the knowledge nor opinions about the implementation of electronic documentation. The conclusions stated in the referred study strictly refer to the need to create a new course concerning nursing IT, and also to undertake efforts to educate students in the documentation of medical events, with the help of the teaching staff. It is possible that such an initiative could help in more effective use of the tool and in the understanding of the process related to general digitisation [57]. Currently the students undergo the process of training with documentation tools at the first level of graduate education, as part of the "primary health care" course. These changes are reflected in the outcomes of this study. The respondents declare closer contact with the application and positive approach to working with it.

The aforementioned analysis of survey studies, in the answer to the question "Do nurses have a positive attitude to the daily work using the ADPIECare Dorothea system" allows establishing that the positive approach of the nurses to patient care planning using the system may result from presenting a method for improving the documentation of medical events by nurses. To justify the respondents' willingness to use the "ADPIECare Dorothea" system a table of results was created (Tab. 1). In the table the answers were divided by the researcher into three subjective categories: positive, neutral and negative. As demonstrated by the analysis, an

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overwhelming number of arguments refers to the concept of an IT tool, emphasising its clear and modern look. The time savings, which are of key importance in the nursing profession, were also marked as an advantageous element. Nurses are burdened daily with many medical and administrative activities. Effective data input into the IT system, and also access to this data would enable a comprehensive and more effective patient care [58]. Having appropriate collected data at ones disposal enables making of appropriate decisions at a correct time [59]. The issue of data exchange [60] and the possibilities of individual applications also have to be emphasised [61], [62].

Referring to the right side of the table, where negative answers were shown, it can be established that digitisation of medical documentation causes some anxieties among its users. It may result from attachment to paper documentation, or from the time needed to fill out the documents [63], [64]. By analysing the counterarguments, the deficiencies of hardware and access to more modern technology are brought out. Maybe it results from financial limitations of the public health care entities, but another possibility is also not taking into account this professional group when the tool for nurses was being designed [65].

The interest of the researchers focused on the assessment of the view of the screen and of the legibility of information presented in the application. We can obtain this answer when simultaneously analysing the results of the sixth and ninth question (6. The system had a clear, easy to understand and ordered appearance of the screen; 9. The information on the screens was easy to understand). The percentage of respondents with a positive opinion was relatively high. The legibility of functions is of key importance in the skilful use of the application. Its chaotic appearance, layout of the contents or terminology which is incomprehensible to the user could have an adverse impact on the decision about repeated use.

An important element for the assessment of the use of IT tools is the time needed to fill out documentation. Usually, IT systems have multiple functionalities and a nurse does not have to use every functionality. This all depends on the patient's condition. That is why it is so important whether the documentation of a single patient care plan was time-consuming. The answers can be obtained by analysing the results of the fifth question of the survey (5. The time spent to document a care plan for a single patient). The question was intended to indicate the amount of time necessary in order to document a care plan for a single patient. The surveyed person could choose from five answers, which enabled establishing the time needed for work only approximately. Most nurses used from 21 to 40 minutes to prepare the documentation. However, to precisely establish the time needed for

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the documentation process the research should be expanded by individual average time of filling out data, with the same number of approaches to the task. It should be also noted that a significant factor which impacts the results is the experience of each of the surveyed persons and the characteristics of the patient's problem. To summarise the studied problem, it may be established that preparing a single care plan is time consuming. It is possible that the ability to use the classification and the knowledge of used terms which are not commonly used may have an impact on this. This lengthens the time needed to use the system at this stage of working with electronic documentation. Therefore, if it was not possible to acquaint oneself with the classification earlier, searching through a database of over eight hundred diagnoses may have an impact on the time needed to fill out the documents and be reflected in the opinion of the users.

Referring to the research hypotheses postulated in this study, it was established that hypothesis No 1 was not confirmed. A detailed analysis of the results indicated that filling out the care plan for a single patient up to 20 minutes had no impact on the positive assessment by the surveyed. Whereas it was simultaneously noted that after selecting the group of persons which prepared the same care plan for more than 40 minutes, their opinion presented a negative attitude towards the application.

Hypothesis No 2 was positively verified. A clear appearance of the application had significant importance for the studied group.

The conducted research also enabled confirming the last, third hypothesis. The number of care plans prepared in the application influences the approach of the respondents to the use of application. This enables the users to know the tool better, and also to remember the sequence of entered variables. Using the application for the next time enables freer use of its functions.

To recapitulate, the application follows the current trend of correlation of the IT department and the medical department Implementation of decision-supporting systems with the use of terminology — enabling reliable and uniform documentation, may provide the patient with a better quality of medical services and continuity of care, due to access to full nursing information. A useful feature of this tool is the use of prepared care plans based on the ICNP® international classification. The universality of the language for the coding of diagnoses and interventions enables transmitting the data in an electronic format also to locations outside of Poland.

5. Conclusions

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Over 50% of the respondents have indicated the usability of the application concerning the effectiveness of documentation, and the same number of employees have confirmed that they have a positive attitude to patient care planning with the use of the application. Most of the opinions of the surveyed nursing students were positive, such as: "the application is intuitive," "the application facilitates work," "all patient assessments are located in a single location," "the time needed to enter data would be shortened, even though so detailed assessment of individual systems is not necessary," "yes if the option of selecting diagnoses and interventions in the system is improved," "everything is legible and comprehensible," "the application is state-of-the-art," "facilitates the collection of necessary data," "rapid collection of data about the patient," "the software would facilitate and accelerate care planning and would group patient information" or "yes, if this will have a positive impact on better wages." There were also some negative applications, such as e.g.: "too much time," "too much filling out," "anxiety about server or computer freezing and insufficient number of computers at the ward," "I don't need this in the daily work," "the software narrows the manner of formulating of diagnoses and interventions, sometimes it is difficult to adapt the proposed description to the actual problem" or "I prefer paper documentation."

As demonstrated in the study, despite little experience with the "ADPIECare Dorothea" system (some of the students encountered the application for the first time during the study), over half of the respondents has a positive attitude to patient care planning with the use of the application, every third person (30%) was reluctant towards the introduction of the system. The elements which caused the most difficulties when working with the application were: "selection of diagnoses" (selected by 15 persons), "selection of interventions" (marked by 14 persons) and "planning the work pattern" (marked by 15 persons). The same result (7 persons) was given both to the answer "assessment of systems" and to "using tools to assess the patient's health status." Slightly less, 6 persons had problems with preparing a discharge readiness assessment. The simplest to fill out proved to be the medical history chart [66], which may indicate that frequency with which this intervention is performed during the studies is higher. Whereas the remaining phases of the nursing process based on ICNP terminology are insufficiently memorised. Moreover, insufficient practical knowledge in the use of reference terminology and key words may prove to be a hindrance and impact the assessment of the use of the system.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, according to polish law the ethical statement is available only for experiment.

Informed Consent Statement:
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Non-digital data supporting this study are curated by Dorota Kilanska.

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The authors declare no conflict of interest.

Appendix 1

Timesheet of developing ADPIECare System performed by the MUL IT Team

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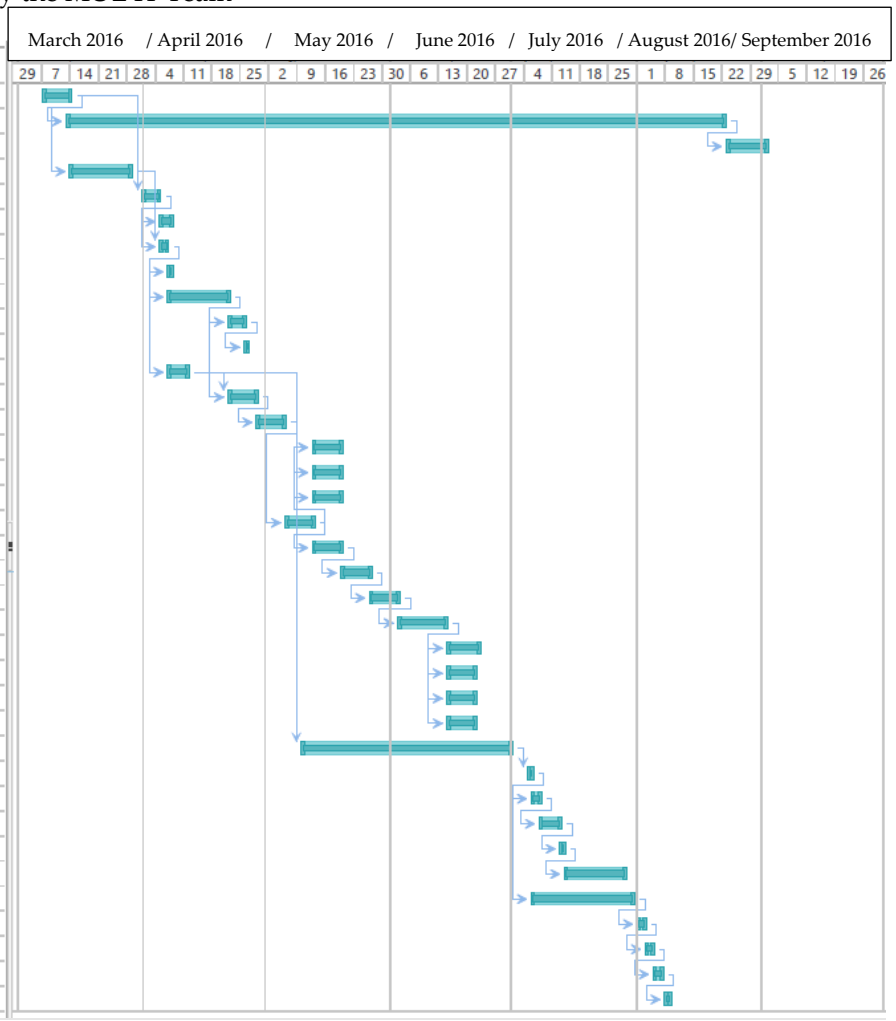
Appendix 1. Timesheet of developing ADPIECare System performed by the MUL IT Team

Iden	Tryb	Nazwa zadania
1		Planowanie projektu
2		Dokumentacja pracy
3		Napisanie instrukcji aplikacji
4		SPOTKANIA - okres dogadywania szczegółów i przedstawienie realizacji planowanej aplikacji
5		Postawienie środowiska testowego
6		Implementacja podstawowych środków zabezpieczających serwera
7		Zaprojektowanie struktury bazy danych
8		Testy struktury bazy danych (wydajność)
9		Implementacja struktury bazy danych
10		Komunikacja bazy danych z aplikacją webową
11		Testy bazodanowe
12		Zaprojektowanie struktury obiektowej projektu
13		PA - implementacja modułu zarządzania rodzajami kont i uprawnieniami do systemu
14		PA - implementacja modułu zarządzania studentami i pielęgniarkami i lekarzami
15		PA - Implementacja modułu zarządzania słownikami
16		PA - Implementacja modułu zarządzania treściami i etykietkami w różnych językach wyświetlanymi w aplikacji
17		PA - Implementacja modułu personalizacji aplikacji (ułożenie zakładek)
18		PA - Implementacja modułu zarzadzania pacjentami
19		PU - implementacja zakładki listy pacjentów
20		PU - implementacja zakładki karty wywiadu
21		PU - implementacja zakładki karty ocen i pomiarów
22		PU - implementacja zakładki diagnoz i planowania opieki
23		PU - implementacja zakładki historii
24		PU - implementacja zakładki wypisu (wydruk)
25		PU - implementacja zakładki raportów pielęgniarskich (wydruk)
26		PU - implementacja zakładki interwencji pielęgniarskich
27		SPOTKANIA - okres prezentacji prac i korekt w projekcie
28		PREZENTACJA - podsumowanie pracy
29		Testy poszczególnych modułów
30		Testy funkcjonalności aplikacji
31		Testy bezpieczeństwa
32		Testy klienta
33		SPOTKANIE - okres przeznaczony na testy klienta i wprowadzanie poprawek
34		Wdrożenie (Postawienie środowiska produkcyjnego oraz instalacja i konfiguracja aplikacji)
35		Skonfigurowanie mechanizmów wykonywania kopii zapasowych
36		Testy błędów krytycznych (wymagających przywrócenie środowiska z kopii zapasowych)
37		FINALIZACJA - Oddanie projektu



Legend

1. Project planning
2. Work documentation
3. Writing the application's manual
4. MEETINGS – period for discussion of details and presenting the realisation of the planned application
5. Creation of a test environment
6. Implementation of basic server security

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7. Designing the database structure
8. Testing the database structure (performance)
9. Implementing the database structure
10. Communication of the database with the web application
11. Database tests
12. Designing the project's object structure
13. PA – implementation of account types and system permissions module
14. PA – implementation of the student and nurse and doctor management module
15. PA – implementation of the terminology management module
16. PA – implementation of various display languages contents and labels management module
17. PA – implementation of application personalisation module (tabs layout)
18. PA – implementation of the patient management module
19. PU – implementation of the patient list tab
20. PU – implementation of the medical history chart tab
21. PU – implementation of the assessment and measurements chart tab
22. PU – implementation of the diagnoses and care plan tab
23. PU – implementation of the history tab
24. PU – implementation of the discharge tab (printout)
25. PU – implementation of the nursing reports tab (printout)
26. PU – implementation of the nursing interventions tab
27. MEETINGS – period for presentation of works and corrections in the project
28. PRESENTATION – summary of work
29. Individual modules' tests
30. Application functionality tests
31. Security tests
32. Client tests
33. MEETING – period for client tests and introduction of fixes
34. Deployment (creation of a production environment and installation and configuration of the application)
35. Configuration of backup mechanisms
36. Critical error tests (which require restoring the environment from backup copies)
37. FINALISATION – handing the project over