A Tracking System for Diabetic Patients

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ABSTRACT

In this thesis, a tracking system named “Diabetes Tracking System” that provides management and control mechanisms for diabetic patients in North Cyprus is proposed. This system allow to store and manage the diabetic patients' health data related to their diabetes lifelong. The system consists of two parts that are the patient portal used by the diabetic patients and doctors, and the management portal used by the system administrators. By using this system, blood glucose values, nutrition, exercises, medications, laboratory tests, vaccines, diagnosis, yearly examinations, complications, diabetes examinatios and other autoimmum diseases such as celiac or tyroid data of diabetic patients can be stored. All these data of a diabetic patient are used to track his/her course of diabetes by himself and the doctor. In the system, it is possible by super admins to filter diabetic patients in the country. Due the system has dynamic infrastructure for laboratory tests, it is easily adaptable to new developments regarding new laboratory test. The proposed system was designed based on responsive Web interface that makes it compatible with various devices such as desktop and smartphones. Therefore, it is expected to have high usage rates. In adition to this, as improvements have been observed in the clinical data of patients who use such diabetes monitoring systems, it is believed that this system will have positive effects n diabetes treathments of diabetic patients in North Cyprus.

Keywords: Diabetes, Responsive Web, Mobile Application, e-Health, m-Health

ÖZ

Bu tezde, Kuzey Kıbrıs'taki diyabetik hastalar için yönetim ve kontrol mekanizmaları sağlayan "Diyabet Takip Sistemi" adlı bir takip sistemi önerilmiştir. Bu sistem, diyabetik hastaların diyabetlerine ilişkin sağlık verilerinin ömür boyu saklanmasına ve yönetilmesine izin verir. Sistem, şeker hastaları ve doktorların kullandığı hasta portalı, sistem yöneticilerinin kullandığı yönetim portalı olmak üzere iki bölümden oluşmaktadır. Bu sistem kullanılarak şeker hastalarının kan şekeri değerleri, beslenme, egzersizler, ilaçları, laboratuvar testleri, aşıları, teşhisleri, yıllık tetkikleri, komplikasyonları, diyabet muayeneleri ve çölyak veya tiroid gibi diğer otoimmün hastalık verileri saklanabilmektedir. Diyabetik bir hastanın tüm bu verileri, kendisi ve doktoru tarafından, diyabetin seyrini takip etmek için kullanılır. Sistemde süper yöneticiler tarafından ülkedeki diyabetik hastaları filtrelemek mümkündür. Sistem, laboratuvar testleri için dinamik bir altyapıya sahip olduğundan dolayı, yeni laboratuvar testleri ile ilgili gelişmelere kolaylıkla adapte edilebilir. Önerilen sistem, masaüstü ve akıllı telefonlar gibi çeşitli cihazlarla uyumlu hale getiren duyarlı Web arayüzüne dayalı olarak tasarlanmıştır. Bu nedenle kullanım oranlarının yüksek olması beklenmektedir. Buna ek olarak, bu tür diyabet takip sistemlerini kullanan hastaların klinik verilerinde iyileşme gözlemlendiğinden, bu sistemin Kuzey Kıbrıs'taki diyabet hastalarının, diyabet tedavilerine olumlu etkileri olacağı inanılmaktadır.

Anahtar Kelimeler: Diyabet, Duyarlı Web, Mobil uygulama, e-Sağlık, m-Sağlık

To my family...

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TABLE OF CONTENTS

ABSTRACT iii

ÖZ iv

DEDICATION v

ACKNOWLEGMENT vi

LIST OF TABLES ix

LIST OF FIGURES xii

LIST OF ABBREVIATIONS xix

1 INTRODUCTION 1

2 SYSTEM DESIGN OF THE PROPOSED SYSTEM 4

2.1 System Architecture 4

2.2 Use Case Diagram 7

2.2.1 “Admin” and “Super Admin” Use Case Diagram 7

2.2.2 “Diabetes Doctor” Use Case Diagram 8

2.2.3 “Patient” Use Case Diagram 11

2.2.4 “Other Doctor” Use Case Diagram 12

2.3 Database 14

3 IMPLEMENTATION OF THE PROPOSED SYSTEM 54

3.1 Responsive Web Application 54

3.1.1 Management Portal 55

3.1.2 Patient Portal 73

3.2 Mobile Application 144

3.3 Tools and Utilities Used and System Requirements 146

4 COMPARISON 147

5 CONCLUSION & FUTURE WORK 153

REFERENCES..... 155

LIST OF TABLES

Table 2.1: “user_information” table’s attributes in detail 15

Table 2.2: “patient” table’s attributes in detail..... 16

Table 2.3: “doctor” table’s attributes in detail 16

Table 2.4: “doctor_patient” table’s attributes in detail 17

Table 2.5: “patient_temp_password” table’s attributes in detail 17

Table 2.6: “tests” table’s attributes in detail 19

Table 2.7: “data_areas_of_tests” table’s attributes in detail 19

Table 2.8: “selection_areas” table’s attributes in detail 19

Table 2.9: “selection_areas_values” table’s attributes in detail..... 20

Table 2.10: “selection_areas_of_tests” table’s attributes in detail..... 20

Table 2.11: “patient_test” table’s attributes in detail 21

Table 2.12: “diagnostic_data” table’s attributes in detail 22

Table 2.13: “diagnostic_data_test_definition” table’s attributes in detail 22

Table 2.14: “diagnostic_data_test_result” table’s attributes in detail..... 23

Table 2.15: “yearly_examination” table’s attributes in detail..... 24

Table 2.16: “yearly_examination_test_definition” table’s attributes in detail..... 25

Table 2.17: “yearly_examination_test_result” table’s attributes in detail 25

Table 2.18: “thyroid_disease” table’s attributes in detail 26

Table 2.19: “thyroid_disease_test_definition” table’s attributes in detail 27

Table 2.20: “thyroid_disease_test_result” table’s attributes in detail..... 27

Table 2.21: “celiac_disease” table’s attributes in detail..... 28

Table 2.22: “celiac_disease_test_definition” table’s attributes in detail 29

Table 2.23: “celiac_disease_test_result” table’s attributes in detail 29

Table 2.24: “autoimmune_diseases” table’s attributes in detail 31

Table 2.25: “autoimmune_diseases_test_result” table’s attributes in detail 31

Table 2.26: “types_of_complications” table’s attributes in detail 32

Table 2.27: “patient_complications” table’s attributes in detail 33

Table 2.28: “external_examination” table’s attributes in detail 35

Table 2.29: “external_examination_test_result” table’s attributes in detail 35

Table 2.30: “diabetes_medications” table’s attributes in detail 37

Table 2.31: “patient_medications” table’s attributes in detail 38

Table 2.32: “medication_identification_requests” table’s attributes in detail 39

Table 2.33: “patient_medication_use” table’s attributes in detail 39

Table 2.34: “alert_medicine_definition” table’s attributes in detail 40

Table 2.35: “patient_vaccine” table’s attributes in detail 42

Table 2.36: “patient_daily_values” table’s attributes in detail 42

Table 2.37: “patient_diabetes_type_treatment” table’s attributes in detail 43

Table 2.38: “patient_examination” table’s attributes in detail 45

Table 2.39: “patient_examination_test_definition” table’s attributes in detail 46

Table 2.40: “patient_examination_test_result” table’s attributes in detail 46

Table 2.41: “puberte_examination” table’s attributes in detail 47

Table 2.42: “patient_examination_extra_test” table’s attributes in detail 47

Table 2.43: “patient_examination_vaccines” table’s attributes in detail 48

Table 2.44: “patient_examination_medications” table’s attributes in detail 48

Table 2.45: “notifications” table’s attributes in detail 50

Table 2.46: “patient_bazal_insulin” table’s attributes in detail 52

Table 2.47: “patient_bolus_insulin” table’s attributes in detail 52

Table 2.48: “patient_subkutan_insulin” table’s attributes in detail 53

Table 2.49: “patient_subkutan_insulin_additional” table’s attributes in detail 53

Table 4.1: Comparison Between Proposed System and Other Studies..... 149

Table 4.2: Comparison Between Proposed System and Mobile Applications..... 152

LIST OF FIGURES

Figure 2.1: System Architecture 5

Figure 2.2: Use Case Diagram for “Admin” and “Super Admin” 8

Figure 2.3: Use Case Diagram for “Diabetes Doctor” 10

Figure 2.4: Use Case Diagram for “Patient” 12

Figure 2.5: Use Case Diagram for “Other Doctor” 13

Figure 2.6: The diabetes_monitoring2 database’s entity relationship diagram #1 of 14. 14

Figure 2.7: The diabetes_monitoring2 database’s entity relationship diagram #2 of 14 18

Figure 2.8: The diabetes_monitoring2 database’s entity relationship diagram #3 of 14 21

Figure 2.9: The diabetes_monitoring2 database’s entity relationship diagram #4 of 14 23

Figure 2.10: The diabetes_monitoring2 database’s entity relationship diagram #5 of 14 25

Figure 2.11: The diabetes_monitoring2 database’s entity relationship diagram #6 of 14 27

Figure 2.12: The diabetes_monitoring2 database’s entity relationship diagram #7 of 14 30

Figure 2.13: The diabetes_monitoring2 database’s entity relationship diagram #8 of 14 32

Figure 2.14: The diabetes_monitoring2 database’s entity relationship diagram #9 of 14 34

Figure 2.15: The diabetes_monitoring2 database's entity relationship diagram #10 of 14 36
Figure 2.16: The diabetes_monitoring2 database's entity relationship diagram #11 of 14 41
Figure 2.17: The diabetes_monitoring2 database's entity relationship diagram #12 of 14 44
Figure 2.18: The diabetes_monitoring2 database's entity relationship diagram #13 of 14 49
Figure 2.19: The diabetes_monitoring2 database's entity relationship diagram #14 of 14 51
Figure 3.1: Sign-in Page 55
Figure 3.2: Management portal menu. (a) "Laboratuvar" menu is displayed. (b) "İlaç" menu displayed. (c) "Onay İşlemleri" menu displayed. (d) "Listeler" menu displayed. 56
Figure 3.3: "Test Tanımla" Page Form 57
Figure 3.4: "Tüm Testler" table 58
Figure 3.5: Preview of "Test Form" 58
Figure 3.6: "Çoklu Seçim Alanları" Page 59
Figure 3.7: "Sayfaya Tanımla" page 61
Figure 3.8: "Sayfaya Tanımla" page's Test List 62
Figure 3.9: "İlaç Tanımla" page 62
Figure 3.10: "İlaç İstek" page's "İlaç İstekler" Table 63
Figure 3.11: "İlaç İstek" page's "İlaç Bağla" Form 63
Figure 3.12: "İlaç İstek" page's "İlaç Tanımla" form 63
Figure 3.13: "Doktor Onay" page's "Doktorlar" Table 65

Figure 3.14: “Doktorun Hastaları” page’s “Takip Edilen Hastalar” Table 66
Figure 3.15: “Hastalar” page’s “Hastalar” Table 66
Figure 3.16: “Hastanın Doktorları” page’s “Takip Eden Doktorlar” Table 67
Figure 3.17: “BMI Sorgula” page 68
Figure 3.18: “Toplu Filtreleme” page’s “Filtreler” form 69
Figure 3.19: “Toplu Filtreleme” page’s “Filtre Sonuç Listesi” table 70
Figure 3.20: Management Portal’s Top Menu 71
Figure 3.21: “Şifre Değiş” page 72
Figure 3.22: Notifications list 72
Figure 3.23: Notification page 73
Figure 3.24: Patient portal menu 75
Figure 3.25: “Diabetes Doctor’s” registration page 76
Figure 3.26: Registration confirmation waiting page 77
Figure 3.27: Patient portal’s top menu for “Diabetes Doctors” 78
Figure 3.28: “Profil” page for doctor 79
Figure 3.29: “Hastalarım” page 80
Figure 3.30: “Hastalarım” page’s Patient List 81
Figure 3.31: Selected patient from “Hastalarım” page for follow-up 81
Figure 3.32: “Hastalarım” page’s followed-up patients table 81
Figure 3.33: “Hasta Kayıt” page 82
Figure 3.34: Patient password 83
Figure 3.35: Patient selection field for patient data 84
Figure 3.36: Patient list of patient selection area for patient data 84
Figure 3.37: View of selected patient for patient data 84
Figure 3.38: “Diyabet Türü ve Tedavi Şekli” page 85

Figure 3.39: “Diyabet Türü ve Tedavi Şekli (Günümüzden Geçmişe)” table of “Diyabet Türü ve Tedavi Şekli” page 87
Figure 3.40: “Diyabet Türü ve Tedavi Şekli” page for patient 87
Figure 3.41: “İnsülin Dozlarım” page 88
Figure 3.42: “Bazal Dozlarım” page 89
Figure 3.43: “Tanı Verisi” page form 1st piece 90
Figure 3.44: “Tanı Verisi” page form 2nd piece 91
Figure 3.45: “Tanı Verisi” page form 3rd piece 92
Figure 3.46: “Tanı Verisi” page’s value block 93
Figure 3.47: “Tanı Verisi” page’s table of block value 93
Figure 3.48: “Yıllık Tetkikler” page form 1st piece 94
Figure 3.49: “Yıllık Tetkikler” page form 2nd piece 95
Figure 3.50: “Yıllık Tetkikler” page form 3rd piece 95
Figure 3.51: “Yıllık Tetkikler” block data 97
Figure 3.52: “Laboratuvar” page 97
Figure 3.53: “Laboratuvar” page’s “Yeni Sonuç” Form Test List 98
Figure 3.54: “Laboratuvar” page’s “Yeni Sonuç” Form 99
Figure 3.55: “Laboratory” page’s “Tüm Laboratuvar Sonuçları” Table 99
Figure 3.56: “İlaçlar” Page 100
Figure 3.57: Medication List of “İlaçlar” page’s “Yeni İlaç” form 101
Figure 3.58: “İlaçlar” page’s “Yeni İlaç” form 102
Figure 3.59: “İlaçlar” page’s “Tüm İlaçlar” table 102
Figure 3.60: “İlaçlar” page’s “Tüm İlaçlar” table for patient 103
Figure 3.61: “Alarm” page 103
Figure 3.62: “İlaç Kullanım Bilgisi” page 105

Figure 3.63: “Aşı” page 106
Figure 3.64: “Çölyak” page form 107
Figure 3.65: “Çölyak” page’s data block 108
Figure 3.66: “Tiroid” page 109
Figure 3.67: “Tiroid” page’s data block 110
Figure 3.68: “Diğer Otoimmün Hastalıklar” page 111
Figure 3.69: “Diğer Otoimmün Hastalıklar” page’s data block 112
Figure 3.70: “Göz Muayenesi” page 113
Figure 3.71: “Göz Muayenesi” page’s data block 114
Figure 3.72: “3 Aylık HbA1c” page’s “Yeni Sonuç” form 114
Figure 3.73: “3 Aylık HbA1c” page’s chart and table 115
Figure 3.74: “Muayeneler” page 116
Figure 3.75: “Muayene Genel Bilgiler” form 118
Figure 3.76: “Puberte Muayenesi” form 119
Figure 3.77: “Komplikasyonlar” form 120
Figure 3.78: “Muayene Ek Testler” page 121
Figure 3.79: “Muayene İlaçlar” page 122
Figure 3.80: “Muayene Aşı” page 123
Figure 3.81: “Muayeneler” page’s data blocks 123
Figure 3.82: “Muayeneler” page data block “Seyir” area 124
Figure 3.83: “Muayeneler” page’s data block “Genel Bilgiler” area 124
Figure 3.84: “Muayeneler” page’s data block “Puperte Muayenesi” area 125
Figure 3.85: “Muayeneler” page’s data block “Komplikasyonlar” area 125
Figure 3.86: “Muayeneler” page’s data block “Ek Testler” area 126
Figure 3.87: “Muayeneler” page’s data block “İlaçlar” area 126

Figure 3.88: “Muayeneler” page’s data block “Aşılar” area..... 127
Figure 3.89: “Diyabet Günlüğü” page 128
Figure 3.90: “Haftalık Kan Şekeri Grafigi” line chart 131
Figure 3.91: “Diyabet Günlüğü” page’s “Ekle” button 131
Figure 3.92: “Diyabet Günlüğü” page's form blocks..... 132
Figure 3.93: “Diyabet Günlüğü” page's “Açlık Şekeri”form..... 133
Figure 3.94: “Diyabet Günlüğü” page’s oral form..... 133
Figure 3.95: “Diyabet Günlüğü” page’s bolus form 134
Figure 3.96: “Diğer Muayeneler” page..... 134
Figure 3.97: “Diğer Muayeneler” page’s form 136
Figure 3.98: Patient portal top menu for patient 136
Figure 3.99: Patient temp password..... 137
Figure 3.100: “Doktorlarım” page 138
Figure 3.101: “Profil” page for patient 138
Figure 3.102: “Other Doctor’s” sign-in page..... 139
Figure 3.103: “Other Doctor’s” registration page..... 139
Figure 3.104: Patient portal top menu for “Other Doctor” 141
Figure 3.105: The notifications menu. (a) Notifications menu on patient portal. (b) Notifications menu on diabetes doctor portal 142
Figure 3.106: The notifications page. (a) Notifications page on patient portal. (b) Notifications page on diabetes doctor portal..... 143
Figure 3.107: Patient notification for “Diabetes Doctor” follow-up request..... 144
Figure 3.108: Patient notification for medication alarm..... 144

Figure 3.109: Some views of mobile application. (a) Sign-in page. (b) “Muayaneler” page with patient portal menu. (c) “Muayeneler” page”. (d) “Göz Muayenesi” page. (e) “3 Aylık HbA1c” page’s line chart. (f) “3 Aylık HbA1c” page’s table. 145

LIST OF ABBREVIATIONS

API	Application Programming Interface
HbA1c	Hemoglobin A1c
ID	Identification Number
MySQL	My Structured Query Language
PHP	Hypertext Preprocessor
REST	Representational State Transfer

Chapter 1

INTRODUCTION

With the technological developments in the world, the usage of technological systems has increased in many areas. Health is one of these areas. Various systems have been developed for each branch of health. Diabetes is one of these branches.

Kwon et al. [1] proposed a Web based system that uses short message service (SMS) for diabetic patients. The patients recorded their health data to this system for 3 months. As a result of this study, an improvement on the HbA1c levels of the patients has been observed and they have proposed this Web based system as a new communication way between the patients and heath service providers. McMahon et al. [2] proposed a Web based system for diabetic patients who were not under good health control, and they observed that patients experienced a decrease in their HbA1c levels. They also indicated that the proposed Web based health system was beneficial for diabetic patients. Quinn et al. [3] proposed a mobile coaching system for glycemic control on patients who have diabetes type 2 and 45-64 years of age. As a result, this study, the patients experienced a decrease in HbA1c level during the 12-month study. Menon et al. [4] proposed a mobile model for insulin dose adjustment. They concluded that with this model, an improvement was observed in the clinical data of patients and that such systems improve health care.

In North Cyprus, there are general health systems for hospitals and health centers. These systems are designed to work for a certain hospital or health center. They act independently. North Cyprus has no centralized system for tracking diabetic patients over the country at all. In the study conducted by the Cyprus Turkish Diabetes Association in 2008, it was found that 11% of the population between the ages of 20 and 80 had diabetes and 18% had hidden sugar [5]. The sum of these two ratios is 29% and this implies that people with diabetes in North Cyprus cannot be ignored. Diabetes is a chronic disease [6] and diabetic patients should be under lifelong control. As a result, a solution is necessity in North Cyprus.

In this thesis, a tracking system that provides management and control mechanisms for diabetic patients in North Cyprus is proposed. It is named as “Diabetes Tracking System”. It allows to store and manage the health data of diabetic patients related to diabetes lifelong. Diabetes of patients can be followed up and kept under control by themselves as well as the doctors. The proposed system is designed based on responsive Web interface that makes it compatible with various devices such as desktop computers and smartphones. Therefore, it is expected to have higher number of users for the system.

The proposed system users are diabetic patients, doctors and system administrators (i.e. admins and super admins). The system consists of two parts; the patient portal and the management portal. The management portal is used by the doctors and administrators. It allows to add medical tests and diabetes medications to the system and to manage the information of doctors and patients registered in the system. On the other hand, the patient portal is used by diabetic patients. It allows to store a patient's daily data such as blood glucose, nutrition, exercises and medications. Besides that, it

also allows to store the data of medical tests, vaccines, diagnosis, yearly examinations, complications, diabetes examinatios and autoimmum diseases such as celiac or tyroid data. All these data of a diabetic patient are used to track his/her course of diabetes by himself and the doctor. In the system, it is possible by super admins to filter diabetic patients in the country. Due the system has dynamic infrastructure for laboratory tests, it is easily adaptable to new developments regarding new laboratory test. In addition to all these aforementioned above, the system was designed to inform users with automatic notifications on some important dates and events such as medical tests, examinations and user registrations.

The further chapters of the thesis are organized as follows: the next chapter describes our proposed system's design including the architecture, use cases and database; the third chapter describes the implementation of the proposed system containing responsive Web application and mobile application; the fourth chapter contains the comparisons of the proposed system with similar systems; and the last chapter gives concluding remarks and future work.

Chapter 2

SYSTEM DESIGN OF THE PROPOSED SYSTEM

In this chapter, architecture of the system, use case diagrams of the system and the entity relationship of the system database will be presented.

2.1 System Architecture

As shown in Figure 2.1, the system is used by “Super Admins”, “Admins”, “Diabetes Doctors”, “Other Doctors” and “Patients”.

Operations such as adding medical tests and diabetes medicines to the system and requests for undefined medicines are carried out by “Admins”.

“Super Admins” can perform all the operations that “Admins” can do, and in addition to these operations, they can manage the user profiles of doctors and patients in the system. They can render the accounts as active or passive, monitor the doctors of patients, monitor the patients of doctors, and they can grant the doctors with admin or “Super Admins” privileges. Furthermore, they can list all patients in the system according to their BMI scores considering the upper and lower bounds.

There are two types of doctors in the system. “Diabetes Doctors” and “Other Doctors”. “Diabetes Doctors” can add new patients to the system and monitor existing patients. They can display all the data of monitored patients in the system. They can enter examination, diagnostic data, annual examination, 3-month HbA1c, test data,

medications, complications, and accompanying diseases to system by using relevant pages.

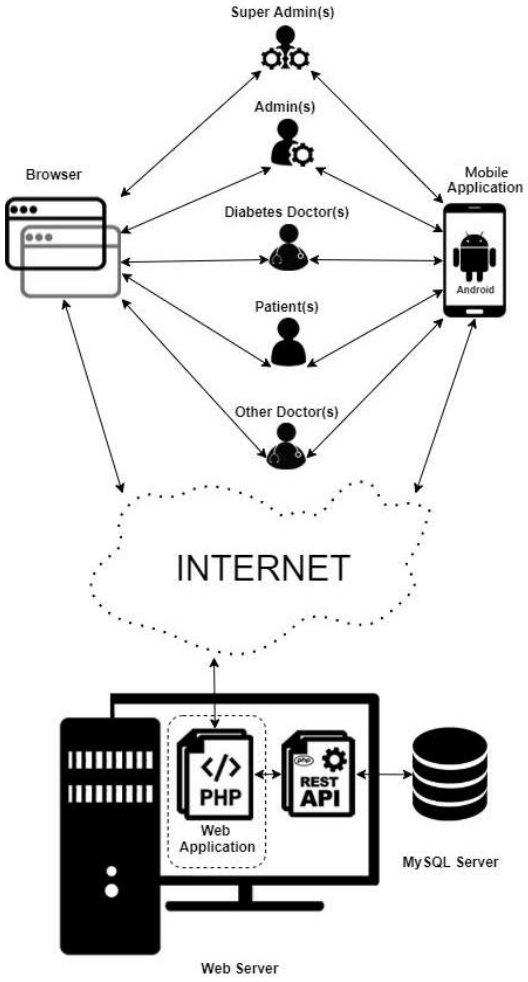


Figure 2.1: System Architecture

"Other Doctors" are doctors that patients go for emergency situations. They can quickly register to the system. Then, they can sign-in to the system with the temporary password given by the patients to be able to display her/his information for 30 minutes. Other doctors do not need super-admin or admin approval because it is an emergency and needs to proceed very smoothly. The session will be terminated after 30 minutes. By using temporary password generated by the patient, these doctors can display all information of patients except the examination reports written by diabetes doctors. The

reason behind of this restriction is that the possibility that there may be records that will worry the patient in the examination reports. Since other doctors can display patient information with the consent of the patient, it is foreseen that the patient can sign-in to the system by pretending as “other doctors”. Therefore, other doctors are only allowed to enter examination information to the “other examinations” page.

“Patients” can enter information such as daily insulin measurements, exercise information, carbohydrate amount, blood glucose values and medicine usage to the system as well as test results. In addition, they can set notifications about medicine usage. “Patients” can display their own data except the text fields entered by doctors. The reason behind of this restriction is to prevent the patient to be worried.

Through to the REST API pages, which are automatically triggered by the system, the system is enabled to send medicine notifications to patients, prepare medicine usage instructions, and remind three-month HbA1c and annual examination dates. In addition, if patients do not use the system for a certain period, the system sends a notification automatically to the patient's doctors and the patient.

Data communication between web application pages and MySQL server is handled through by REST API pages. The Web pages are designed responsively to allow the device to adapt automatically according to the screen size. The devices with responsive-Web-application-supporting Web browsers can display the Web application properly whatever their screen sizes are.

Additionally, a mobile application is created for Android platform to display these responsive Web pages in “WebView” component. Therefore, the mobile application

can be used to display the Web application. Thus, users who will use the mobile application do not need to use Web browser directly.

2.2 Use Case Diagram

In this subsection, the use case diagrams for “Admin”, “Super Admin”, “Diabetes Doctor”, “Patient” and “Other Doctor” will be presented.

2.2.1 “Admin” and “Super Admin” Use Case Diagram

In Figure 2.2, the use case diagram for the user types “Admin” and “Super Admin” is shown. After these users signed-in to the system they will have accesses to the following use cases; “Change Password”, “Selection Areas”, “Define Test”, “Define Page Tests”, “Notifications”, “Define Medication”, “Medication Requests”, “Change Password” and “Sign-out”. “Super Admin” type users will have additional access to the “Doctor Approval”, “Patients” and “List Patients according to BMI” use cases.

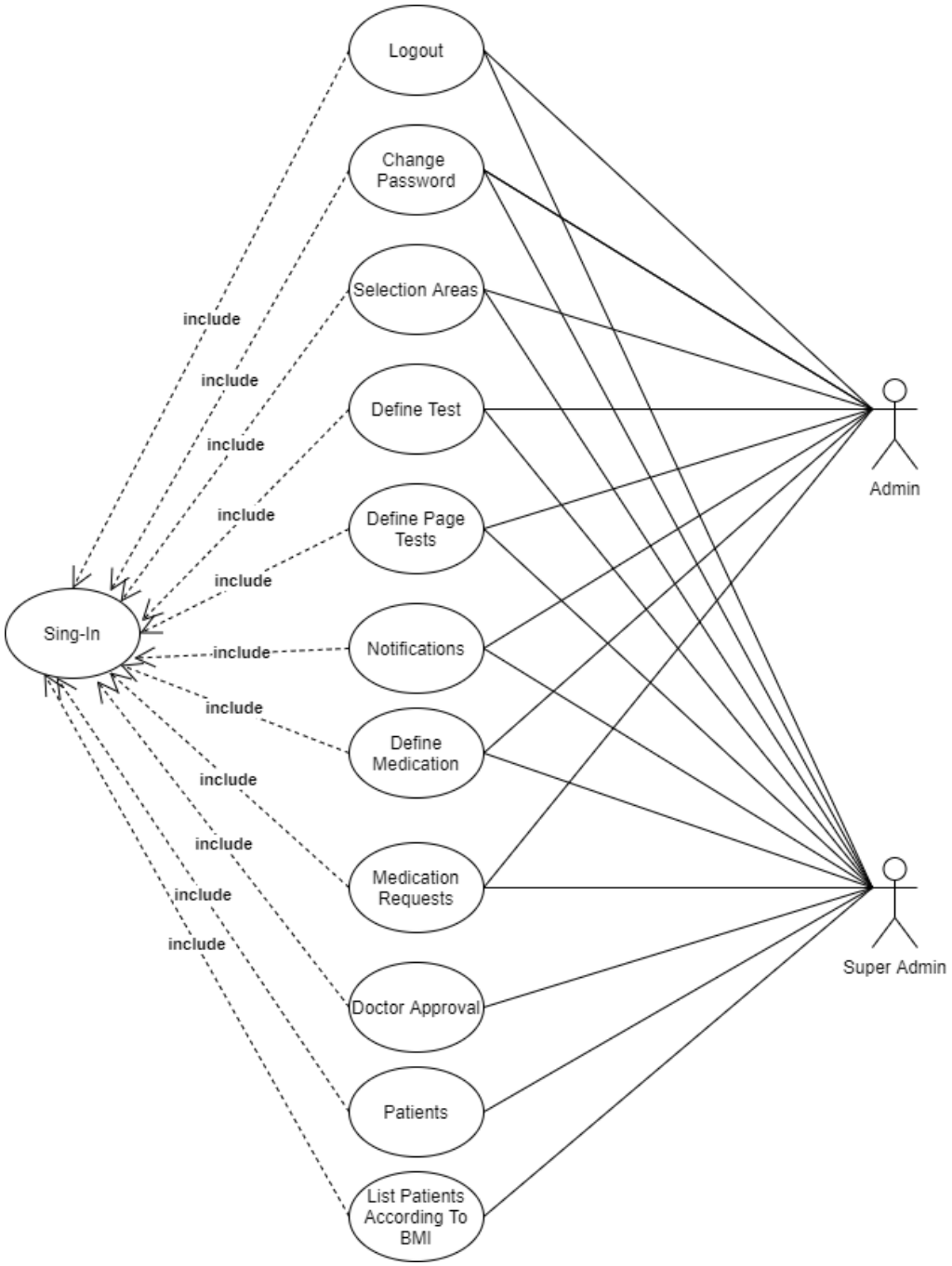


Figure 2.2: Use Case Diagram for “Admin” and “Super Admin”

2.2.2 “Diabetes Doctor” Use Case Diagram

The use case diagram for the “Diabetes Doctor” type users is shown in Figure 2.3. The use cases that “Diabetes Doctor” type users can access are the Patient Register”, “My Patients”, “List My Patients BY BMI”, “Change Password”, “My Profile”, “Notifications”, “Patient Choice”, “Other Examination”, “Complications”,

“Examination”, “3 Months of HbA1c”, “Yearly Examination”, “Lab”, “Medicine”, “Vaccine”, “Type and Treatment”, “Autoimmune Diseases”, “Diagnostic Data”, “Daily Values” and “Sign-out”. However, to be able to access the above use cases, they must use and confirm “Sign-in” use case first.

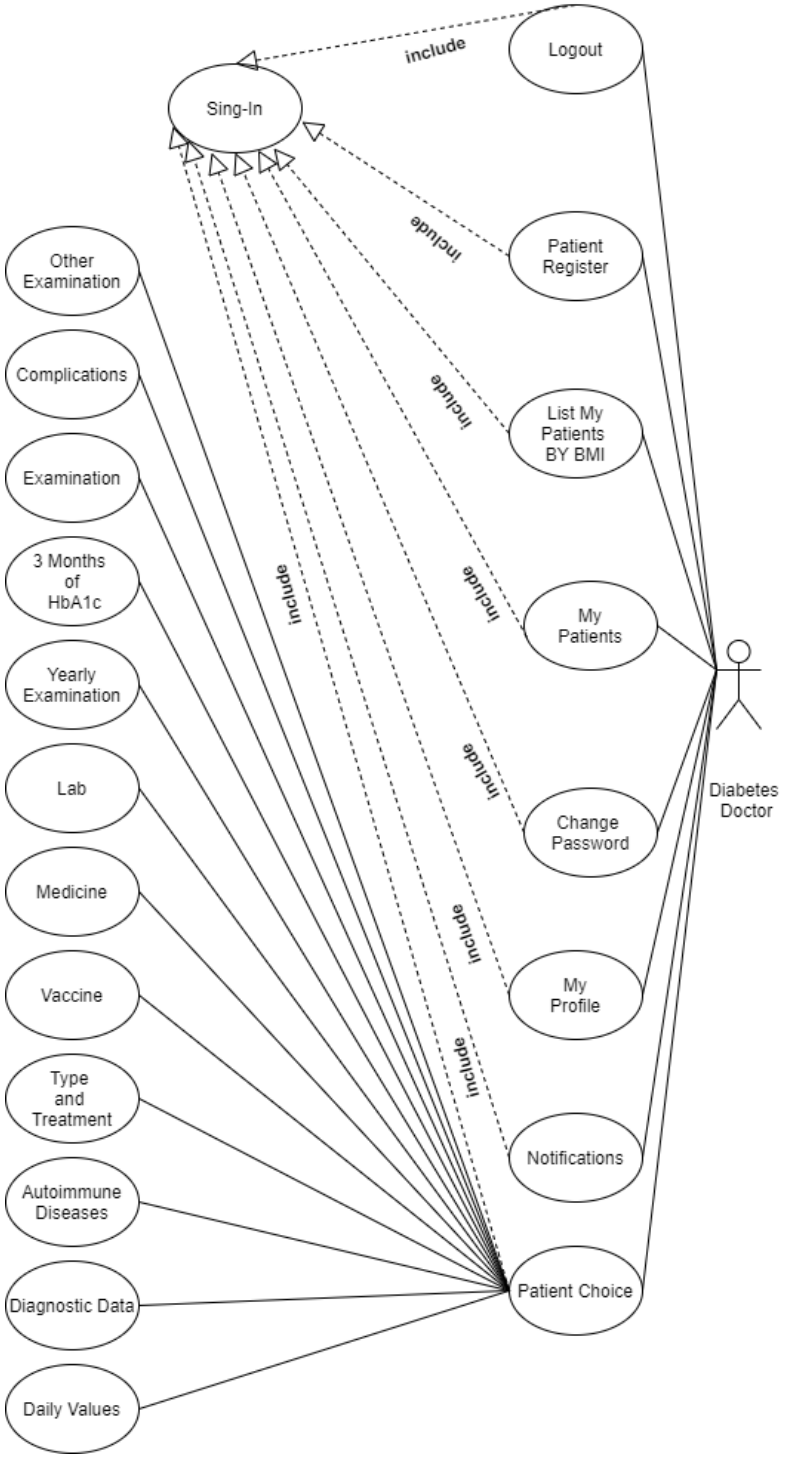


Figure 2.3: Use Case Diagram for “Diabetes Doctor”

2.2.3 “Patient” Use Case Diagram

In Figure 2.4, the use case diagram for the “Patient” type users is shown. As in the Figure 2.4, “Patient” type users can use the following use cases: “My Doctors”, “Temporary Password”, “Change Password”, “My Profile”, “Notifications”, “Other Examination”, “Complications”, “Examination”, “3 Months of HbA1c”, “Yearly Examination”, “Lab”, “Medicine”, “Vaccine”, “Type and Treatment”, “Autoimmune Diseases”, “Diagnostic Data”, “Daily Values” and “Sign-out”. Similarly, to the other type of users, the “Patient” type users must use and confirm “Sign-in” use case first.

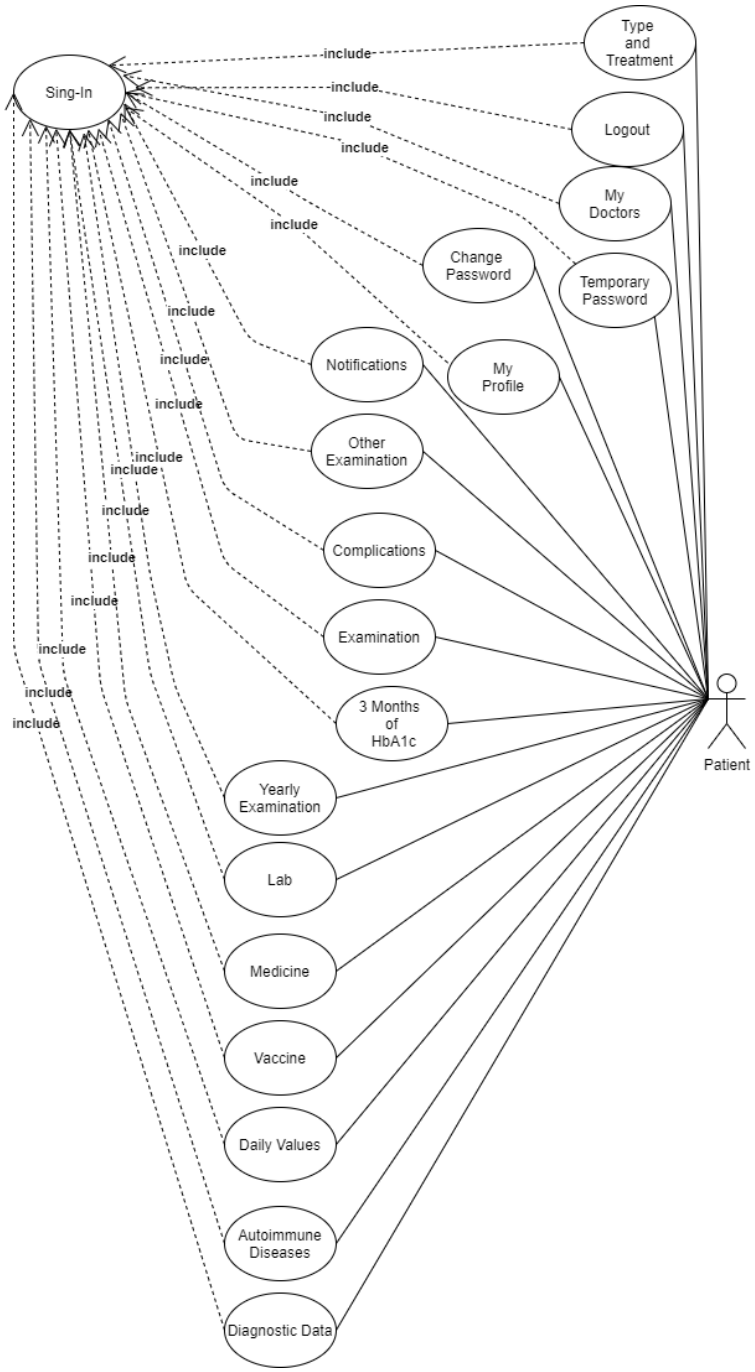


Figure 2.4: Use Case Diagram for “Patient”

2.2.4 “Other Doctor” Use Case Diagram

The use cases for the “Other Doctor” type users are shown in Figure 2.5. Likely to the other type users, “Other Doctor” type users must use and confirm “Sign-in” use case first. Then they can use the following use cases: “Change Password”, “My Profile”, “Other Examination”, “Complications”, “Examination”, “3 Months of HbA1c”,

“Yearly Examination”, “Lab”, “Medicine”, “Vaccine”, “Type and Treatment”, “Autoimmune Diseases”, “Diagnostic Data”, “Daily Values” and “Sign-out”.

Figure 2.5: Use Case Diagram for “Other Doctor”

2.3 Database

The database that is used by the system is named as “diabetes_monitoring2” and it contains 49 relational tables. The database of the system is designed accordance with 1nF, 2nF, 3nF and 3.5nF. These tables and their relations will be mentioned in the following parts. Note that, since all these tables cannot be fit into one single figure, they will be represented by separating them into 14 different figures.

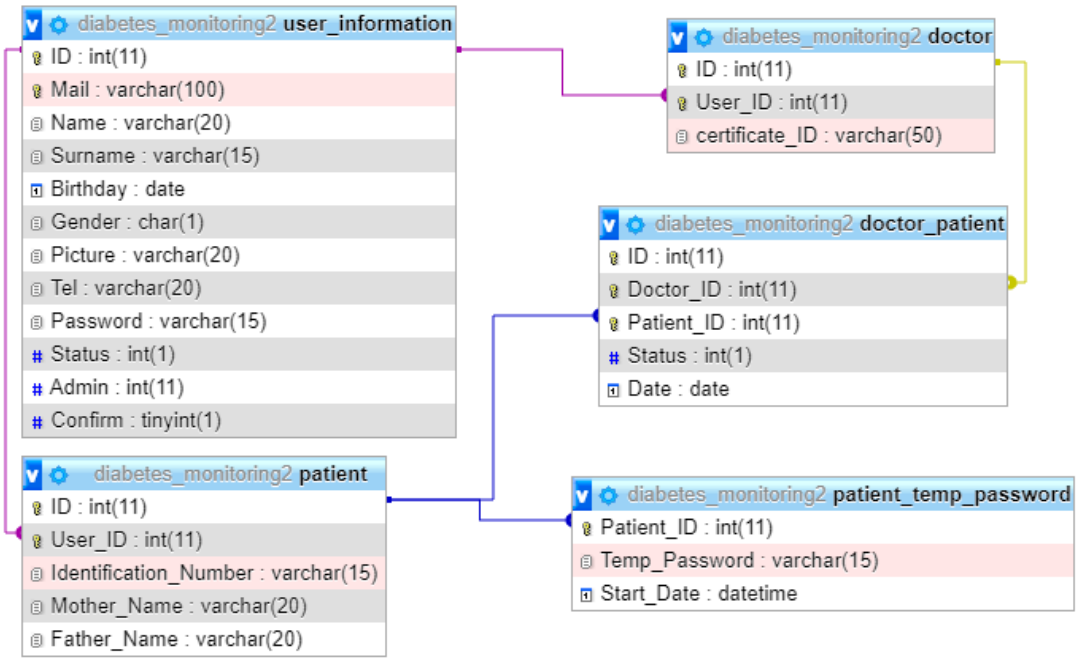


Figure 2.6: The diabetes_monitoring2 database’s entity relationship diagram #1 of 14.

Figure 2.6, total 5 database tables are shown with available entity relations. The tables that are shown in Figure 2.6 are “user_information”, “doctor”, “patient” and “patient_temp_password”.

The “user_information” table keeps the general information of the users such as their name, surname, email etc. This table consists of 12 attributes which are “ID”, “Mail”, “Name”, “Surname”, “Birthday”, “Gender”, “Picture”, “Tel”, “Password”, “Status”,

"Admin" and "Confirm". The detailed information about these attributes are given in Table 2.1 below.

Table 2.1: "user_information" table's attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Mail	varchar	100	Unique	E-mail address of user
Name	varchar	20	Not null	Name of user
Surname	varchar	15	Not null	Surname of user
Birthday	datetime		Not null	Date of birth of user
Gender	char	1	Not null	Gender of user
Picture	varchar	20	Not null	Profile image file path of user
Tel	varchar	20	Not null	Phone number of user.
Password	varchar	15	Not null	Password of user
Status	integer	1	Foreign Key	Status of user. (1, if the user is diabetes doctor; 2, if the user is patient; 3, if the user is other doctor and 0 for the other users)
Admin	integer	11	Foreign Key	Admin status of user. (0, if the user is not admin; 1 if the user is admin; 3, if the user is super admin)
Confirm	integer	1	Foreign Key	Confirmation status of user. (0, if the user is not confirmed; 1, if the user is confirmed)

The "patient" table keeps the records of the patients. It has 5 attributes such that "ID", "User_ID", "Identification_Number", "Mother_Name" and "Father_Name". Table 2.2 contains the details of these attributes.

Table 2.2: “patient” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
User_ID	integer	11	Foreign Key	ID number of user from “user_information ” table
Identification_Number	varchar	15	Not null	ID card no of user
Mother_Name	varchar	20	Not null	Mother name of user
Father_Name	varchar	20	Not null	Father name of user

The “doctor” table keeps the information of the doctors in the system and it contains 3 attributes which are “ID”, “User_ID” and “certificate_ID”. Table 2.3 contains the detailed information about these attributes.

Table 2.3: “doctor” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
User_ID	integer	11	Foreign Key	ID number of user from “user_information” table
certificate_ID	varchar	50	Not null	Diploma number of the doctor

The “doctor_patient” table keeps the relations between doctors and patients. This table contains 5 attributes which are “ID”, “Doctor_ID”, “Patient_ID”, “Status” and “Date”. Table 2.4 contains the detailed information about these attributes.

Table 2.4: “doctor_patient” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Doctor_ID	integer	11	Foreign Key	The ID number of the doctor from “doctor” table
Patient_ID	integer	11	Foreign Key	The ID number of the patient from “patient” table
Status	integer	11	Foreign Key	Doctors' request status of patient follow-up (1; awaiting requests; 2, confirmed request; 3, rejected request)
Date	datetime		Not null	Record date and time

The “patient_temp_password” table keeps the record of a temporary password for the doctors who wants to follow a patient up. This table has 3 attributes which are “Patient_ID”, “Temp_Password” and “Start_Date”. Table 2.5 contains the details of these attributes.

Table 2.5: “patient_temp_password” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
Patient_ID	integer	11	Primary Key	Auto generated record number.
Temp_Password	integer	11	Not null	Temporary password for a doctor
Start_Date	datetime		Not null	Start date and time of password assigned

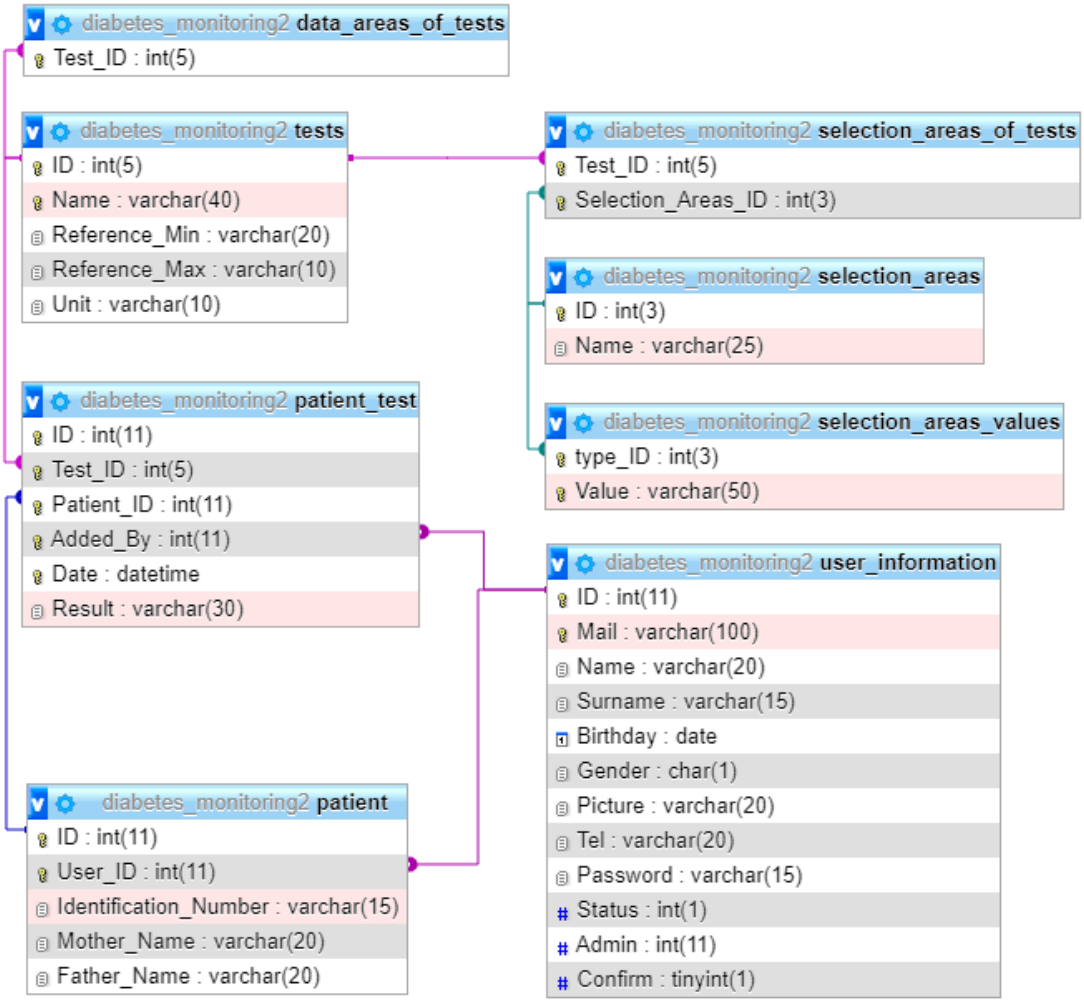


Figure 2.7: The diabetes_monitoring2 database's entity relationship diagram #2 of 14

In Figure 2.7, total 8 database tables are shown with available entity relations. The "patient" and "user_information" tables in Figure 2.7, were explained in Figure 2.6 previously. The rest of the tables in Figure 2.7 are "tests", "data_areas_of_tests", "selection_areas", "selection_areas_values, "selection_areas_of_tests" and "patient_test".

The "tests" table is the table where the definitions of the medical tests in the system are kept. This table consists of 5 fields such that "ID", "Name", "Reference Min", "Reference Max" and "Unity" where their descriptions are given in Table 2.6.

Table 2.6: “tests” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	5	Primary Key	Auto generated record number.
Name	varchar	40	Not null	Name of test
Reference_Min	varchar	20		Minimum reference test value, if exists
Reference_Max	varchar	10		Maximum reference test value, if exists
Unit	varchar	10		Test’s unit value, if exists

The “data_areas_of_tests”, “selection_areas”, “selection_areas_values” and “selection_areas_of_tests” tables allow the definition of the Web form structures of the tests that have been defined in the system. The details of these attributes are given in Table 2.7.

Table 2.7: “data_areas_of_tests” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
Tests_ID	integer	5	Foreign Key	The ID number of the test from “tests” table

The “selection_areas” table consists of 2 attributes and keeps the records of the list definitions. These 2 attributes are “ID” and “Name” as their detailed information are given in Table 2.8.

Table 2.8: “selection_areas” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	3	Foreign Key	Auto generated record number.
Name	varchar	25	Not null	Name of the list

The “selection_areas_values” table is the table where the values of the lists are kept. This table consists of 2 columns that are “type_ID” and “Value” where their details are given in Table 2.9.

Table 2.9: “selection_areas_values” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
type_ID	integer	3	Primary Key	Auto generated record number.
Value	varchar	50	Not null	Value of the list

The “selection_areas_of_tests” table is the table that provides a relationship between the “test” table and the “selection_areas” table. It has 2 attributes that are “Test_ID” and “Selection_Areas_ID” where their details are given in Table 2.10.

Table 2.10: “selection_areas_of_tests” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
Test_ID	integer	5	Foreign Key	Auto generated record number from table “tests”
Selection_Areas_ID	integer	3	Foreign Key	ID number of the selection area from “selection_areas_values” table

The “patient_test” table consists of 6 attributes, namely “ID”, “Test_ID”, “Patient_ID”, “Added_By”, “Date” and “Result”. This table keeps the relationship between patients and test values. Table 2.11 contains the details information about these attributes. In addition to the descriptions in Table 2.11, the union of the attributes “Test_ID”, “Patient_ID”, “Added_By” and “Date” is a unique key.

Table 2.11: “patient_test” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Test_ID	integer	5	Foreign Key	ID number of the test from “tests” table
Patient_ID	integer	11	Foreign Key	ID number of the patient from “patient” table
Added_By	integer	11	Foreign Key	ID number of the user who adds the record from “user_information” table
Date	datetime		Not null	The date and time of the test result generated
Result	varchar	30	Not null	The result of the test

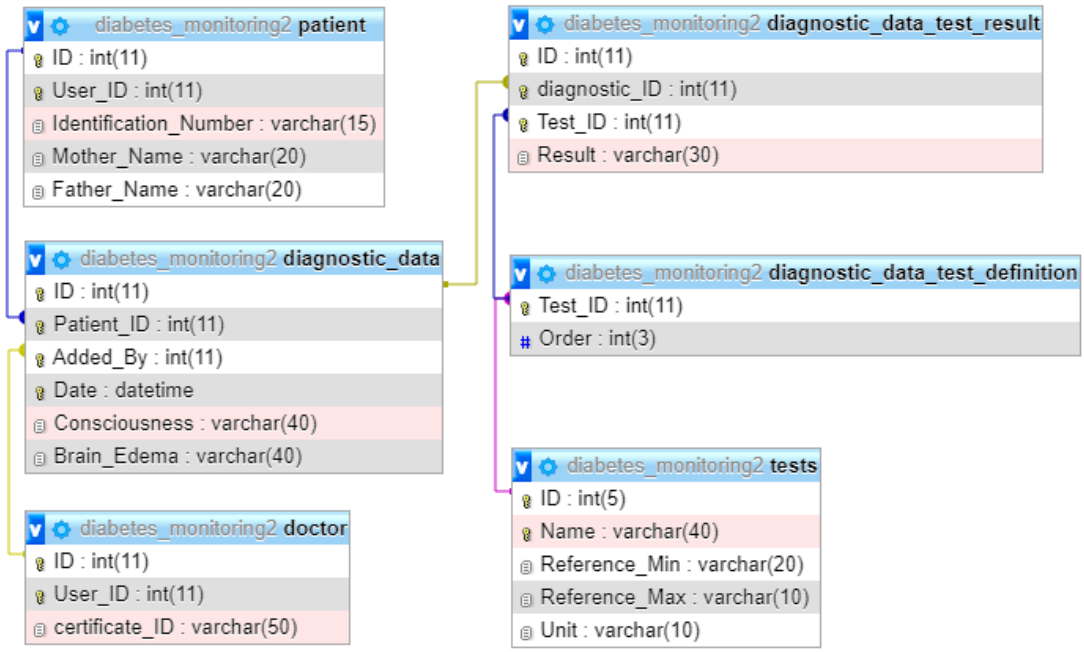


Figure 2.8: The diabetes_monitoring2 database’s entity relationship diagram #3 of 14

In Figure 2.8, total 6 database tables are shown with available entity relations. The “patient” and “doctor” tables were mentioned in Figure 2.6 and the “tests” table was mentioned in Figure 2.7 previously. The rest of the tables in Figure 2.8 are “diagnostic_data_test_definition”, “diagnostic_data_test_result” and “diagnostic_data”.

The “diagnostic_data” table keeps the records of the patients’ diagnostics. This table consists of 6 attributes that are “ID”, “Patient_ID”, “Added_By”, “Date”, “Consciousness” and “Brain_Edema” where their details are given in Table 2.12.

Table 2.12: “diagnostic_data” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from “patient” table
Added_By	integer	11	Foreign Key	ID number of the doctor who adds the record from “doctors” table
Date	datetime		Not null	The date and time of the diagnostic recorded.
Consciousness	varchar	40		Application Consciousness
Brain_Edema	varchar	40		Whether the patient is has brain edema treatment (yes, if patient has brain edema; no, otherwise)

The “diagnostic_data_test_definition” table stores test definitions for diagnostic data and it contains 2 attributes named “Test_ID” and “Order”. Table 2.13 contains the detailed information about these attributes.

Table 2.13: “diagnostic_data_test_definition” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
Test_ID	integer	11	Primary Key	Auto generated record number.
Order	integer	3	Not null	Diagnostic data test order

The “diagnostic_data_test_result” table consists of 4 attributes and it keeps the test results which defined for the diagnostic data. Its attributes are “ID”, “diagnostic_ID”,

"Test_ID" and "Result". Table 2.14 contains detailed information about these attributes.

Table 2.14: "diagnostic_data_test_result" table's attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
diagnostic_ID	integer	11	Foreign Key	ID number of the diagnostic from "diagnostic_data" table
Test_ID	integer	11	Foreign Key	ID number of the test from "tests" table
Result	varchar	30	Not null	Result of the test

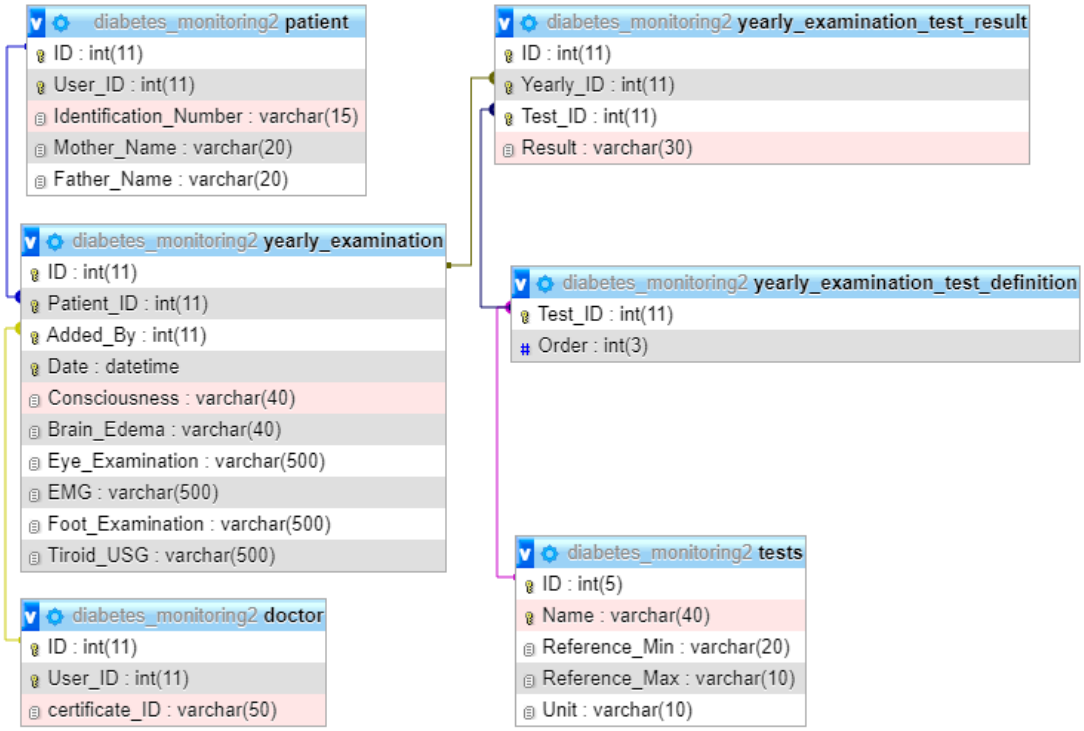


Figure 2.9: The diabetes_monitoring2 database's entity relationship diagram #4 of 14

In Figure 2.9, total 6 database tables are shown with available entity relations. The "patient" and "doctor" tables were mentioned in Figure 2.6 and the "tests" table was mentioned in Figure 2.7 previously. The rest of the tables in Figure 2.9 are

“yearly_examination”, “yearly_examination_test_definition” and “yearly_examination_test_result”.

The “yearly_examination” table which contains 10 attributes keep the records of the patient’s yearly examinations. The table’s attributes are “ID”, “Patient_ID”, “Added_By”, “Date”, “Consciousness”, “Brain_Edema”, “Eye_Examination”, “EMG”, “Foot_Examination” and “Tiroid_USG” where their details are given in Table 2.15.

Table 2.15: “yearly_examination” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from “patients” table
Added_By	integer	11	Foreign Key	ID number of the doctor who adds the record from “doctors” table
Date	datetime			The date and time of the examination
Consciousness	varchar	40		Application’s consciousness status
Brain_Edema	varchar	40		Whether the patient is receiving brain edema treatment
Eye_Examination	varchar	500		Eye examination
EMG	varchar	500		EMG examination
Foot_Examination	varchar	500		Foot examination
Tiroid_USG	varchar	500		Tiroid_USG examination

The “yearly_examination_test_definition” table keeps the data of test definitions for yearly examinations and contains 2 attributes as “Test_ID” and “Order”. The attributes’ definitions are given in Table 2.16.

Table 2.16: “yearly_examination_test_definition” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
Test_ID	integer	11	Primary Key	Auto generated record number.
Order	integer	3	Not null	Test order of yearly examination

The “yearly_examination_test_result” table keeps the data of test results for yearly examinations and contains 4 attributes such that “ID”, “Yearly_ID”, “Test_ID” and “Result” where their definitions are given in Table 2.17.

Table 2.17: “yearly_examination_test_result” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Yearly_ID	integer	11	Foreign Key	ID number of the examination from “yearly_examination” table
Test_ID	integer	11	Foreign Key	ID number of the test from “tests” table
Result	varchar	30	Not null	Result of test

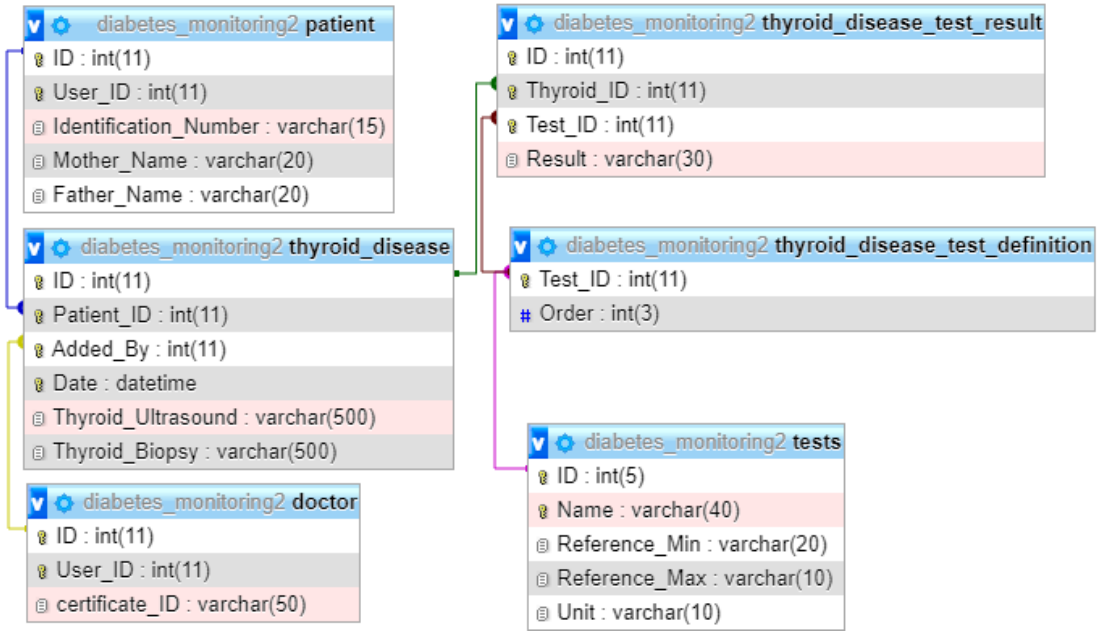


Figure 2.10: The diabetes_monitoring2 database’s entity relationship diagram #5 of 14

In Figure 2.10, total 6 database tables are shown with available entity relations. The "patient" and "doctor" tables were mentioned in Figure 2.6 and the "tests" table was mentioned in Figure 2.7 previously. The rest of the tables in Figure 2.10 are "thyroid_disease", "thyroid_disease_test_definition" and "thyroid_disease _test_result".

The "thyroid_disease" table keeps the data for thyroid disease of the patients if exists. This table has 6 attributes that are "ID", "Patient_ID", "Added_By", "Date", "Thyroid_Ultrasound" and "Thyroid_Biopsy". The detailed information about these attributes is given in Table 2.18.

Table 2.18: "thyroid_disease" table's attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from "patients" table
Added_By	integer	11	Foreign Key	ID number of the doctor who adds the record from "doctors" table
Date	datetime			The date and time that thyroid disease recorded
Thyroid_Ultrasound	varchar	500		Notes for the thyroid ultrasound, if any
Thyroid_Biopsy	varchar	500		Notes for the thyroid biopsy, if any

The "thyroid_disease_test_definition" table maintains test definitions for thyroid disease data and contains 2 attributes that are "Test_ID" and "Order" which their definitions are given in Table 2.19.

Table 2.19: “thyroid_disease_test_definition” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
Test_ID	integer	11	Primary Key	Auto generated record number.
Order	integer	3	Not null	Test order

The “thyroid_disease_test_result” table maintains defined test data results for thyroid disease data and contains 4 attributes. These attributes are “ID”, “Thyroid_ID”, “Test_ID” and “Result” where their details are given in Table 2.20.

Table 2.20: “thyroid_disease_test_result” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Thyroid_ID	integer	11	Foreign Key	ID number of thyroid disease from “thyroid_disease” table
Test_ID	integer	11	Foreign Key	ID number of the test from “tests” table
Result	varchar	30	Not Null	The result of the test

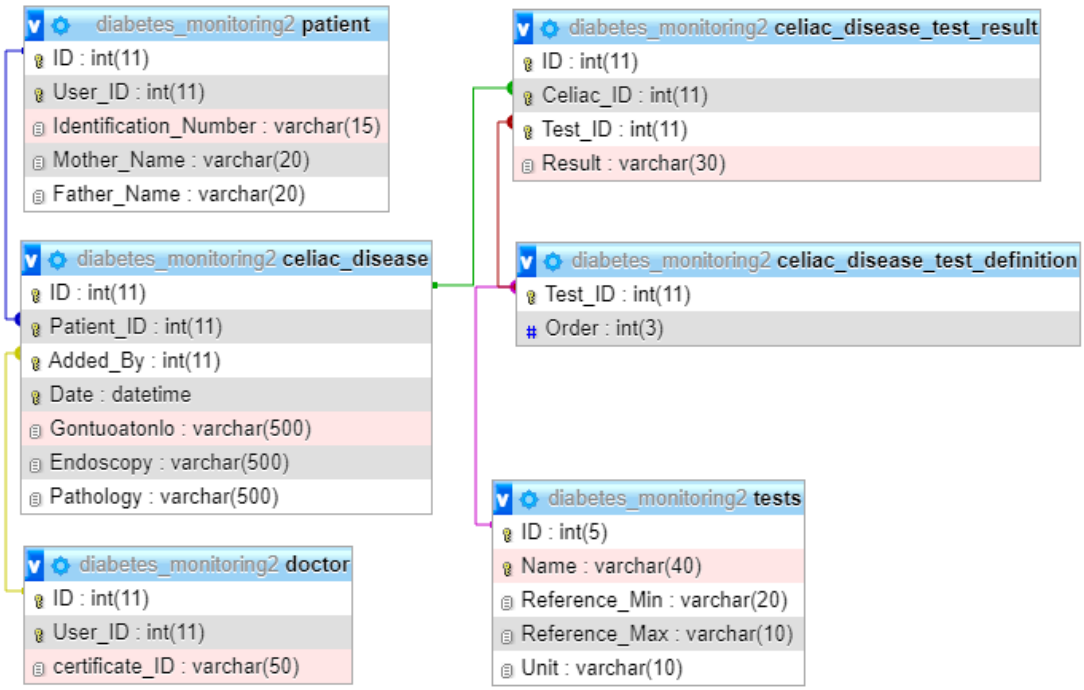


Figure 2.11: The diabetes_monitoring2 database’s entity relationship diagram #6 of 14

In Figure 2.11, total 6 database tables are shown with available entity relations. The “patient” and “doctor” tables were mentioned in Figure 2.6 and the “tests” table was mentioned in Figure 2.7 previously. The rest of the tables in Figure 2.11 are ““celiac_disease”, “celiac_disease_test_definition”, “celiac_disease_test_result”.

The “celiac_disease” table keeps the records of patients’ celiac disease, if any. This table consists of 7 attributes “ID”, “Patient_ID”, “Added_By”, “Date”, “Gontuoatonlo”, “Endoscopy” and “Pathology” where their details are given in Table 2.21.

Table 2.21: “celiac_disease” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from “patients” table
Added_By	integer	11	Foreign Key	ID number of the doctor who adds the record from “doctors” table
Date	datetime		Not null	The date and time celiac disease recorded
Gontuoatonlo	varchar	500		Notes for the gastroenterology examination, if any
Endoscopy	varchar	500		Notes for the endoscopy report, if any
Pathology	varchar	500		Notes for the pathology report, if any

The “celiac_disease_test_definition” table maintains the test definitions for celiac disease and consists of 2 attributes. These attributes are “Test_ID” and “Order” which their descriptions are given in Table 2.22.

Table 2.22: “celiac_disease_test_definition” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
Test_ID	integer	11	Primary Key	Auto generated record number.
Order	varchar	3	Not null	The order of the test

The “celiac_disease_test_result” table maintains the definitions of the test data results for celiac disease and consists of 4 attributes such that “ID”, “Celiac_ID”, “Test_ID”, “Result”. Table 2.23 contains the descriptions of the “celiac_disease_test_result” table’s attributes.

Table 2.23: “celiac_disease_test_result” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Celiac_ID	integer	11	Foreign Key	ID number of the celiac disease from “celiac_disease” table
Test_ID	integer	11	Foreign Key	ID number of the test from “test” table
Result	varchar	30		The result of the test

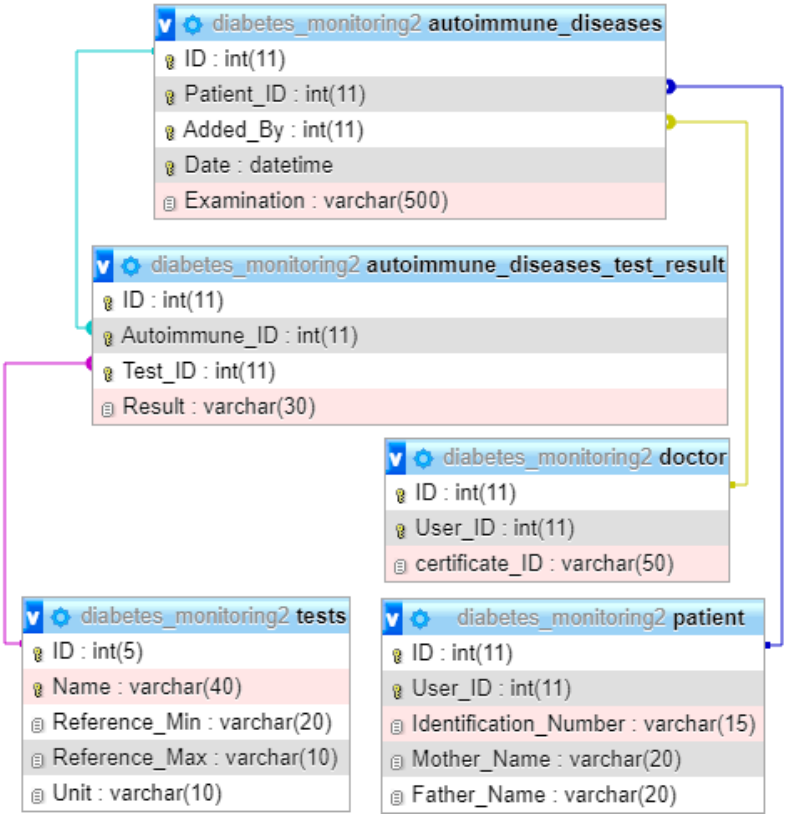


Figure 2.12: The diabetes_monitoring2 database's entity relationship diagram #7 of 14

In Figure 2.12, total 5 database tables are shown with available entity relations. The "patient" and "doctor" tables were mentioned in Figure 2.6 and the "tests" table was mentioned in Figure 2.7 previously. The rest of the tables in Figure 2.12 are "autoimmune_diseases" and "autoimmune_diseases_test_result".

The "autoimmune_diseases" table keeps the data about autoimmune diseases of the patients other than celiac and thyroid, if any. This table has 5 attributes named "ID", "Patient_ID", "Added_By", "Date" and "Examination" where their details are given in Table 2.24. In addition to the descriptions given in Table 2.24, the union of the attributes "Patient_ID", "Added_By" and "Date" is a unique key.

Table 2.24: “autoimmune_diseases” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from “patients” table
Added_By	integer	11	Foreign Key	ID number of the doctor who adds the record from “doctors” table
Date	datetime			The date and time of autoimmune disease recorded
Examination	varchar	500		Notes for examination, if any

The “autoimmune_diseases_test_result” table maintains the defined test data results for other autoimmune disease. This table has 4 attributes that are “ID”, “Autoimmune_ID”, “Test_ID” and “Result” where their details are given in Table 2.25.

Table 2.25: “autoimmune_diseases_test_result” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Autoimmune_ID	integer	11	Foreign Key	ID number of the disease from “autoimmune_diseases” table
Test_ID	integer	11	Foreign Key	ID number of the test from “tests” table
Result	varchar	30		The test result

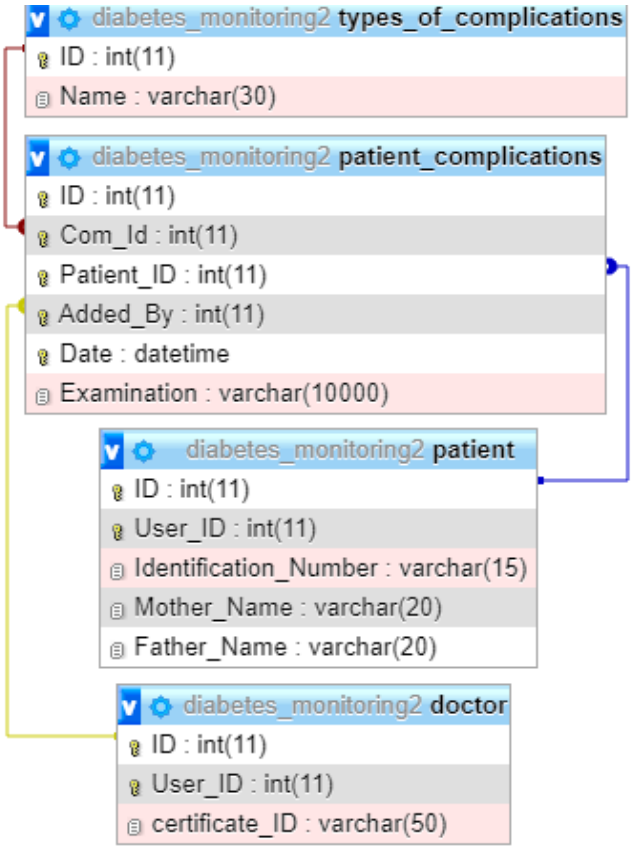


Figure 2.13: The diabetes_monitoring2 database's entity relationship diagram #8 of 14

In Figure 2.13, total 5 database tables are shown with available entity relations. The "patient" and "doctor" tables were mentioned in Figure 2.6 previously. The rest of the tables in Figure 2.13 are "types_of_complications" and "patient_complications".

The "types_of_complications" table keeps the types of complications that can be added to patients. It has 2 attributes named "ID" and "Name" where their details are given in Table 2.26.

Table 2.26: "types_of_complications" table's attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number
Name	varchar	30	Not null	Name of complication

The “patient_complications” table keeps the complication type that is added to the patients. This table consists of 6 attributes which are “ID”, “Com_ID”, “Patient_ID”, “Added_By”, “Date” and “Examination” and their details are given in Table 2.27. In addition to the descriptions given in Table 2.27, the union of the attributes Patient_ID”, “Added_By” and “Date” is a unique key.

Table 2.27: “patient_complications” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Com_ID	integer	11	Foreign Key	ID number of the complication from “types_of_complications” table
Patient_ID	integer	11	Foreign Key	ID number of the patient from table “patients”
Added_By	integer	11	Foreign Key	ID number of the user who adds the record from “doctors” table
Date	datetime		Not null	Date and time of complication recorded
Examination	varchar	10000		Notes for examination, if any

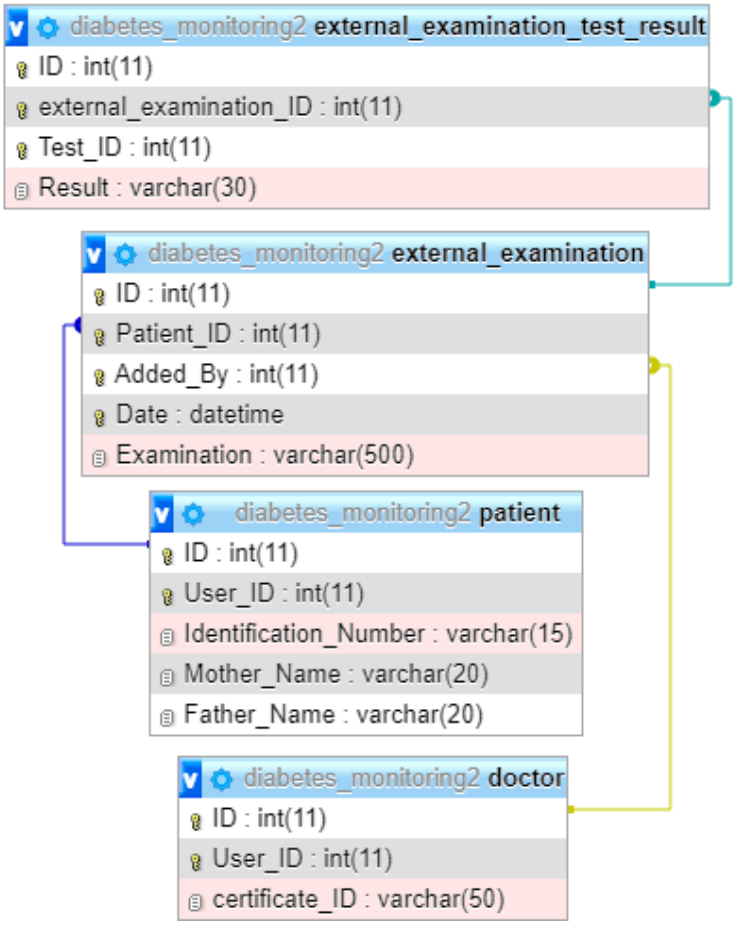


Figure 2.14: The diabetes_monitoring2 database's entity relationship diagram #9 of 14

In Figure 2.14, total 4 database tables are shown with available entity relations. The "patient" and "doctor" tables were mentioned in Figure 2.6 previously. The rest of the tables in Figure 2.14 are "external_examination" and "external_examination_test_result".

The "external_examination" table keeps the patients examination data made by other doctors. This table consists of 5 attributes that are ID", "Patient_ID", "Added_By", "Date" and "Examination" where their detils are given in Table 2.28. In addition to the descriptions given in Table 2.28, the union of the attributes "Patient_ID", "Added_By" and "Date" is a unique key.

Table 2.28: “external_examination” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from “patients” table
Added_By	integer	11	Foreign Key	ID number of the doctor who adds the record from “doctors” table
Date	datetime			Date and time of examination recorded
Examination	varchar	500		Notes for examination, if any

The “external_examination_test_result” table keeps the test results for the examinations that made by other doctors. This table has 4 attributes that are “ID”, “external_examination_ID”, “Test_ID” and “Result”. The detailed information about these attributes is given in Table 2.29.

Table 2.29: “external_examination_test_result” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
external_examination_ID	integer	11	Foreign Key	ID number of the examination from “external_examination” table
Test_ID	integer	11	Foreign Key	ID number of the test from “tests” table
Result	varchar	30	Not null	Result of the test

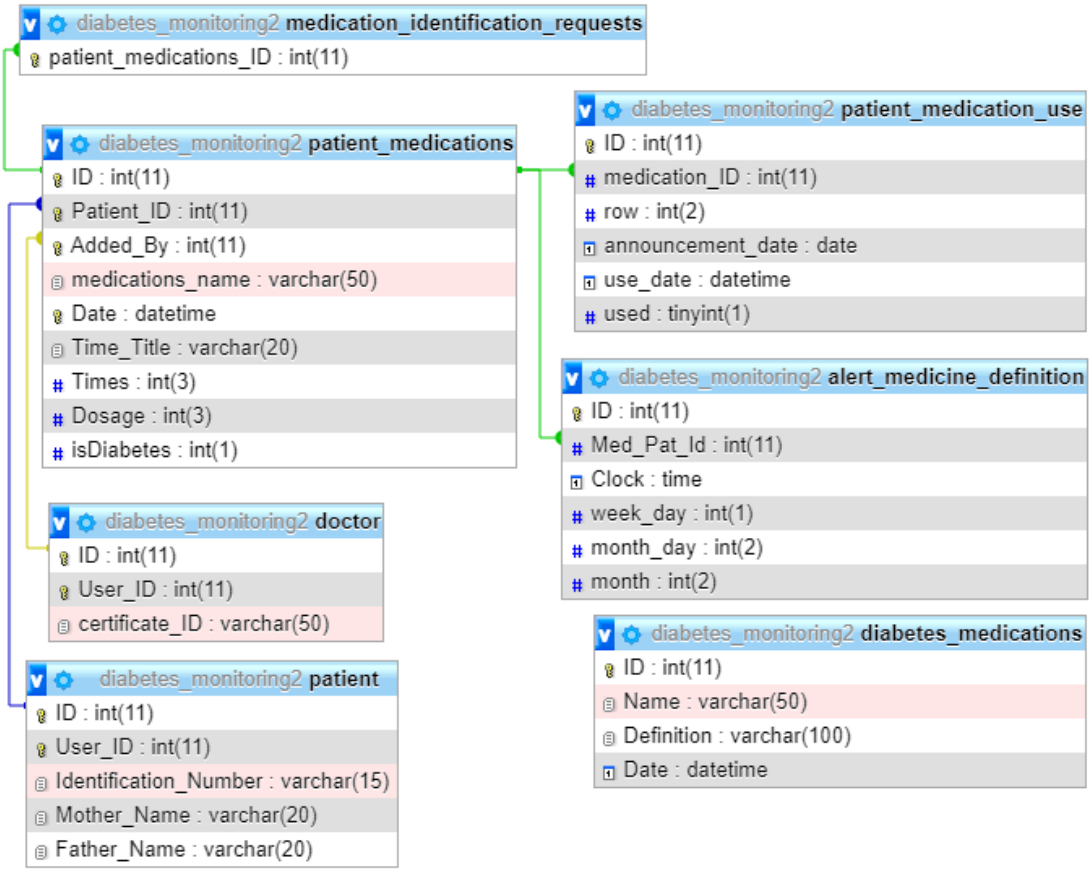


Figure 2.15: The diabetes_monitoring2 database's entity relationship diagram #10 of 14

In Figure 2.15, total 7 database tables are shown with available entity relations. The "patient" and "doctor" tables were mentioned in Figure 2.6 previously. The rest of the tables in Figure 2.15 are "diabetes_medications", patient_medications", "medication_identification_requests", "patient_medication_use" and "alert_medicine_definition".

The "diabetes_medications" table stores the information about the diabetes medicines that are recorded to the system. This table consists of 4 attributes namely "ID", "Name", "Definition" and "Date" where their details are given in Table 2.30.

Table 2.30: “diabetes_medications” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number
Name	varchar	50	Not null	Name of the medication
Definition	varchar	100	Not null	Definition of the medication
Date	datetime		Not null	Date and time of the medicine recorded.

The “patient_medications” table stores the information about the medications that patients use. This table is designed to store patients’ diabetes medications together with their all medications. The “patient_medications” table has 9 attributes that are “ID”, “Patient_ID”, “Added_By”, “medications_name”, “Date”, “Time_Title”, “Times”, “Dosage” and “isDiabetes”. These attributes’ details are given in Table 2.31. In addition to the descriptions given in Table 2.31, the union of the attributes “Patient_ID”, “Added_By” and “Date” is a unique key.

Table 2.31: “patient_medications” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number
Patient_ID	integer	11	Foreign Key	ID number of patient from “patients” table
Added_By	integer	11	Foreign Key	ID number of the user who adds the record from “user_information” table
Date	datetime		Not null	Date and time that medication recorded
medications_name	varchar	50	Not null	Name of the medication
Time_Title	varchar	20	Not null	Medication usage periods(daily, weekly, monthly or yearly)
Times	integer	3	Not null	Number of times that the medication will be used.
Dosage	integer	3	Not null	Dosage of the medication
isDiabetes	integer	1	Not null	Whether the medication is for diabetes. (0, if it is not a diabetes medicine; 1, if it is a diabetes medicine; 2, if it is a diabetes medicine that is not recorded to the system)

The “medication_identification_requests” table is designed to store the requests for defining diabetes medicine. If this table has a diabetes medicine record, this means that the considering diabetes medicine is not defined in the system. This table has only one attribute namely “patient_medications_ID” and its description is given in Table 2.32.

Table 2.32: “medication_identification_requests” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
patient_medications_ID	integer	11	Foreign Key	ID number of the medication from “patient_medications” table

The “patient_medication_use” table stores the usage information of a medicine for the patients. This table consists of 6 attributes that are “ID”, “medication_ID”, “row”, “announcement_date”, “use_date” and “used” that their definitions are given in Table 2.33.

Table 2.33: “patient_medication_use” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number
medication_ID	integer	11	Foreign Key	ID number of the medication from “patient_medications. table
row	integer	2	Not null	Number of times the drug is used within the specified period
announcement_date	date		Not null	The start date of the medication that the patient will use
use_date	datetime		Not null	The date and time of medicine used
used	integer	1	Not null	Whether the medicine is used. (0, if not used; 1 if used)

The “alert_medicine_definition” table stores the information of the alarms that patients will set for the medications. This table consists of 6 attributes namely “ID”, “Med_Pat_Id”, “clock”, “week_day”, “month_day” and “month” that their definitions are given in Table 2.34.

Table 2.34: “alert_medicine_definition” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number
Med_Pat_Id	integer	11	Foreign Key	ID number of the medication from “patient_medications. table
clock	time			The hour and minute information of the medication will be used.
week_day	integer	1		The day data, if the medication is used in weekly period. (1 to 7 for Sunday to Saturday respectively)
month_day	integer	2		The month data, if the medication is used in monthly or yearly period.
month	integer	2		The month data, if the medication is used in period. (1 to 12 for January to December respectively)

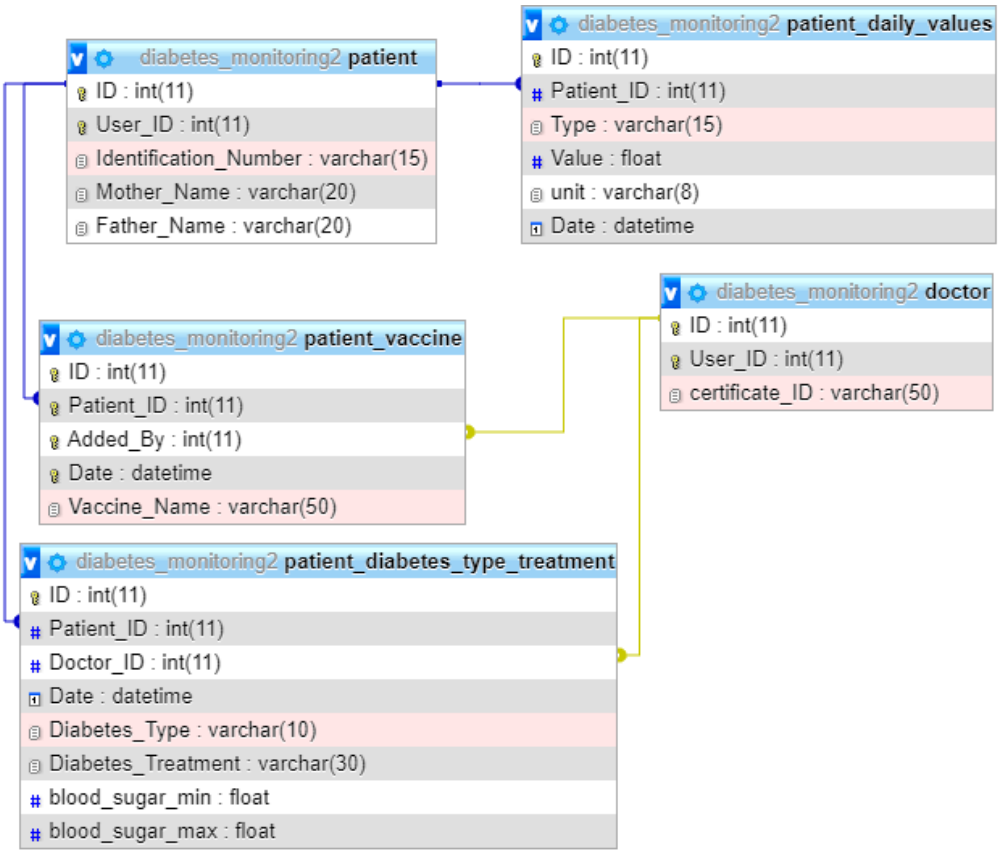


Figure 2.16: The diabetes_monitoring2 database's entity relationship diagram #11 of 14

In Figure 2.16, total 5 database tables are shown with available entity relations. The "patient" and "doctor" tables were mentioned in Figure 2.6 previously. The rest of the tables in Figure 2.16 are "patient_diabetes_type_treatment", "patient_vaccine", "patient_daily_values" and "patient_vaccine".

The "patient_vaccine" table stores the vaccine data of the patients. This table consists of 5 attributes namely "ID", "Patient_ID", "Added_By", "Date" and "Vaccine_Name" that their details are given in Table 2.35. In addition to the descriptions given in Table 2.35, the union of the attributes "Patient_ID", "Added_By" and "Date" is a unique key.

Table 2.35: “patient_vaccine” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of patient from “patients” table
Added_By	integer	11	Foreign Key	ID number of the user who adds the record from “doctor” table
Date	datetime		Not null	The date and time of vaccine data recorded.
Vaccine_Name	varchar	50	Not null	Name of the vaccine

The “patient_daily_values” table stores the patients' daily blood glucose, carbohydrate and exercise data. This table consists of 6 attributes namely “ID”, “Patient_ID”, “Type”, “Value”, “unit” and “Date” where their details are given in Table 2.36.

Table 2.36: “patient_daily_values” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of patient from “patients” table.
Type	varchar	15	Not null	The type of the daily data. (A for pre-prandial blood glucose, T for postprandial blood glucose, E for exercise and K for carbohydrate)
Value	float		Not null	Numerical value of data
unit	varchar	8	Not null	The unit of the data. (mg/dl for blood glucose, dk for exercise and gr for carbohydrate)
Date	datetime		Not null	The date and time of the record.

The “patient_diabetes_type_treatment” table stores the patients' diabetes type, treatment method, and minimum and maximum blood glucose values. This table consists of 8 attributes namely “ID”, “Patient_ID”, “Doctor_ID”, “Date”, “Diabetes_Type”, “Diabetes_Treatment”, “blood_sugar_min” and “blood_sugar_max” where their details are given in Table 2.37.

Table 2.37: “patient_diabetes_type_treatment” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of patient from “patients” table.
Doctor_ID	integer	11	Foreign Key	ID number of doctor from “doctor” table.
Date	Datetime		Not null	Date and time of the record
Diabetes_Type	varchar	10	Not null	Type of diabetes
Diabetes_Treatment	varchar	30	Not null	Type of treatment
blood_sugar_min	float		Not null	Minimum blood glucose value.
blood_sugar_max	float		Not null	Maximum blood glucose value.

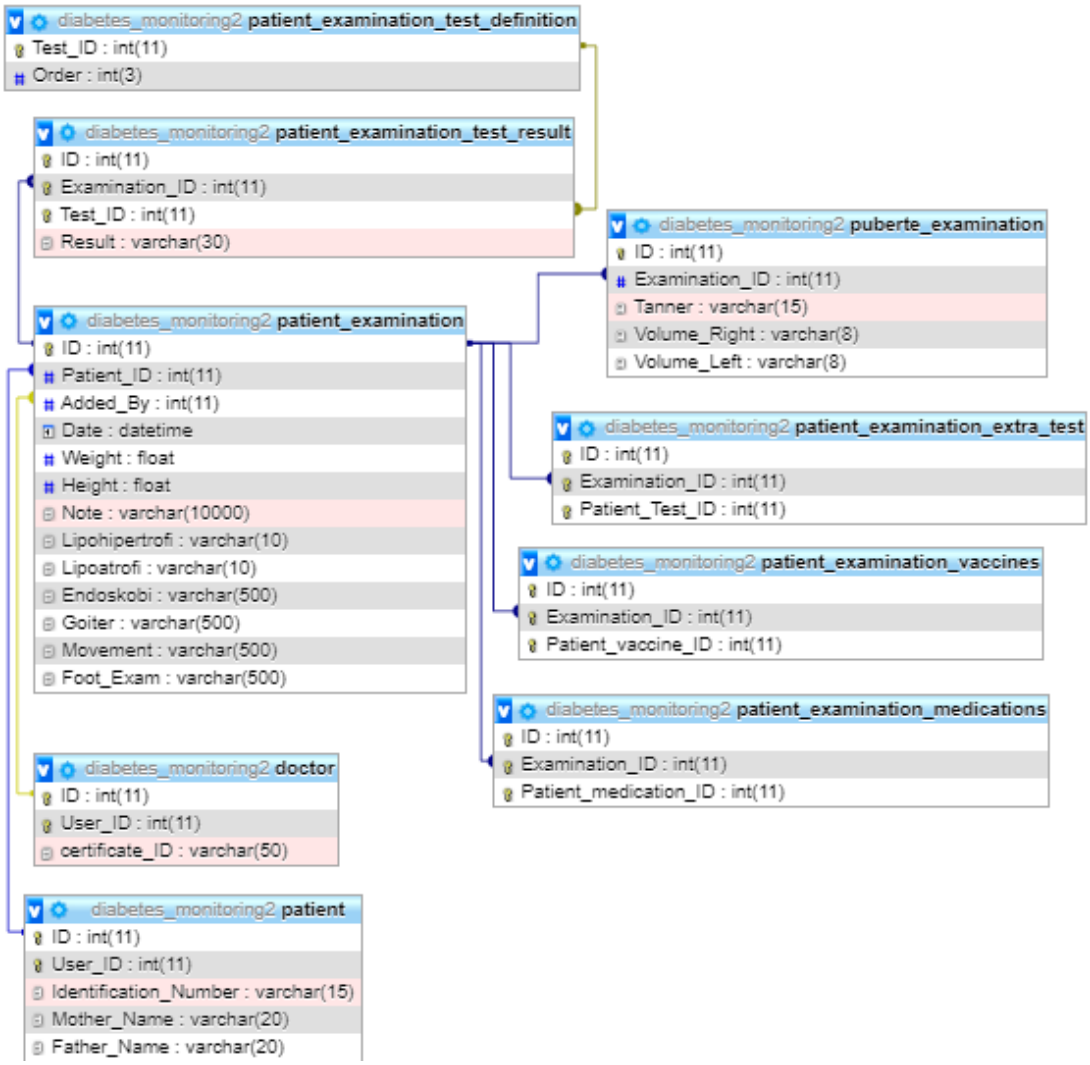


Figure 2.17: The diabetes_monitoring2 database's entity relationship diagram #12 of 14

In Figure 2.17, total 9 database tables are shown with available entity relations. The "patient" and "doctor" tables were mentioned in Figure 2.6 previously. The rest of the tables in Figure 2.17 are "patient_examination", "puberte_examination", "patient_examination_test_result", "patient_examination_test_definition", "patient_examination_extra_test", "patient_examination_vaccines" and "patient_examination_medications".

The "patient_examination" table stores the information of diabetes examination of the patients. It consists of 13 attributes namely, "ID", "Patient_ID", "Added_By", "Date",

"Weight", "Height", "Note", "Lipohipertrofi", "Lipoatrofi", "Endoskobi", "Goiter", "Movement" and "Foot_Exam" where their details are given in Table 2.38. In addition to the descriptions given in Table 2.38, the union of the attributes "Patient_ID", "Added_By" and "Date" is a unique key.

Table 2.38: "patient_examination" table's attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from "patients" table.
Added_By	integer	11	Foreign Key	ID number of the doctor who adds the record from "user_information" table
Date	datetime		Not null	Date and time of the record
Weight	float		Not null	Body weight of the patient
Height	float		Not null	Body height of the patient
Note	varchar	10000	Not null	Notes for examination
Lipohipertrofi	varchar	10	Not null	Lipohypertrophy status
Lipoatrofi	varchar	10	Not null	Lipoatrophy status
Endoskobi	varchar	500	Not null	Notes for endoscopy report
Goiter	varchar	500	Not null	Goiter examination
Movement	varchar	500	Not null	Notes for joint movements
Foot_Exam	varchar	500	Not null	Notes for foot examination

The "patient_examination_test_definition" table stores the test definitions for the diabetes examination. This table consists of 2 attributes namely "Test_ID" and "Order" where their details are given in Table 2.39.

Table 2.39: “patient_examination_test_definition” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
Test_ID	integer	11	Primary Key	Auto generated record number.
Order	integer	3	Not null	Order of the test

The “patient_examination_test_result” table stores the test results data of diabetes examinations. This table consists of 4 attributes namely “ID”, “Examination_ID”, “Test_ID” and “Result” that their descriptions are given in Table 2.40.

Table 2.40: “patient_examination_test_result” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Examination_ID	integer	11	Foreign Key	ID number of the examination from “patient_examinations” table
Test_ID	integer	11	Foreign Key	ID number of the test from “patient_examination_test_definition” table
Result	varchar	30	Not null	Result of the test

The “puberte_examination” table stores the information about the puberte examination. This table consists of 5 attributes namely “ID”, “Examination_ID”, “Tanner”, “Volume_Right” and “Volume_Left” where their details are given in table Table 2.41.

Table 2.41: “puberte_examination” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Examination_ID	integer	11	Foreign Key	ID number of the examination from “patient_examinations” table
Tanner	varchar	15	Not null	Tanner value
Volume_Right	varchar	8	Not null	Right volume
Volume_Left	varchar	8	Not null	Left volume

The “patient_examination_extra_test” table stores the information about additional tests for diabetes examination, if any. This table consists of 3 attributes namely “ID”, “Examination_ID” and “Patient_Test_ID” where their details are given in Table 2.42.

Table 2.42: “patient_examination_extra_test” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Examination_ID	integer	11	Foreign Key	ID number of the examination from “patient_examinations” table
Patient_Test_ID	integer	11	Foreign Key	ID number of the examination from “patient_test” table

The “patient_examination_vaccines” table stores the vaccine information that are defined during the diabetes examination. This table consists of 3 attributes namely “ID”, “Examination_ID” and “Patient_vaccine_ID” where their details are given in Table 2.43.

Table 2.43: “patient_examination_vaccines” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Examination_ID	integer	11	Foreign Key	ID number of the examination from “patient_examinations” table
Patient_vaccine_ID	integer	11	Foreign Key	ID number of the examination from “patient_vaccine” table

The “patient_examination_medications” table stores the medication information that are defined during the diabetes examination. This table consists of 3 attributes namely “ID”, “Examination_ID” and “Patient_medication_ID” where their details are given in Table 2.44.

Table 2.44: “patient_examination_medications” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Examination_ID	integer	11	Foreign Key	ID number of the examination from “patient_examinations” table
Patient_medication_ID	integer	11	Foreign Key	ID number of the examination from “patient_medication” table

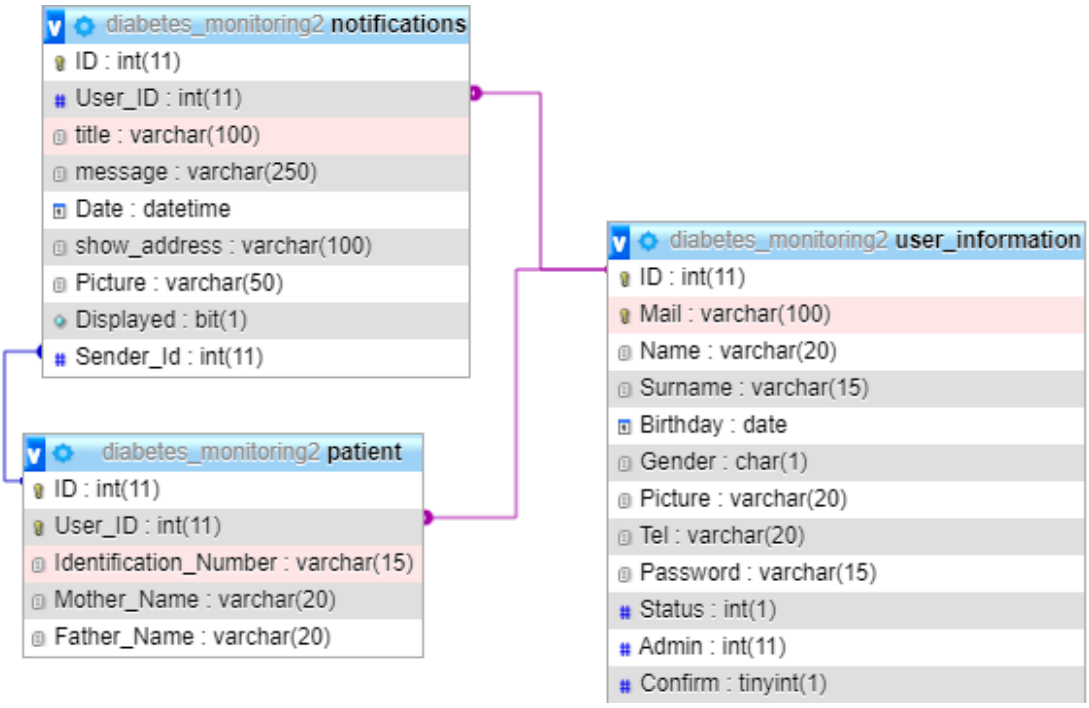


Figure 2.18: The diabetes_monitoring2 database's entity relationship diagram #13 of 14

In Figure 2.18, total 3 database tables are shown with available entity relations. The "patient" and "user_information" tables were mentioned in Figure 2.6 previously. The other table shown in Figure 2.18 is "notifications".

The "notifications" table stores the notifications that are used to inform the patients in the system. This table has 9 attributes namely "ID", "User_ID", "title", "message", "Date", "show_address", "Picture", "Displayed" and "Sender_Id" where their details are given in Table 2.45.

Table 2.45: “notifications” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
User_ID	integer	11	Foreign Key	ID number of user who receives the notification from “user_information” table
title	varchar	100	Not null	Title of notification
message	varchar	250	Not null	The content of notification
Date	datetime		Not null	Date and time of the record
show_address	varchar	100	Not null	The page link that will be redirected when the notification clicked
Picture	varchar	50	Not null	Data path of an image related with notification
Displayed	bit	1	Not null	Whether the notification is displayed (0, if notification is not clicked;1 if notification is clicked)
Sender_Id	integer	11	Foreign Key	If a new record is created for a patient, the patient's ID is placed in the field to be able to send a notification to that patient's doctor.

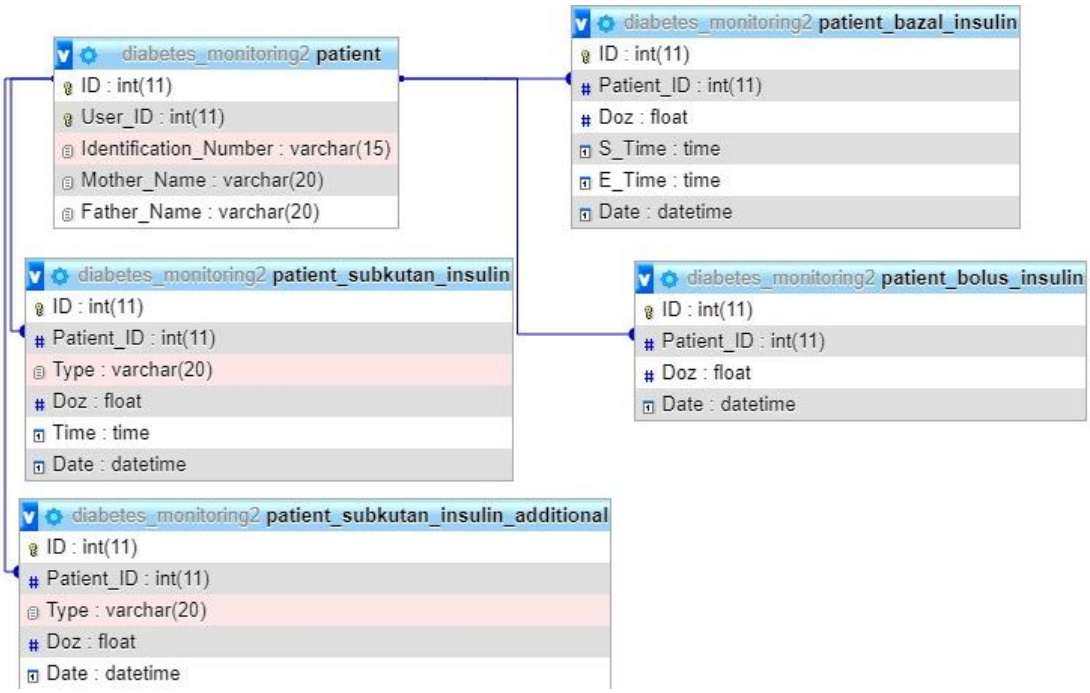


Figure 2.19: The diabetes_monitoring2 database's entity relationship diagram #14 of 14

In Figure 2.19, total 5 database tables are shown with available entity relations. The "patient" table in Figure 2.19 were explained in Figure 2.6 previously. The rest of the tables in Figure 2.19 are "patient_bazal_insulin" and "patient_bolus_insulin", "patient_subkutan_insulin", "patient_subkutan_insulin_additional".

The "patient_bazal_insulin" table is used to store the patients' daily basal insulin data. This table consists of 6 fields that are "ID", "Patient_ID", "Doz", "S_Time", "E_Time" and "Date" where their descriptions are given in Table 2.46.

Table 2.46: “patient_bazal_insulin” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from “patient” table
Doz	float		Not null	The dose of the insulin
S_Time	time		Not null	The start time that the dose is taken
E_Time	time		Not null	The end time that the dose is taken
Date	date		Not null	The date that the record created

The “patient_bolus_insulin” table is used to store the patients’ daily bolus insulin data. This table consists of 4 fields that are “ID”, “Patient_ID”, “Type”, “Doz”, “S_Time”, “E_Time” and “Date” where their descriptions are given in Table 2.47.

Table 2.47: “patient_bolus_insulin” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from “patient” table
Doz	float		Not null	The dose of the insulin
Date	datetime		Not null	The date that the dose taken

The “patient_subkutan_insulin_additional” table is used to store the insulin doses used by the patients in addition to the insulin they use daily. This table consists of 6 fields that are “ID”, “Patient_ID”, “Type”, “Doz”, “Time” and “Date” where their descriptions are given in Table 2.48.

Table 2.48: “patient_subkutan_insulin” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from “patient” table
Type	varchar	20	Not null	The type of the subkutan insulin
Doz	float		Not null	The dose of the subkutan insulin
Time	time		Not null	The time that the dose was taken
Date	date		Not null	The date that the record created

The “patient_subkutan_insulin_additional” table is used to store the patients’ daily subkutan insulin data. This table consists of 5 fields that are “ID”, “Patient_ID”, “Type”, “Doz” and “Date” where their descriptions are given in Table 2.49.

Table 2.49: “patient_subkutan_insulin_additional” table’s attributes in detail

Attribute Name	Data Type	Length	Constraint	Description
ID	integer	11	Primary Key	Auto generated record number.
Patient_ID	integer	11	Foreign Key	ID number of the patient from “patient” table
Type	varchar	20	Not null	The type of the insulin
Doz	float		Not null	The dose of the insulin
Date	datetime		Not null	The date that the dose taken

Chapter 3

IMPLEMENTATION OF THE PROPOSED SYSTEM

In this chapter, responsive Web application and system tools and utilities to use will be presented.

3.1 Responsive Web Application

The Diabetes Tracking System consists of two distinct portals that are management portal and patient portal. The sign-in page of the system is given in Figure 3.1. The sign-in page can used by all users accept “Other Doctors”. The sign-in page for “Other Doctors” is mentioned in the next section. To sign-in to the system, users must click “Giriş Yap” button after entering their username and passwords into “Kullanıcı Adı” and “Şifre” fields. In case of an error while sign-in to the system, users will be notified with an appropriate message. Users who sign-in to the system and have only “Admin” or “Super Admin” privileges are automatically redirected to the management portal and other users are redirected to the patient portal. These portals are explained below.

Figure 3.1: Sign-in Page

3.1.1 Management Portal

As shown in Figure 3.2, the management portal has four menu items which are "Laboratuvar", "İlaç", "Onay İşlemleri" and "Listeler". "Admins" and "Super Admins" can click "Test Tanımla", "Çoklu Seçim Alanları" and "Sayfaya Tanımla" items from "Laboratuvar" (Figure 3.2 (a)) and "İlaç Tanımla", "İlaç İstekler" items from "İlaç" (Figure 3.2 (b)). "Doktor Onay" and "Hastalar" items from "Onay İşlemleri" (Figure 3.2 (c)) and "BMI Sorgulama" and "Toplu Filtreleme" items from "Listeler" (Figure 3.2 (d)) can be accessed by "Super Admins" only. When user clicks an item on portal menu, the corresponding portal page is redirected. These pages are explained below in detail.

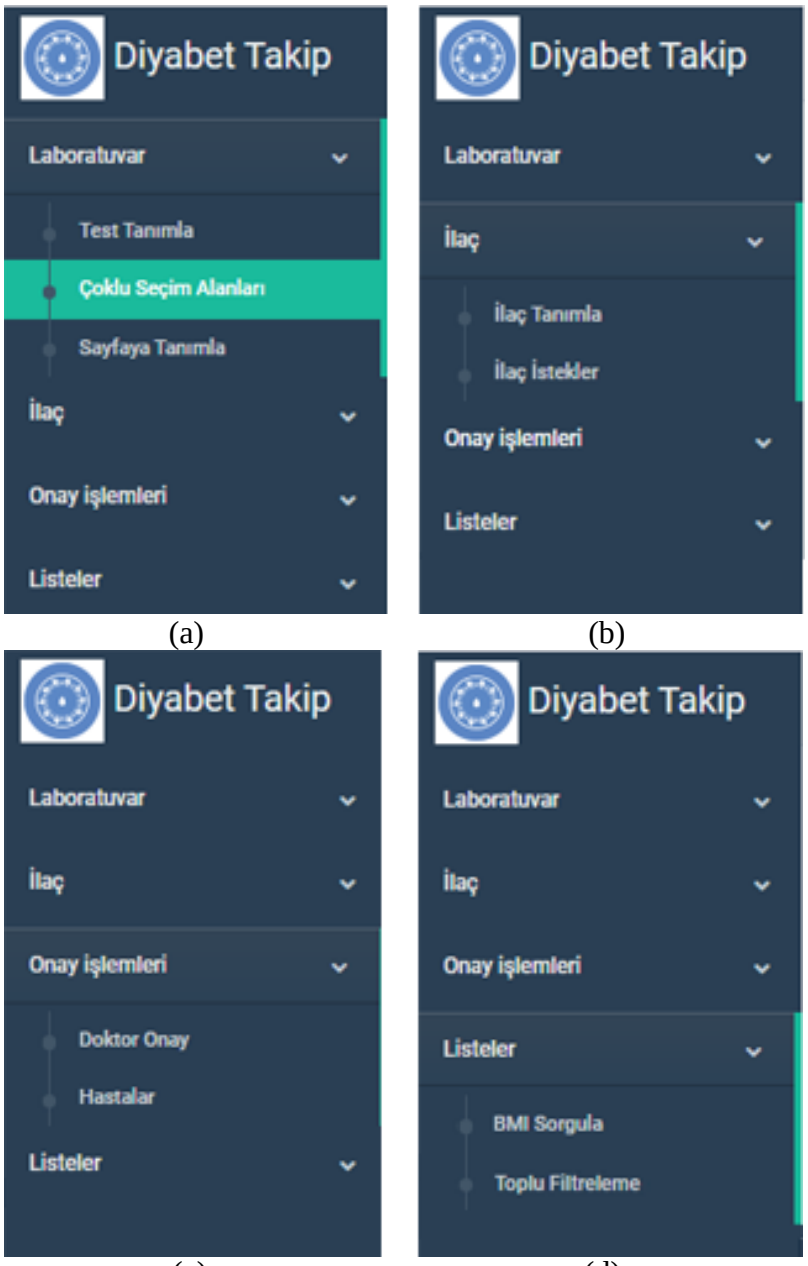


Figure 3.2: Management portal menu. (a) “Laboratuvar” menu is displayed. (b) “İlaç” menu displayed. (c) “Onay İşlemleri” menu displayed. (d) “Listeler” menu displayed.

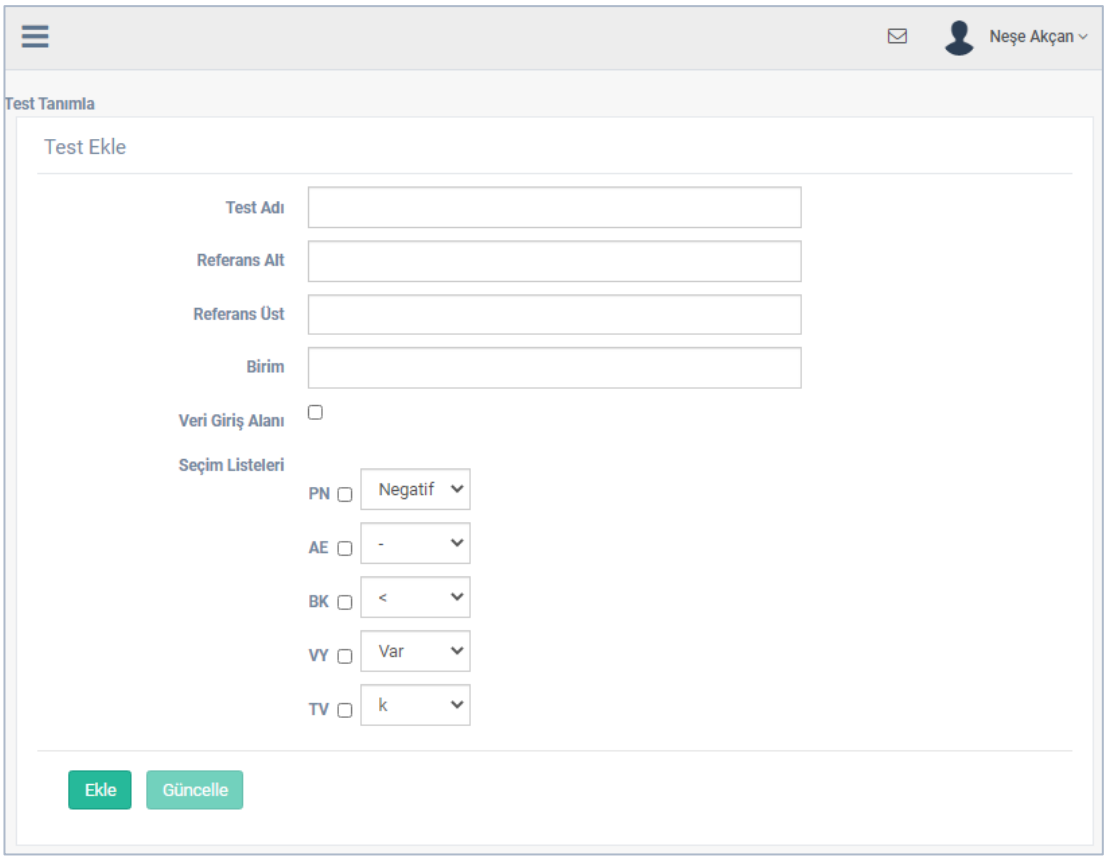


Figure 3.3: “Test Tanımla” Page Form

“Test Tanımla” page consists of two parts which are “Test Ekle” form and “Tüm Testler” table.

Figure 3.3 shows “Test Ekle” form of “Test Tanımla” page. A new test can be defined to the system with “Test Ekle” form on this page. The most important components in this form are “Veri Giriş Alanı” check box and “Seçim Listeleri”. If the checkbox component is clicked while defining a test, the input text component will be created in the form for the defined test. The data to be entered in “Birim” field appears as a unit on the right side of the test if there is an input text component. “Seçim Listeleri” are dynamic components which are created on “Çoklu Seçim Alanı” page. When an item from “Seçim Listeleri” is checked, its list will be displayed on the test form. See Figure 3.5.

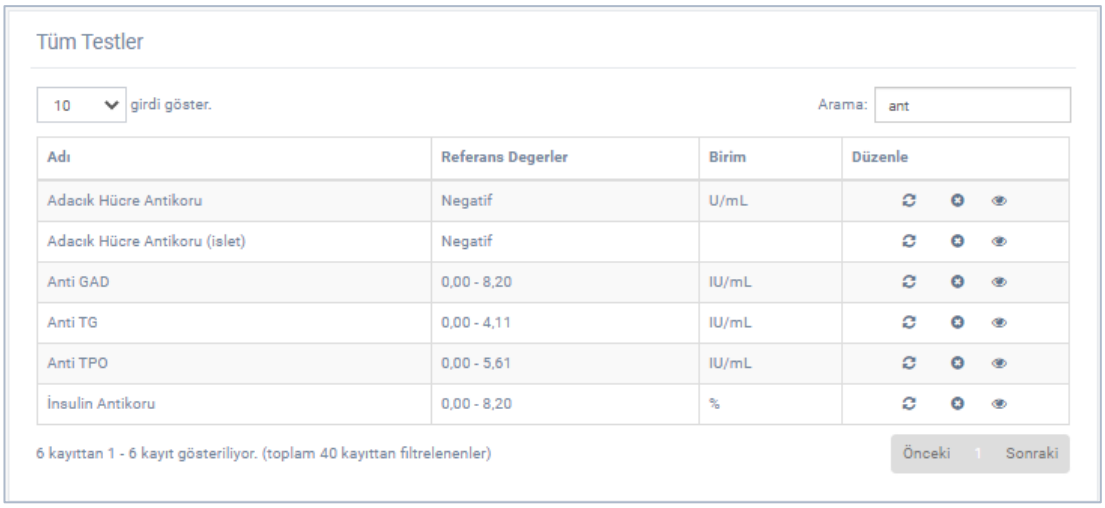


Figure 3.4: “Tüm Testler” table

Figure 3.4 shows “Tüm Testler” table of “Test Tanımla” page that contains the list of defined tests. “” button preview button. This button allows to preview how the defined test form will appear where it is used. A preview form as shown in Figure 3.5 will be displayed when this button is clicked.

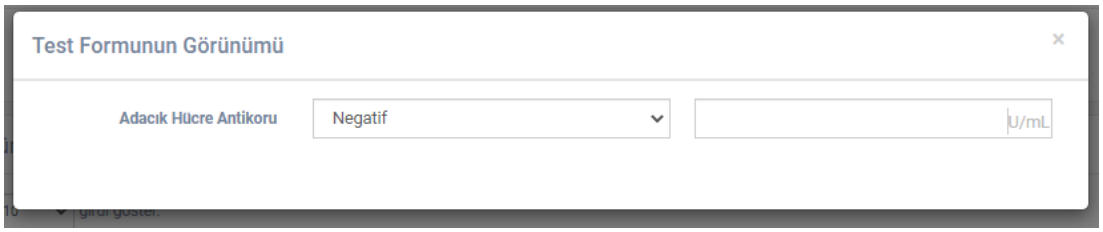


Figure 3.5: Preview of “Test Form”

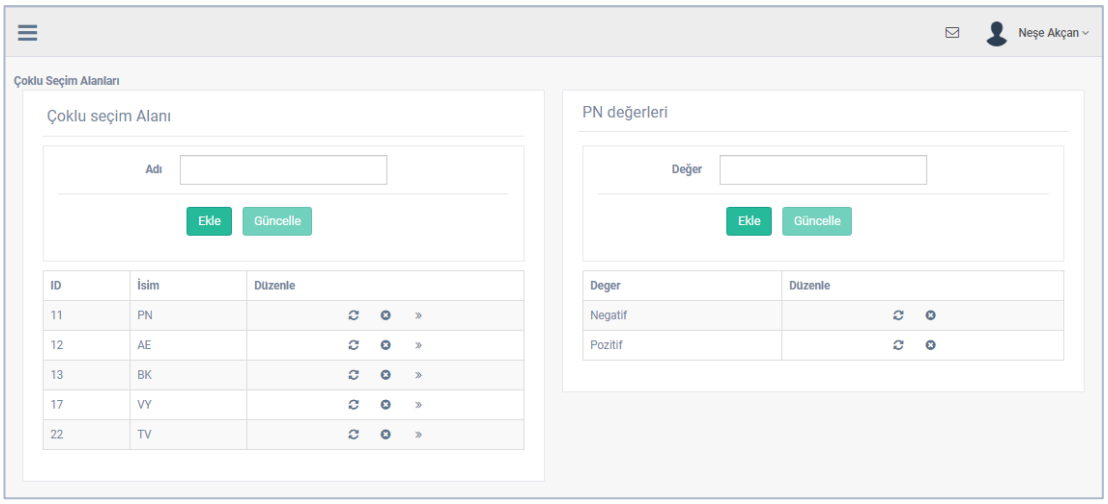


Figure 3.6: "Çoklu Seçim Alanları" Page

Figure 3.6 shows "Çoklu Seçim Alanları" page. The components on "Test Tanımla" page under "Seçim Listeleri" can be defined here. In order to create a new component, user enters a name into "Adı" field and clicks "Ekle" button. All created components are shown as a list. Every component can be updated by clicking the corresponding " " button. When " " button is clicked, the corresponding name will be displayed in "Adı" text box. User can change it and click to "Güncelle" button for saving. When user clicks " " button, "Ekle" button will be inactive and "Güncelle" button will be active. After user clicks "Güncelle" button, "Ekle" button will be active and "Güncelle" button will be inactive. To delete a selected component with all its values from the system completely, " " button next to the component to be deleted is clicked. The value of the selected component in any row in the table which is in "Çoklu Seçim Alanı" field can be defined by clicking " " button next to the component. The automatically selected row values are transferred to "PN Değerleri". The name of this field depends on the selected item's row. For example, if " " button which is in the line with "AE" is clicked, its name will be "AE Değerleri". In this field, the values required to be in the selected component are entered in "Değer" field and added to the system by clicking "Ekle" button. The value to be updated is taken to "Değer" field by

clicking “ ” button and it can be updated by clicking “Güncelle” button. The desired value can be deleted with the help of “ ” button.

“ ” button is a common update button in the system and used to update the corresponding records. When this button is clicked, the data in the relevant row will be transferred to its own data form. It ensures that “Düzenle” or “Güncelle” button which is required to update the data is activated and “Ekle” button is deactivated.

“ ” button is a common delete button in the system, and it is used to delete the relevant records. When this button is clicked, the data in the corresponding row will be deleted with the user’s confirmation.

Figure 3.4 above shows “Arama”, “Girdi Göster” components and “Önceki”, “Sonraki” buttons to search records that are in the system. “Arama” component searches all rows and columns in the table containing the query and lists the corresponding records. As shown in Figure 3.4, “ant” is entered into “Arama” component, and all rows in which the input is included are listed in the table. “Girdi Göster” component divides the records into parts as many as the selected value and allows the table to display as many rows as the selected value. In “Girdi Göster” component, the number of displayed results can be selected as 10, 25, 50, or 100. For example, this value is selected as 10 in the table as shown in Figure 3.4 and there are 10 values are displayed in the table. If there are more records than the selected value, other records can be viewed using “Önceki” and “Sonraki” buttons. Tables containing these buttons and components operate in the same manner in the system.

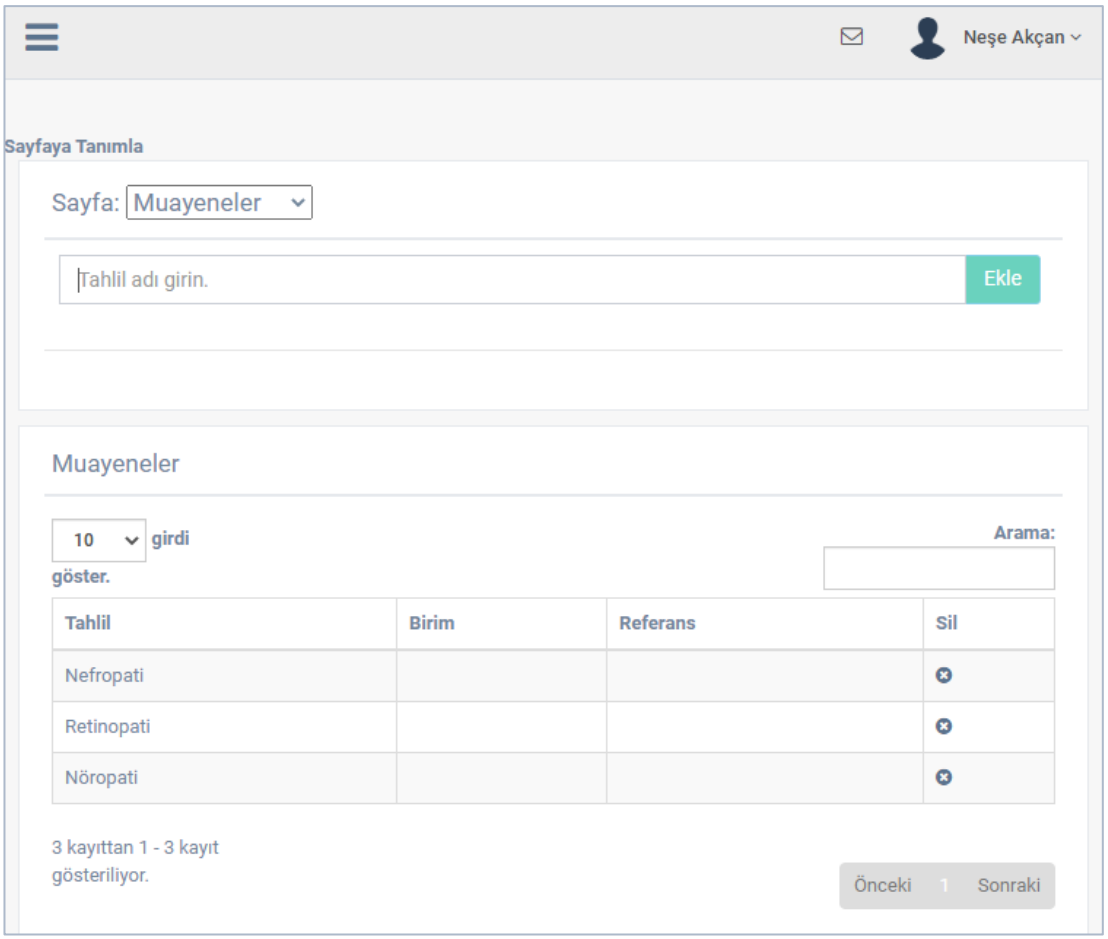


Figure 3.7: “Sayfaya Tanımla” page

Figure 3.7 shows “Sayfaya Tanımla” page of the system. As shown in figure, this page consists of two parts which are “Sayfa” form and corresponding table part. Since “Muayeneler” page is selected from “Sayfa” form, the table part displays records of “Muayeneler” page’s data. This page allows the tests defined in the system to be added to the forms in “Muayeneler”, “Yıllık Tetkikler”, “Çölyak”, “Tiroid”, “Tanı Verisi” pages. The page to be added can be selected from “Sayfa” list given in the drop-down component. Then, the attached tests for that page will be shown in a table on the same page below. When a test name is entered into “Tahlil Adı Girin” field, the tests that match the name entered will be listed as shown in Figure 3.8. In the listed tests section, the previously defined tests are colored with red. If one of these is selected, “Ekle” button becomes inactive. If one of the tests that are not defined on the page is selected,

“Ekle” button becomes active. When the button is clicked, that test will be defined to the page and all the tests of the selected page will be shown in the table part of “Sayfaya Tanımla” page.

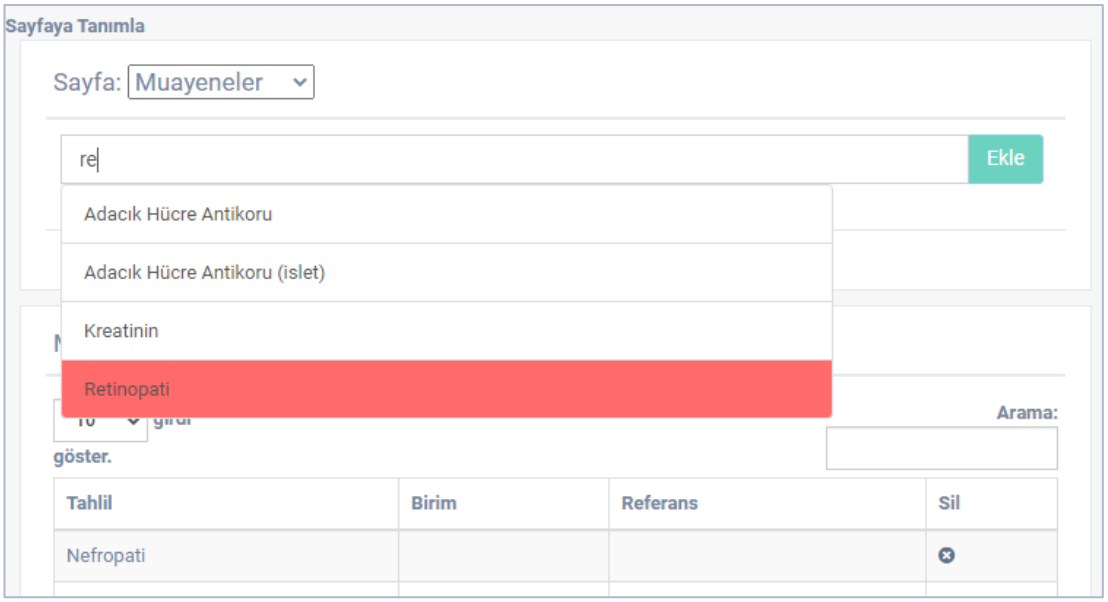


Figure 3.8: “Sayfaya Tanımla” page’s Test List

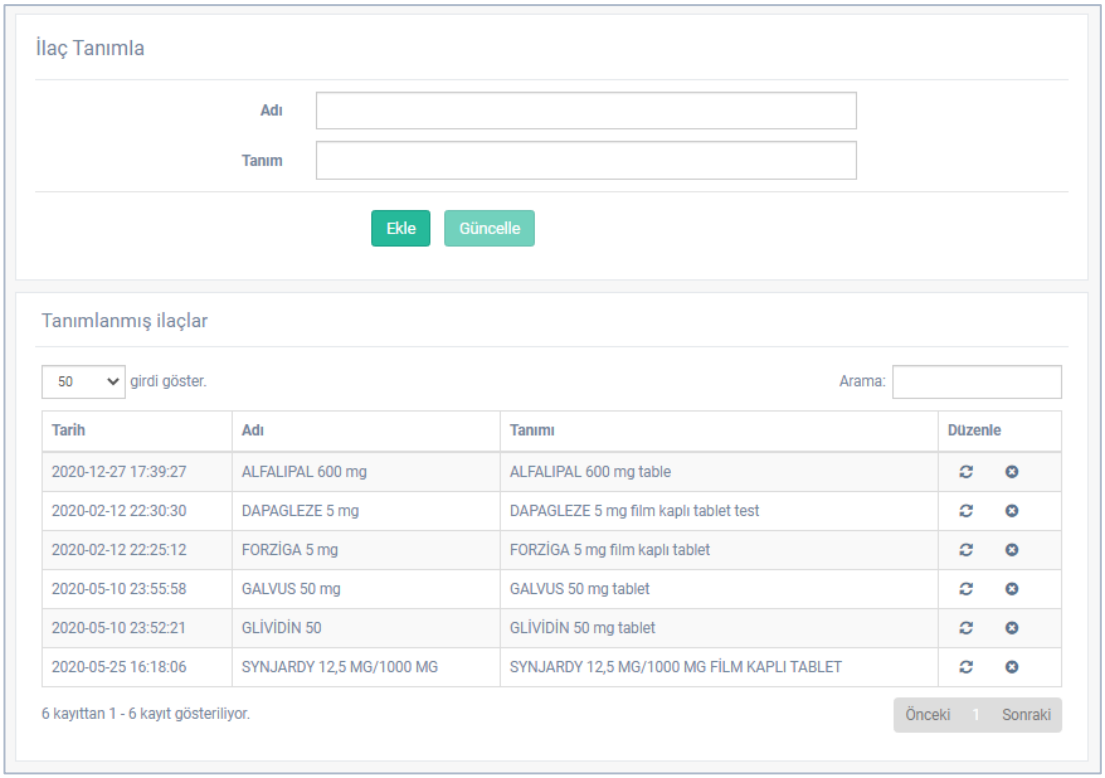


Figure 3.9: “İlaç Tanımla” page

In Figure 3.9, “İlaç Tanımla” form and “Tanımlanmış İlaçlar” table are shown. New diabetes medication can be defined into the system by using this page. If “İlaç Tanımla” form is filled and “Ekle” button is clicked, new diabetes medication is defined in the system. “Tanımlanmış İlaçlar” table shows the list of diabetes medications that are previously defined in the system.

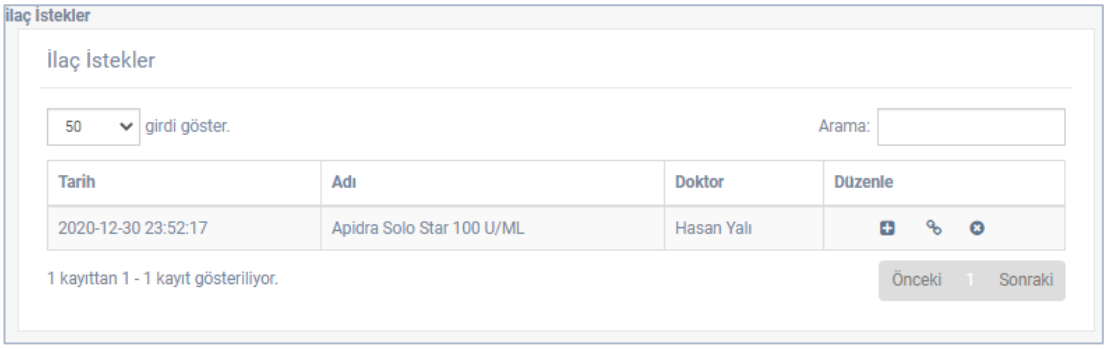


Figure 3.10: “İlaç İstek” page’s “İlaç İstekler” Table

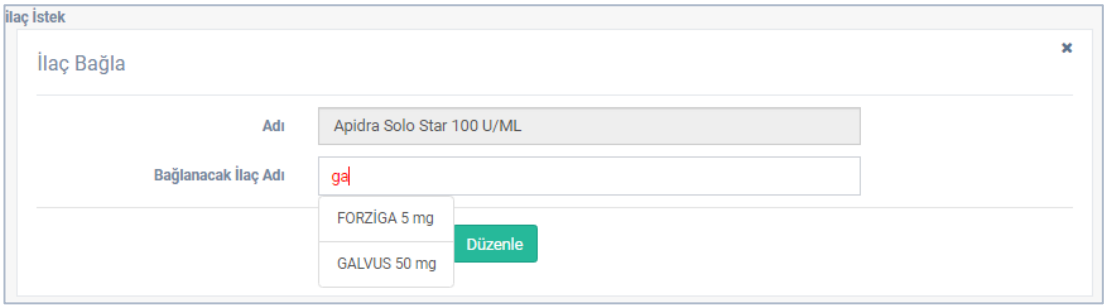


Figure 3.11: “İlaç İstek” page’s “İlaç Bağla” Form

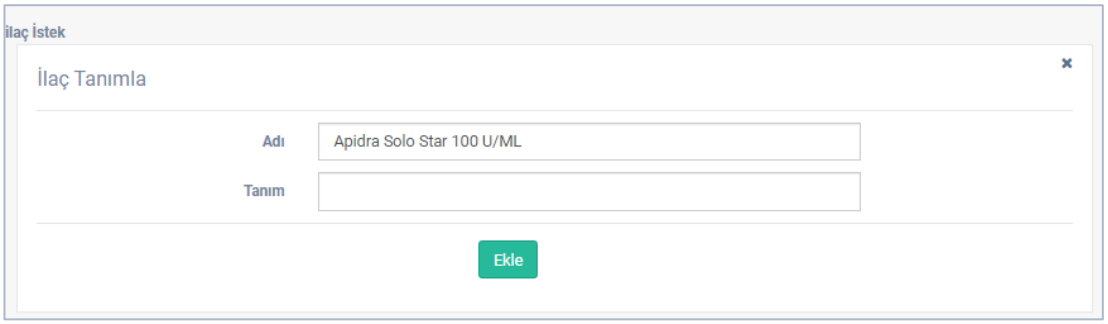


Figure 3.12: “İlaç İstek” page’s “İlaç Tanımla” form

“İlaç İstek” page consists of three sections that are “İlaç İstekler” table, “İlaç Bağla” form and “İlaç Tanımla” form. Diabetes medicines that are not defined but requested to add in the system (this process will be given in details in 3.1.2) are shown in “İlaç İstekler” table as shown in Figure 3.10. For each row in the table, define medicine, link medicine, and delete buttons are denoted by “ ”, “ ”, “ ” icons respectively. “ ” button displays “İlaç Bağla” form as shown in Figure 3.11 for the relevant record. This form allows the requested medicine to match with another previously defined medicine in the system. Thus, correction of the names of the medicines that are on “İlaç İstekler” list due to the wrong spelling of the medicine name is provided. “Adı” field in the form is filled with the data in “Adı” column in the row where the button is clicked, and this value cannot be changed. The medicine to be matched must be entered into “Bağlanacak İlaç Adı” field on the form. To enter the name of this medicine correctly, the first few letters of the medicine name are typed into “Bağlanacak İlaç Adı” field and the desired name is selected from the listed medicines. This list is shown in Figure 3.11. The process is completed when “Düzenle” button is clicked. Clicking “ ” button in any row in “İlaç İstekler” table which is shown in Figure 3.10 displays “İlaç Tanımla” form shown in Figure 3.12. “Adı” field in the form is filled with the data in “Adı” column on the row where the button is clicked, and a new medicine can be added by filling “Tanı” field in the form and clicking “Ekle” button.

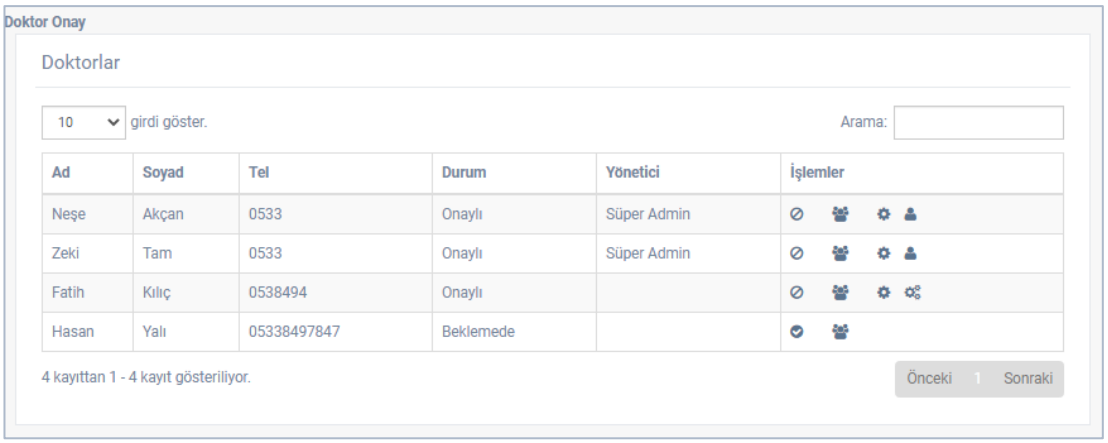


Figure 3.13: "Doktor Onay" page's "Doktorlar" Table

Figure 3.13 shows the view of "Doktor Onay" page. This page contains "Doktorlar" table. The page displays a table containing the list of "Diabetes Doctors" registered in the system. For each row in the table, there are "" -confirm, "" -suspend, "" -display the doctor's patients, "" -assign the doctor as admin, "" -assign doctor as "Super Admin", "" -mark as doctor buttons. If "" button is clicked on any row, it allows the newly registered doctors to be approved and allow them to use the system, and it becomes to "" button. "" button suspends approved doctors again. Thus, the doctor cannot use the system. "" button displays the patient list of the doctor in the row where it is clicked. This list is shown in Figure 3.14. "Admin" or "Super Admin" privileges can be assigned to the "Diabetes Doctors" in the system. That is, a doctor can also be "Admin" or "Super Admin". To make a doctor as "Admin", "" button belonging to that doctor is clicked. To make a doctor "Super Admin", "" button belonging to that doctor is clicked. To revoke "Admin" or "Super Admin" privileges of the doctor, "" button is clicked.

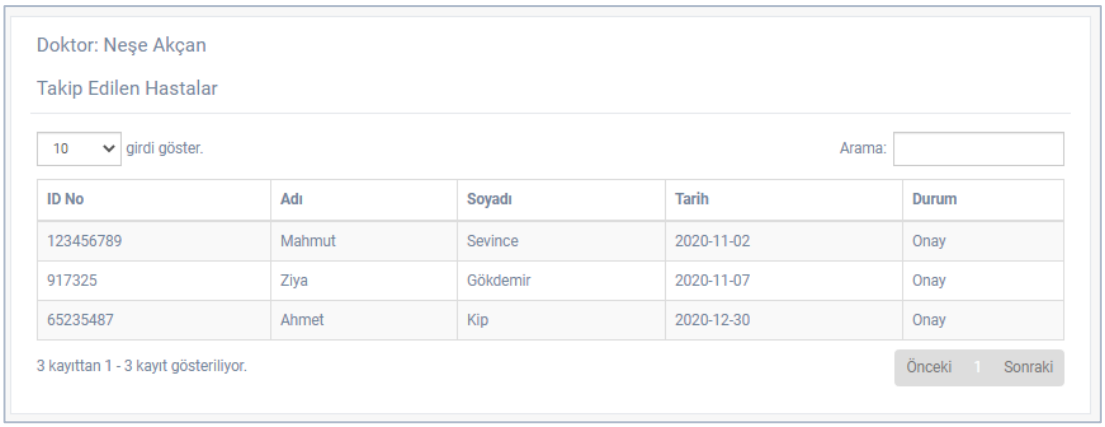


Figure 3.14: "Doktorun Hastaları" page's "Takip Edilen Hastalar" Table

Figure 3.14 shows "Takip Edilen Hastalar" table of "Doktorun Hastaları" page. In the table, "Durum" column indicates approval status of follow-up request which is sent by the doctor to patient. "Onay" value in this column shows that the doctor's follow-up request is approved by the "Patient". If there is "Red" value in this column, the doctor's follow-up request is rejected by the "Patient", and if the value is "Beklemede", the follow-up request is pending.

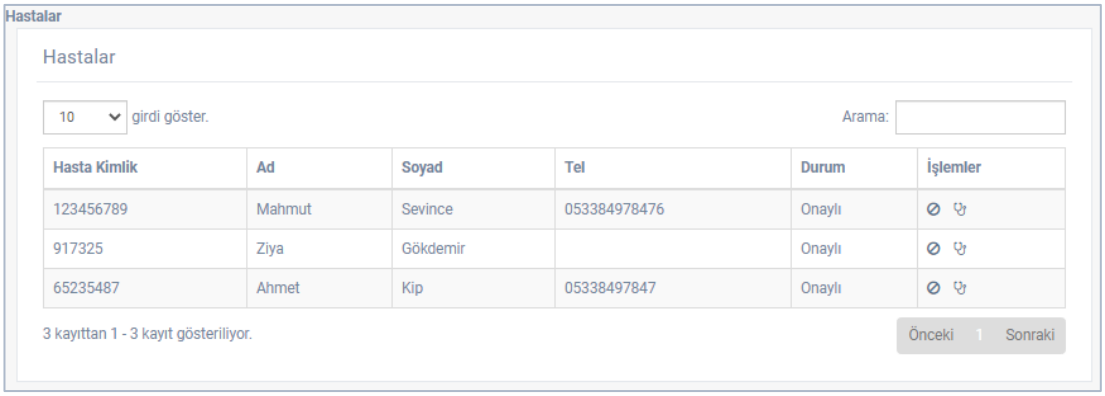


Figure 3.15: "Hastalar" page's "Hastalar" Table

Figure 3.15 shows "Hastalar" page. This page contains the "Hastalar" table. This table contains the list of all the patients who are registered to the system. There are "✓"-confirm, "⊘"-suspend, and "🩺"-display the patient's doctors button for each row in the table. "✓" button approves for the patients on standby to use the system and

becomes “ ” button. To stop a patient from using the system, “ ” button is clicked. “ ” button displays the list of doctors who follow the patient up. This list is shown in Figure 3.16.

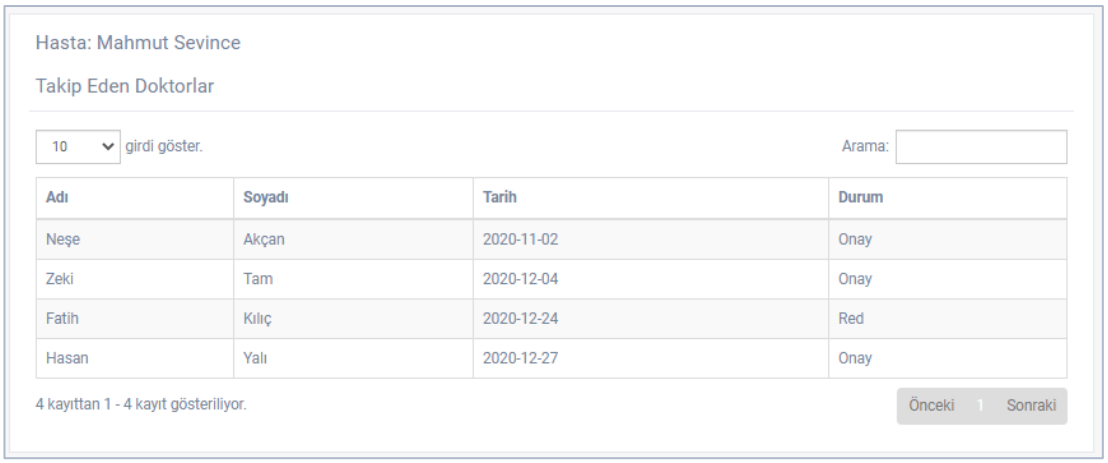


Figure 3.16: “Hastanın Doktorları” page’s “Takip Eden Doktorlar” Table

Figure 3.16 shows “Takip Eden Doktorlar” table of “Hastanın Doktorları” page. In the table, “Durum” column indicates approval status of follow-up request which was sent by a doctor to the patient. If there is “Red” value in this column, the doctor’s follow-up request is rejected by “Patient”, and if the value is “Beklemede”, the follow-up request is pending.

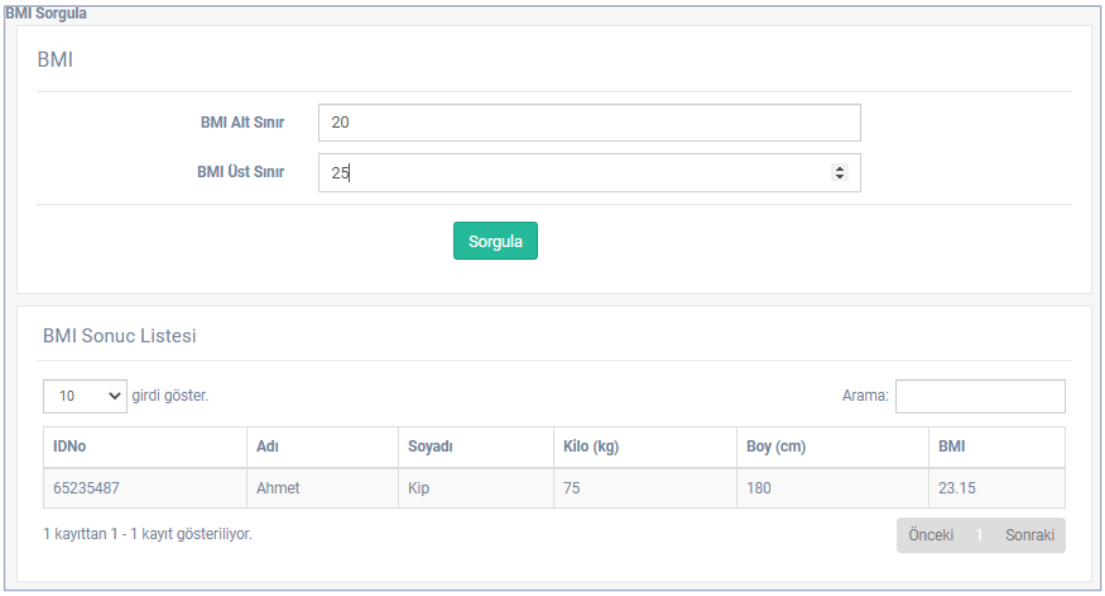


Figure 3.17: “BMI Sorgula” page

Figure 3.17 above shows “BMI Sorgula” page. This page consists of two parts which are “BMI” form and “BMI Sonuç Listesi” table. Patients in the system are listed according to their BMI values via “BMI” form on this page. The minimum BMI value is entered into “BMI Alt Sınır” and the maximum BMI value is entered into “BMI Üst Sınır” fields on this form. When “Sorgula” button is clicked, patients are listed in “BMI Sonuç Listesi” table according to the entered BMI values.

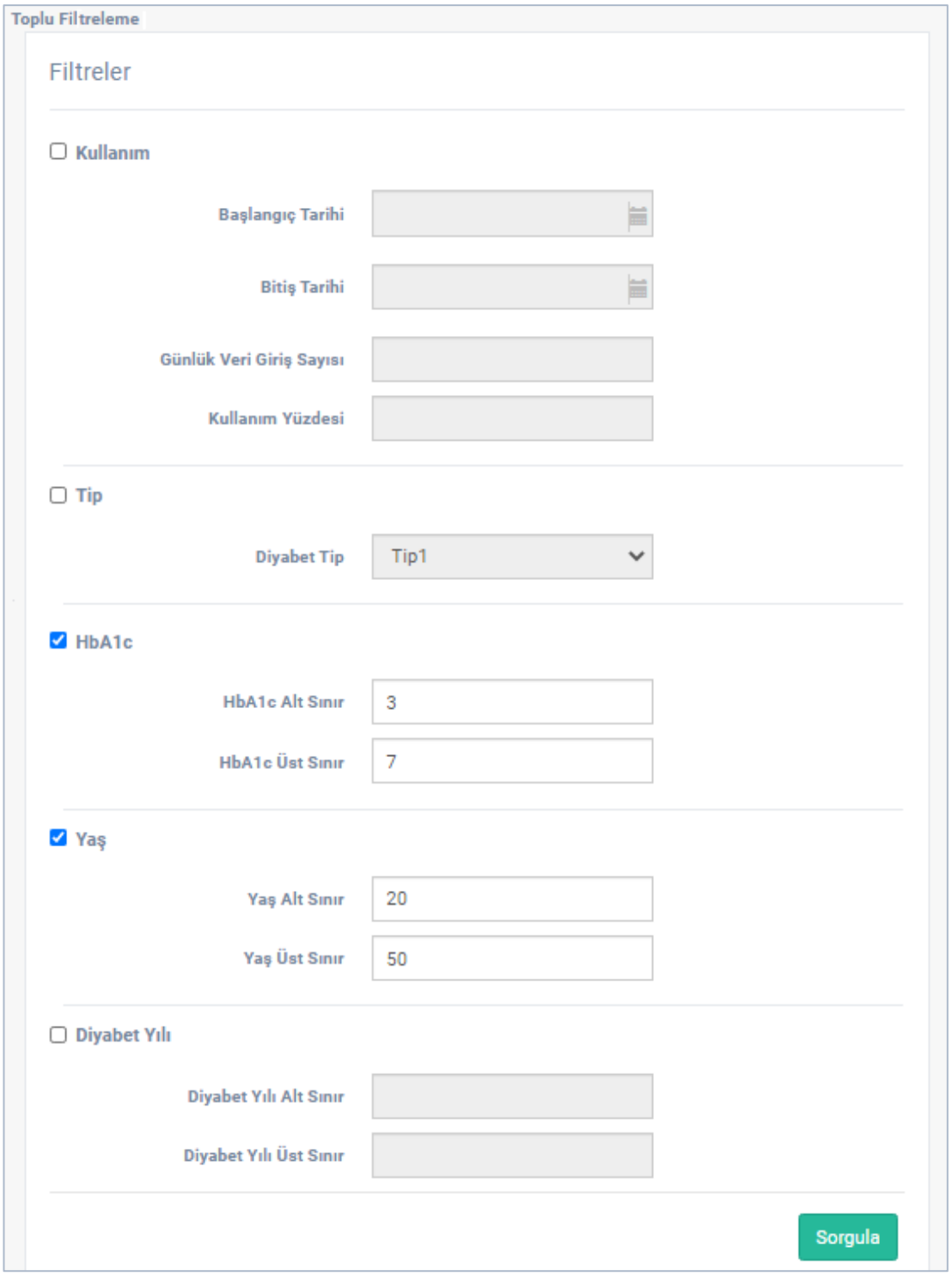


Figure 3.18: “Toplu Filtreleme” page’s “Filtreler” form

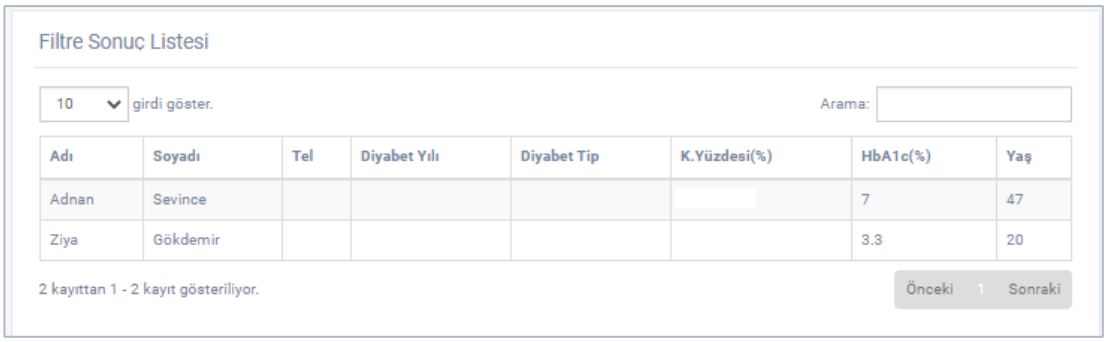


Figure 3.19: “Toplu Filtreleme” page’s “Filtre Sonuç Listesi” table

By using the page “Toplu Filtreler”, the users can filter the records according to the usage routine, diabetes type, HbA1c result, age and year of diabetes. These filters can be used individually or in pairs. The “Toplu Filtreler” page consists of two fields such that a form and a result table. As shown in Figure 3.18, the form fields are “Kullanım” to select system usage routines of patients, “Tip” to select diabetes type, “HbA1c” to select minimum and maximum value of HbA1c result, “Yaş” to select age interval of the patients and “Diyabet Yılı” to select in how many years of diabetes. Each filter option has a checkbox component to activate the considering filtering option. The “Kullanım” filter option has four form fields that are “Başlangıç Tarihi” to select start date, “Bitiş Tarihi” to select end date, “Günlük Veri Giriş Sayısı” to determine the minimum number of data entries per day and “Kullanım Yüzdesi” to determine the minimum value of usage percentage. While filtering the system usage percentage of the patient, it is checked if the patient has entered at least as much as the number of daily blood glucose data entries determined in the " Günlük Veri Giriş Sayısı " field per day between the start date and end date. The usage percentage of a patient is calculated by proportioning the total number of days between the selected start and end days to the number of data entered as much as the determined daily data entry number. The “Tip” filter option contains a list of diabetes types and patients are filtered according to the diabetes type selected from this list. “HbA1c” filter option has two

text fields that are “HbA1c Alt Sınır” and “HbA1c Üst Sınır” to enable determining the minimum and maximum HbA1c result values respectively. According to the values entered in “HbA1c” filter option, the patients whose latest HbA1c results are in the entered minimum and maximum interval including both minimum and maximum values are filtered. The filter option “Yaş” has two text fields that are “Yaş Alt Sınır” and “Yaş Üst Sınır” to enable determining the minimum and maximum age of the patients respectively. If this filter option is active, the patients are in the determined age interval are filtered. “Diyabet Yılı” filter option has two text fields that are “Diyabet Yılı Alt Sınır” and “Diyabet Yılı Üst Sınır” to enable determining the minimum and maximum year of the diabetes respectively. If this filter option is active, the patients whose year of the diabetes are in the selected interval are filtered. Any filter option can be used at the same time. The patient records that satisfy the selected filter options are called and displayed in the table on this page. Figure 3.19 shows the patient records that are filtered according to the selected filter option in Figure 3.18.

Figure 3.20: Management Portal’s Top Menu

Figure 3.20 shows management portal’s top menu. This menu has items which are “Hasta Portalı”, “Şifre Değiş” and “Çıkış”. “Admin” and “Super Admin” privileged users can display and use “Şifre Değiş” and “Çıkış” items. If a “Diabetes Doctor” is also “Admin” or “Super Admin”, such user can display and use “Hasta Portalı” item as well. "Hasta Portalı" item allows users to switch into the patient portal. “Çıkış” item

ends the session. Users can change their password by using “Şifre Değiş” item of the top menu. When “Şifre Değiş” item is clicked, the system redirects the user to the password change page. This page is shown in Figure 3.21 below.

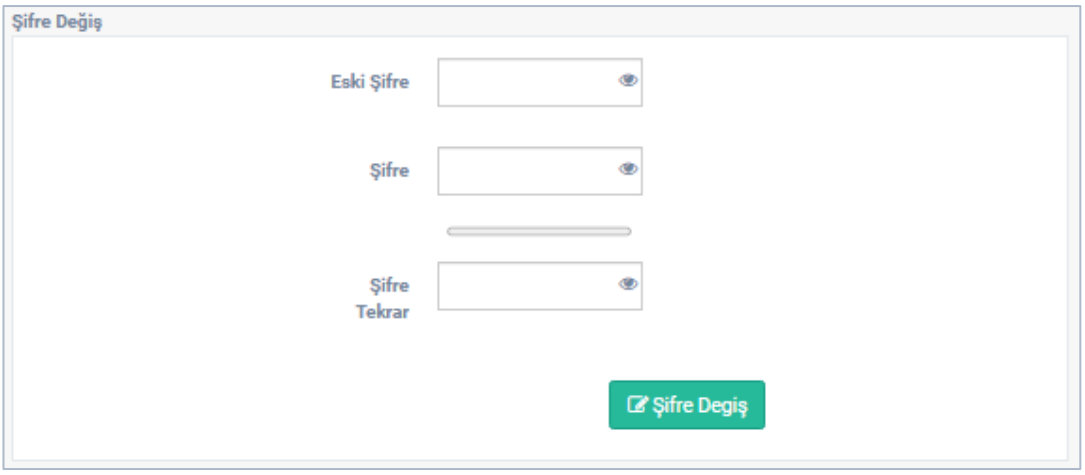


Figure 3.21: “Şifre Değiş” page

Figure 3.21 shows common “Şifre Değiş” page of system. All users can use this page to change their passwords. To change a password, the user must click “Şifre Değiş” button after entering the old password into the “Eski Şifre” field, and the new password into the “Şifre” and “Şifre Tekrar” fields. In case of the password is could not change, the user will be informed with an appropriate message.

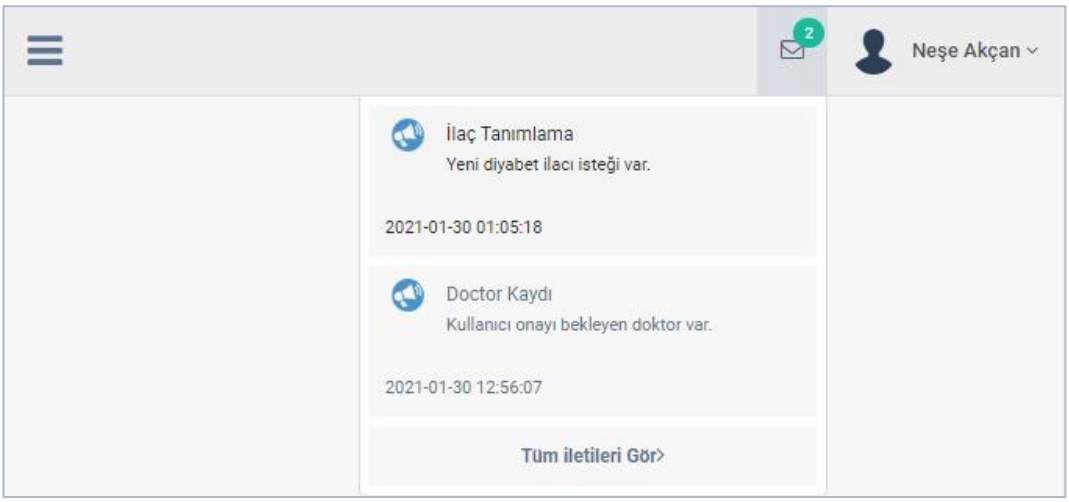


Figure 3.22: Notifications list

Notifications list is given in Figure 3.22. As seen from the figure, notifications list shows the messages that are generated by the system for the users. “Admin” and “Super Admin” users receive two types of notifications which are “İlaç Tanımlama” and “Doktor Kaydı”. When new medicine definition requested, “İlaç Tanımlama” notification is sent by the system to “Admin” and “Super Admin” users. “Doktor Kaydı” notification is sent by the system only to the “Super Admins” when a new doctor registered to the system. The system redirects the user to relevant page when a notification was clicked. For example, if “Doktor Kaydı” notification is clicked, the system redirects the user to “Doktor Onay” page. When a notification in the notification list was clicked, it is removed from this list. To display all previous notifications chronologically in “Notification” page, “Tüm İletileri Gör” button can be used. This page is given in Figure 3.23.

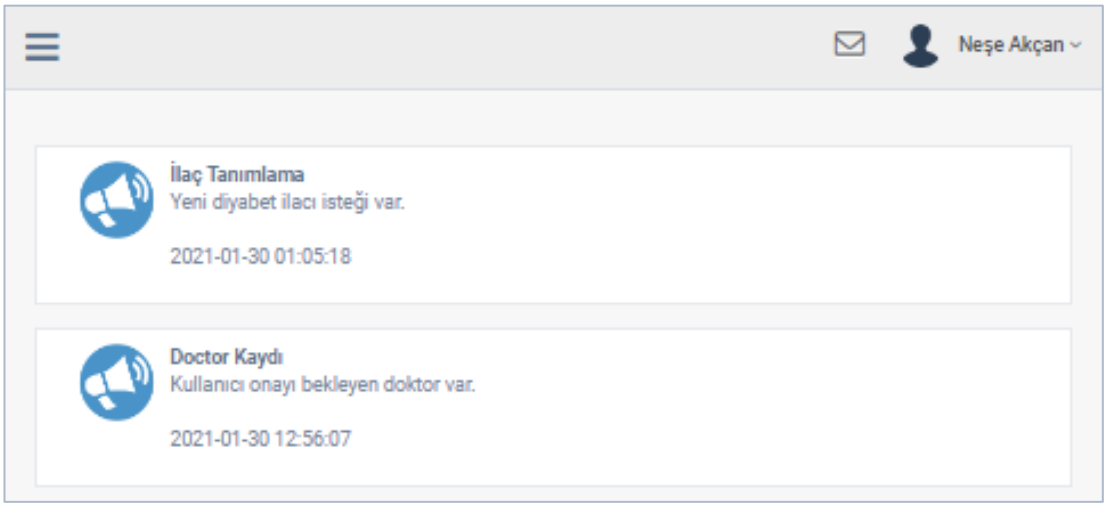
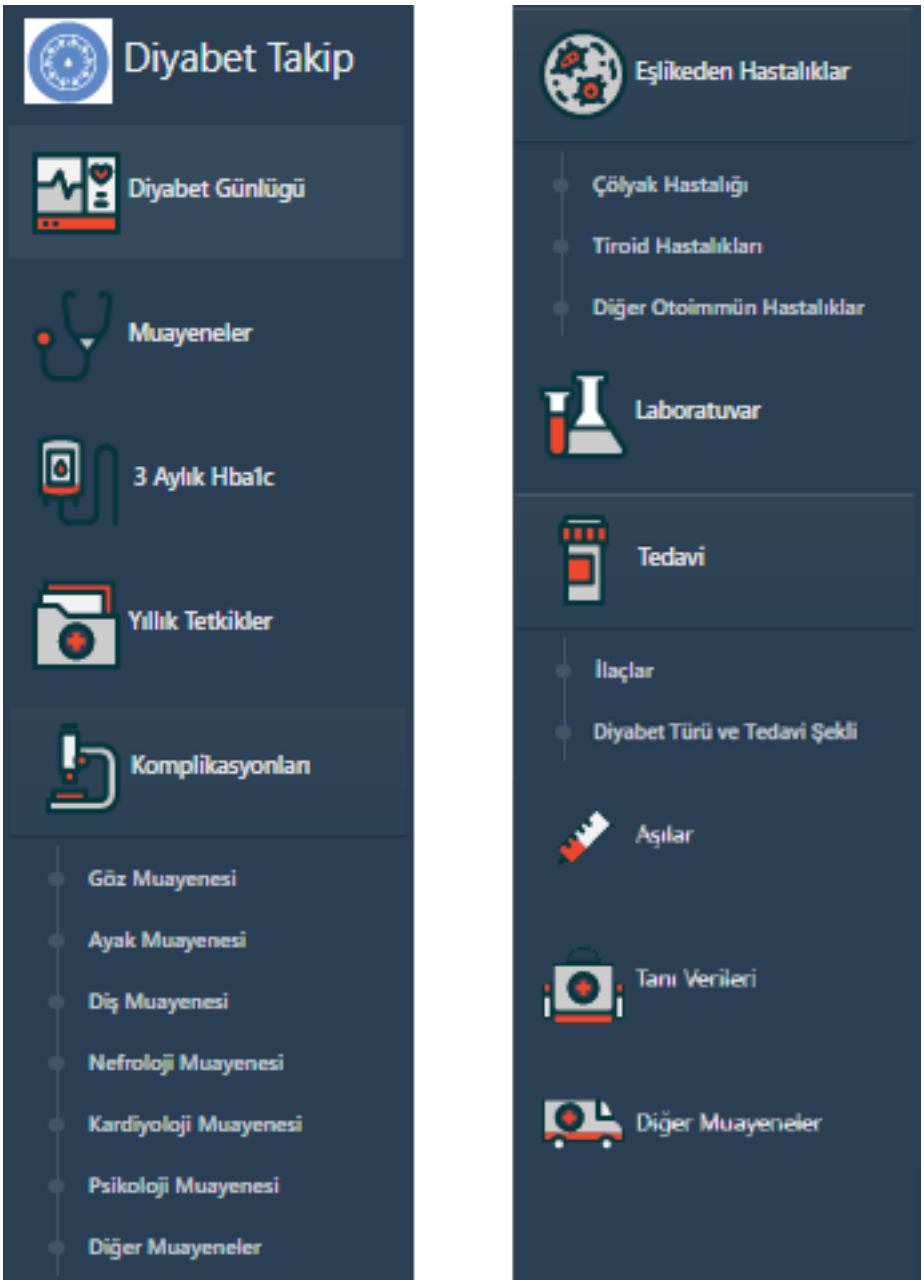


Figure 3.23: Notification page

3.1.2 Patient Portal

The patient portal can be used by “Diabetes Doctors”, “Other Doctors” and “Patients”. Patient portal is the portal that where patients' information can be entered and displayed. Patient portal menu is shown in Figure 3.24. As seen from the figure, patient

portal has 11 main menu items that are “Diyabet Günlügü”, “Muayeneler”, “3 Aylık HbA1c”, “Yıllık Tetkikler”, “Komplikasyonlar”, “Eşlikeden Hastalıklar”, “Laboratuvar”, “Tedavi”, “Aşılar”, “Tanı Verileri” and “Diğer Muayeneler”. “Komplikasyonları” item has 7 sub-menu items which are “Göz Muayenesi”, “Ayak Muayenesi”, “Diş Muayenesi”, “Nefroloji Muayenesi”, “Kardiyoloji Muayenesi”, “Psikoloji Muayenesi” and “Diğer Muayeneler”. “Eşlikeden Hastalıklar” has 3 sub-menu items which are “Çölyak Hastalığı”, “Tiroid Hastalıkları” and “Diğer Otoimmün Hastalıklar”. Finally, there are two sub-menu items that are “İlaçlar”, “Diyabet Türü ve Tedavi Şekli” belongs to “Tedavi” menu item. All users who use patient portal can display all pages of these menu items. There are restrictions on displaying the pages according to the user types (these restrictions will be specified when describing the relevant pages).



(a) (b)

Figure 3.24: Patient portal menu

A “Diabetes Doctor” must be registered to the system to use the patient portal. As shown in Figure 3.1, “Hesap Oluştur” link must be clicked by the doctor. “Hesap Oluştur” link redirects the user to the registration page. The page is shown in Figure 3.25. To register, “Hesap oluştur” button must be clicked after filling the following fields correctly with appropriate information that are “Ad” for name, “Soyad” for surname, “Tel” for phone number, “Mail” for email address, “Mail Tekrar” for email

address repeat, “Şifre” for password and “Şifre Tekrar” for password repeat. The password must be at least 8 and at most 15 characters. The email address and the password are used to sign-in to the system. Users are informed about errors that would occur during registration with the appropriate message.

Figure 3.25: “Diabetes Doctor’s” registration page

“Diabetes Doctors” who complete the registration to the system are redirected to the registration confirmation waiting page. This page is shown in Figure 3.26. If one of the “Super Admins” approves the registration, they will be automatically redirected to the patient portal. If the registered doctor does not want to wait for approval, the doctor can sign-out from the system with “Çıkış” button and sign-in later.

Figure 3.26: Registration confirmation waiting page

“Diabetes Doctors” can use the patient portal after getting approval. “Diabetes Doctors” must first either register a “Patient” or send a follow-up request to registered patients to display or enter data of a patient. These operations can be done by clicking related item on the top menu which is in the patient portal. The top menu of patient portal is shown in Figure 3.27. In the top menu of patient portal, there are items which are “Profil”, “Hastalarım”, “Hasta Kayıt”, “BMI Sorgula”, “Yönetim Portalı”, “Şifre Değiş” and “Çıkış”. Among these items, “Yönetim Portalı” is only shown to “Diabetes Doctors” who have “Admin” or “Super Admin” privileges. “Yönetim Portalı” item provides an option to switch to the management portal. “Şifre Değiştir” item redirects the user to common password change page. Password change page is previously shown

in Figure 3.21. The password change page is the same with the one which is in the management portal. The session is terminated with “Çıkış” button. “BMI Sorgula” item redirects the user to the BMI query page which is previously shown in Figure 3.17. This page operates the same as the one which is in the management portal but the only difference is that “Diabetes Doctors” can query only for followed-up patients by the doctor. “Hasta Kayıt” item redirects the user to patient registration page, “Hastalarım” item redirects to the page that the doctor can display his/her patients only, and “Profil” item redirects to profile page of diabetes doctor.

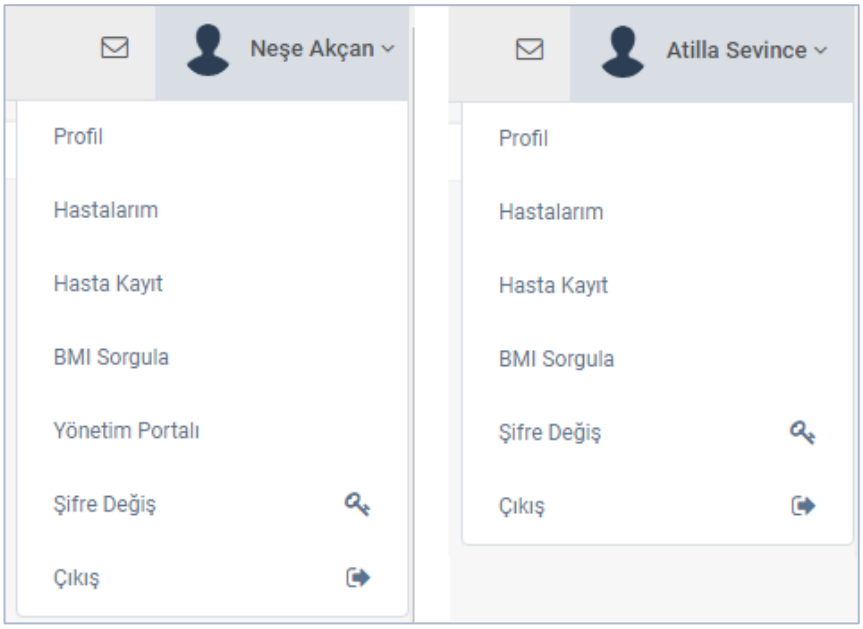


Figure 3.27: Patient portal’s top menu for “Diabetes Doctors”

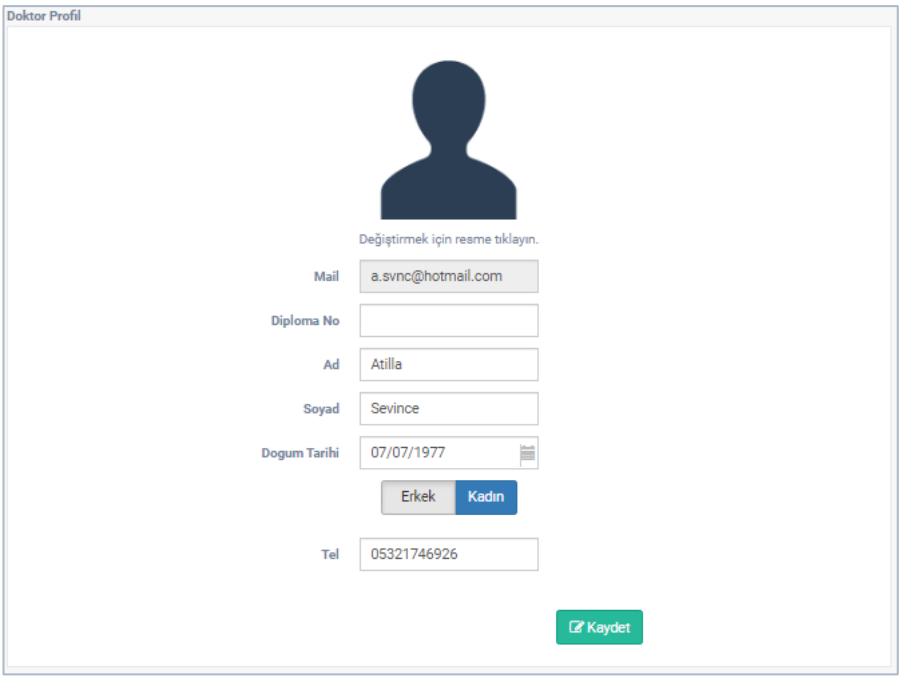


Figure 3.28: “Profil” page for doctor

The profile page of the diabetes doctors is shown in Figure 3.28. In this page, the doctor can access his/her own profile image, e-mail address, diploma number, name, surname, date of birth, gender, and phone number. All of these fields can be edited by the doctor, except email address. To change the profile image, the current image placed on top of the page is clicked and a new image is selected from the popup window. The editable fields can be filled as desired and they can be saved by clicking “Kaydet” button. If the saving process is failed, an appropriate message is displayed for the user.

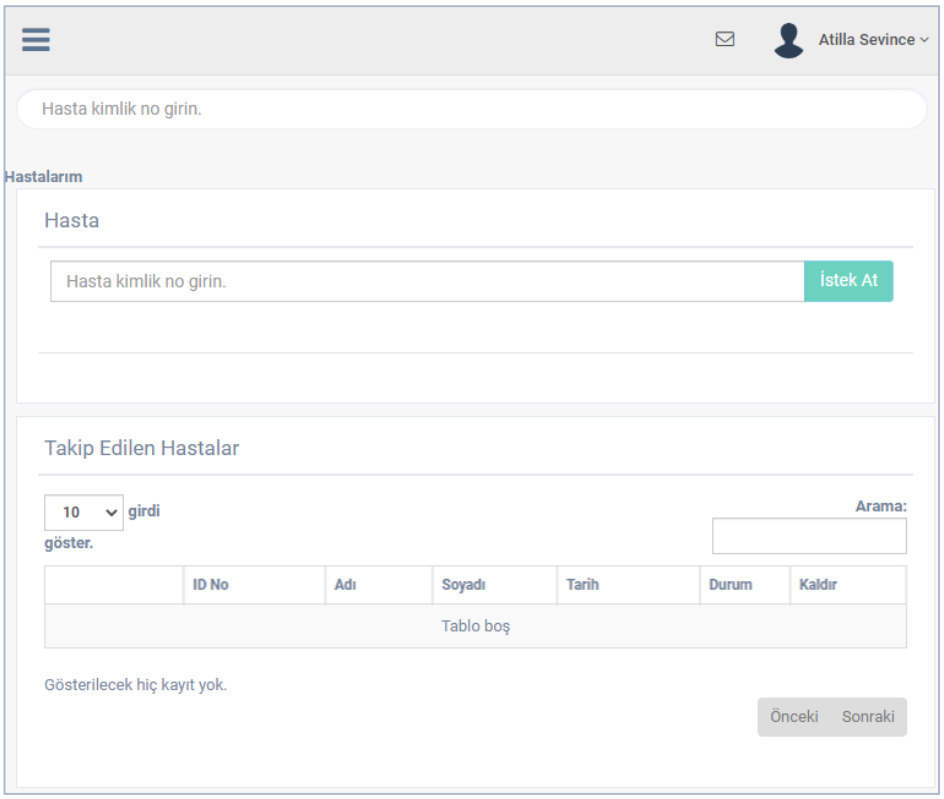


Figure 3.29: “Hastalarım” page

Figure 3.29 shows “Hastalarım” page. As shown in the figure, this page consists of two parts which are “Hasta” form and “Takip Edilen Hastalar” table. “Hasta” form allows “Diabetes Doctor” to send follow-up requests to patients and “Takip Edilen Hastalar” table shows the patients who requested for follow-up by the doctor. Through this page, “Diabetes Doctors” can send follow-up requests to “Patients” or display the follow-up statuses of patients. A few characters of the ID number of the patient to be followed up are entered into the “Hasta kimlik no girin” field on “Hasta” form and a list that contains patients appears just below it. In this list, all the patients whose id number is matched with the characters entered in the form is shown. This operation is shown in Figure 3.30. The patient is selected from the list. Then, “İstek At” button which is in “Hasta” field will be activated and information of the selected patient is displayed under “Hasta kimlik no girin.” field. In Figure 3.31, the selected “Patient” to send a follow-up request is shown. If “İstek At” button is clicked, a follow-up

request is sent to the “Patient” and the “Patient” is added into “Takip Edilen Hastalar” table.

Figure 3.30: “Hastalarım” page’s Patient List

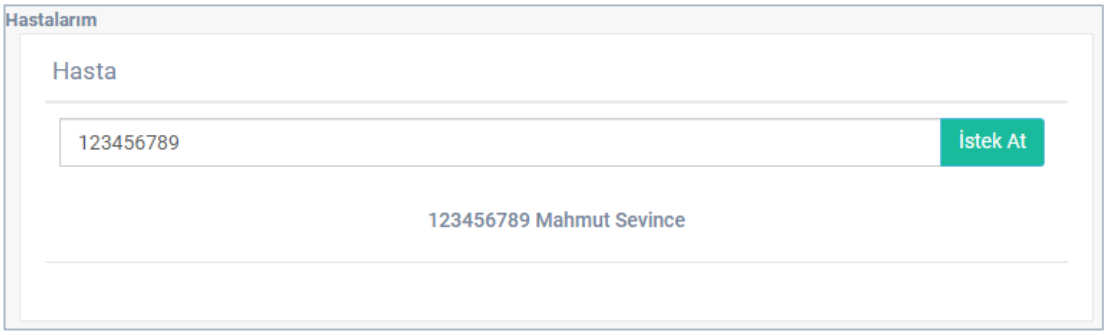


Figure 3.31: Selected patient from “Hastalarım” page for follow-up

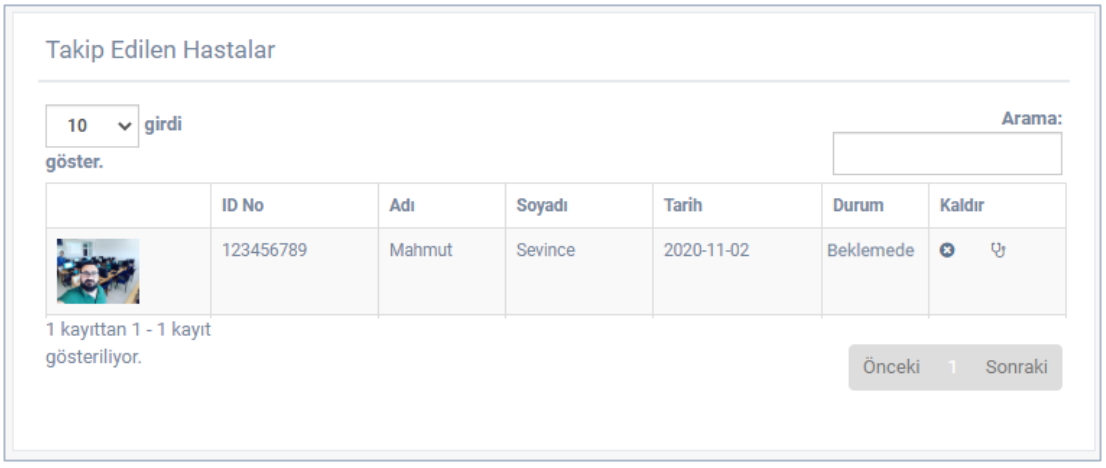


Figure 3.32: “Hastalarım” page’s followed-up patients table

Figure 3.32 shows followed-up patients table of “Hastalarım” page. In this table, “Durum” column keeps the status of the follow-up request of patient. If the value of

this column is “Beklemede”, the patient has not yet approved the request and the status is pending. If the value is “Onay”, the request is approved by the patient and if value is “Red”, the request is rejected by the patient. “ ” button performs the same operation with the button which is in “Hastalar” table of “Hastalar” page in management portal that was shown in Figure 3.15. When this button is clicked, all doctors who follow the patient up in the row where the button is placed are shown. All information of a patient can be displayed by clicking on relevant patient’s photo.

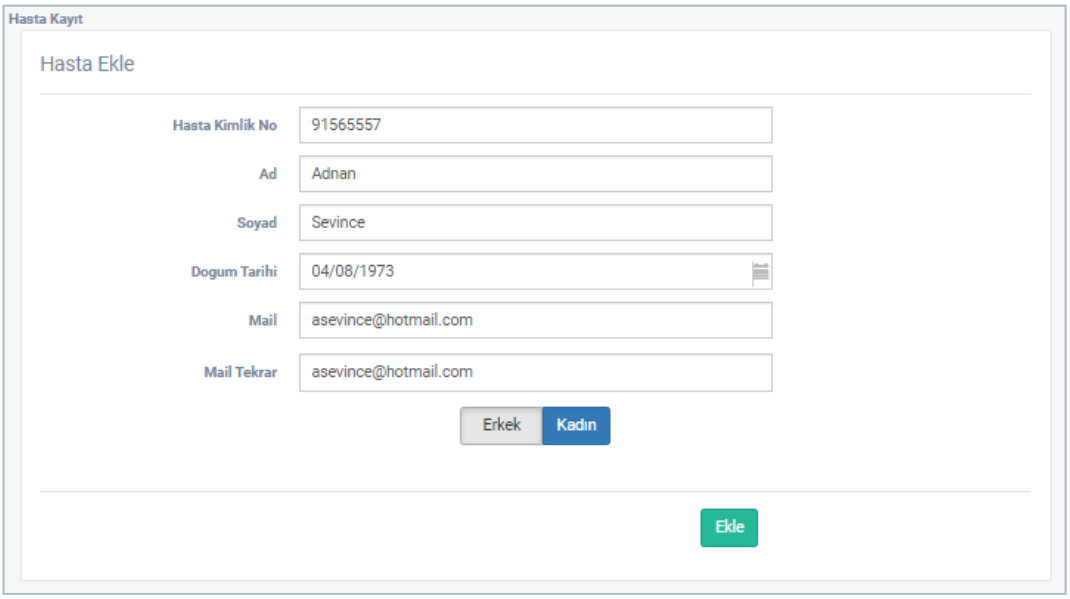


Figure 3.33: “Hasta Kayıt” page

Figure 3.33 shows “Hasta Kayıt” page. The “Patients” who will use the system can be registered by the doctors. This page has “Hasta Ekle” form to add patients. The patient's information is entered in this form. Identification number is entered to “Hasta Kimlik No” field, name of the patient is entered into “Ad” field, surname of the patient is entered into “Soyad” field, date of birth is entered into “Doğum Tarihi” field, the mail adress is entered into “Mail” and “Mail Tekrar” fields. Finally, the gender of patient is chosen. The gender can be either “Erkek” or “Kadın” for female and male respectively. When the form is completed, “Ekle” button is clicked and automatically

generated patient password is shown as in Figure 3.34. “Patient” can use the patient portal after signed-in using the generated password and email address entered during registration. If an error occurs while registering the patient, the user is notified with an appropriate message. The “Patient” registered by the “Diabetes Doctor” is added to doctor’s patients table and the follow-up request is approved automatically.

Figure 3.34: Patient password

In the patient portal, the “Diabetes Doctor” must select from the patients who have approved the follow-up request to display information of the patient and add data to the patient. Once the doctor performed a selection, the doctor can browse all pages of the patient portal with this patient selected. To select a patient, “Hasta kimlik no girin.” field on the top of all pages is used. This field is shown in Figure 3.35. A few characters of the ID number of the patient to be selected are entered in this field and a list appears just below it as shown in Figure 3.36. The appropriate patient is selected from the list and the patient picture and information are displayed just below the selected field. This information is the patient's name-surname and the type of diabetes and treatment method, if exist as shown in Figure 3.37. The “Diabetes Doctor” can now display the information of the selected patient. This case is not available on “Patients” and “Other Doctors” users. “Patients” can monitor and add their information belong to themselves, while “Other Doctors” can only monitor and add specified data of the patients who

have given a temporary password (temporary passwords will be explained in page 137).

Figure 3.35: Patient selection field for patient data

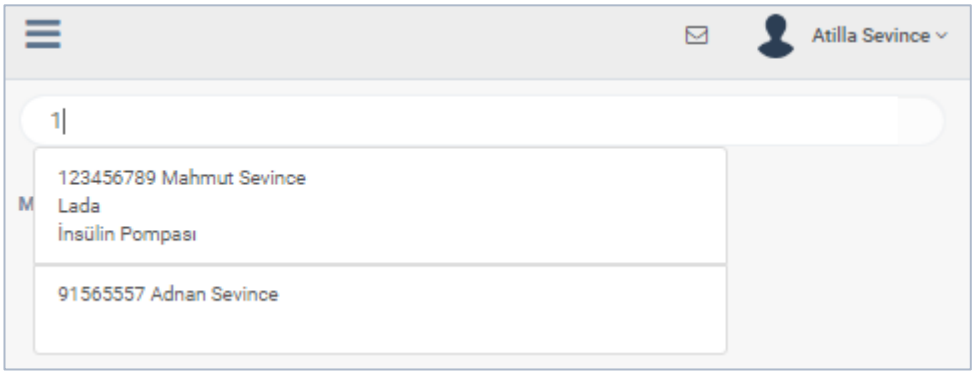


Figure 3.36: Patient list of patient selection area for patient data

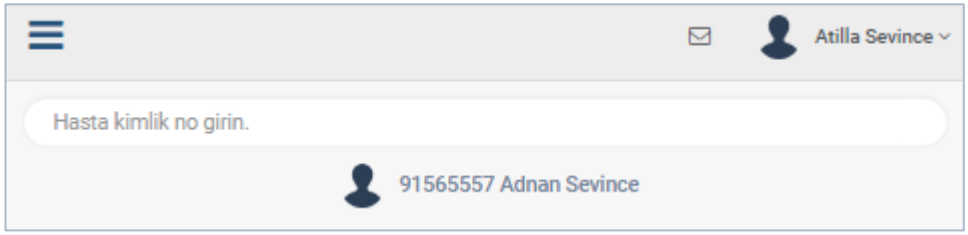


Figure 3.37: View of selected patient for patient data

If there is a data entry form on the patient portal pages, this form is opened by clicking "" button and the button becomes "" on this form. If the opened form is desired to be closed again, the form is closed by pressing "" button in the same place.

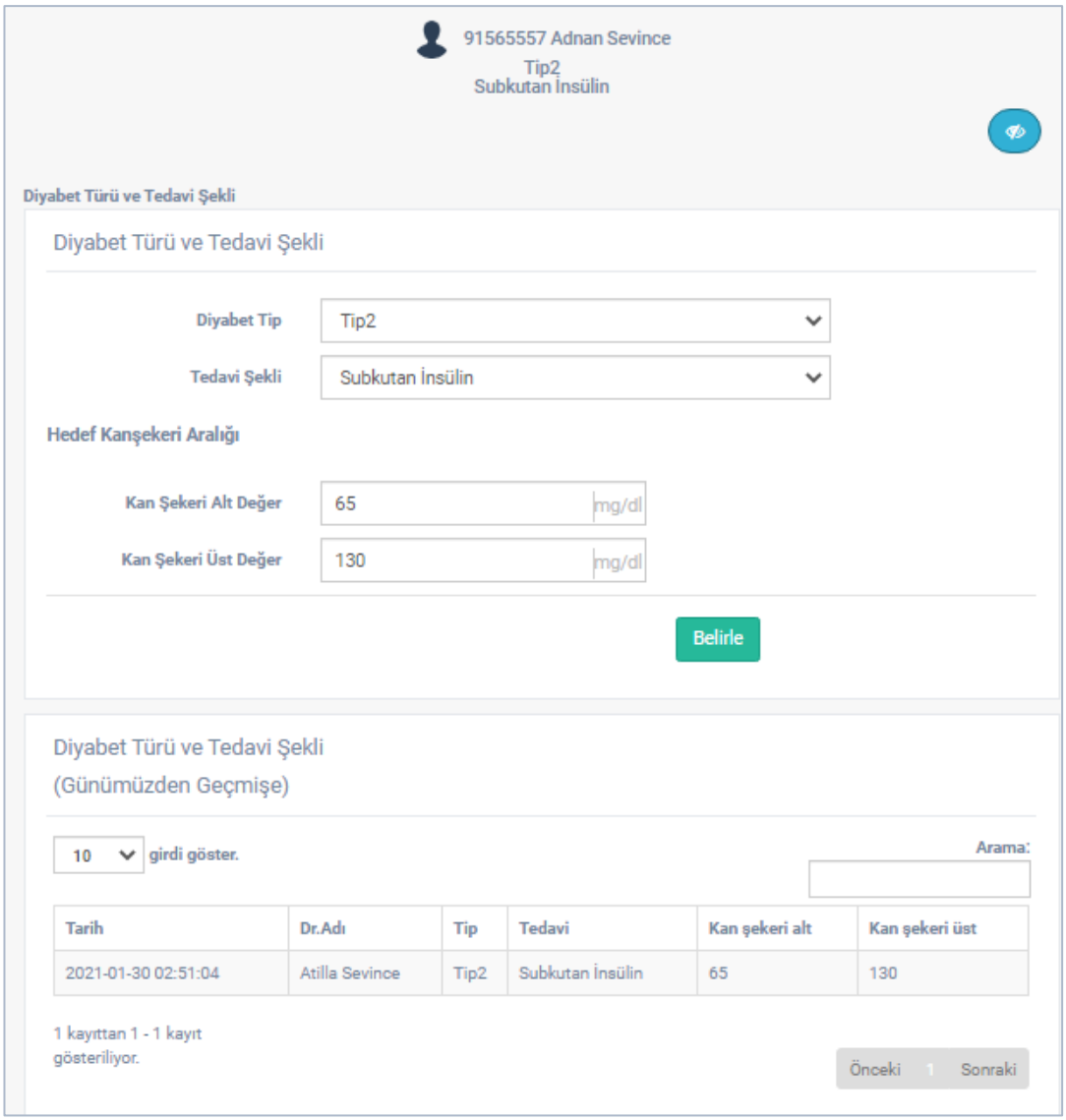


Figure 3.38: “Diyabet Türü ve Tedavi Şekli” page

Figure 3.38 shows “Diyabet Türü ve Tedavi Şekli” page which can be accessed by clicking “Diyabet Türü ve Tedavi Şekli” item of the patient portal menu. As shown in the figure, this page consists of two parts which are “Diyabet Türü ve Tedavi Şekli” form and “Diyabet Türü ve Tedavi Şekli (Günümüzden Geçmişe)” table. In this page, diabetes type of the patient, treatment type and upper and lower bounds of blood glucose of the patient are determined. In the form on the page, there are “Diyabet Tip”, “Tedavi Şekli”, “Kan Şekeri Alt Değer” and “Kan Şekeri Üst Değer” fields. “Diyabet Tip” field is the list that enables the selection of diabetes type. This list includes the

options “Tip1”, “Tip2”, “Lada”, “MODY” and “Diğer”. The type of diabetes is determined by selecting one of the options from the list. The field “Tedavi Şekli” is the list that allows selection of the treatment method. This list includes the options “Subkutan İnsülin”, “İnsülin Pompası” and “Oral Antidiyabetik”. The type of treatment is determined by selecting one of the options from the list. The lowest blood glucose value to be determined for the patient is entered to “Kan Şekeri Alt Değer” field, the highest blood glucose value to be determined for the patient in “Kan Şekeri Üst Değer” field and the type and treatment type for the patient is saved by clicking “Belirle” button. Preview of this page after determining the data is given in Figure 3.39. The most recently saved type and treatment data is valid for the patient. The lower and upper bounds blood glucose values saved from this page are used as a reference while showing the patient's blood glucose data. “Patients” and “Other Doctors” cannot display the form on this page and cannot add data to the form. They can only display the table on the page. “Diabetes Doctors” can both add data to the form and display the table.

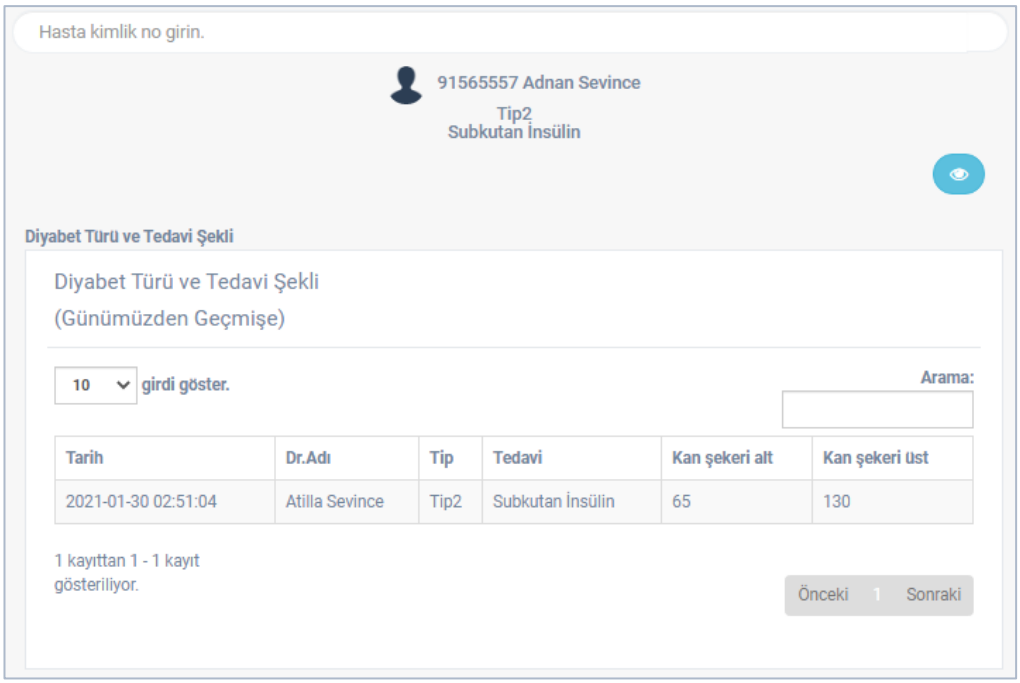


Figure 3.39: “Diyabet Türü ve Tedavi Şekli (Günümüzden Geçmişe)” table of “Diyabet Türü ve Tedavi Şekli” page

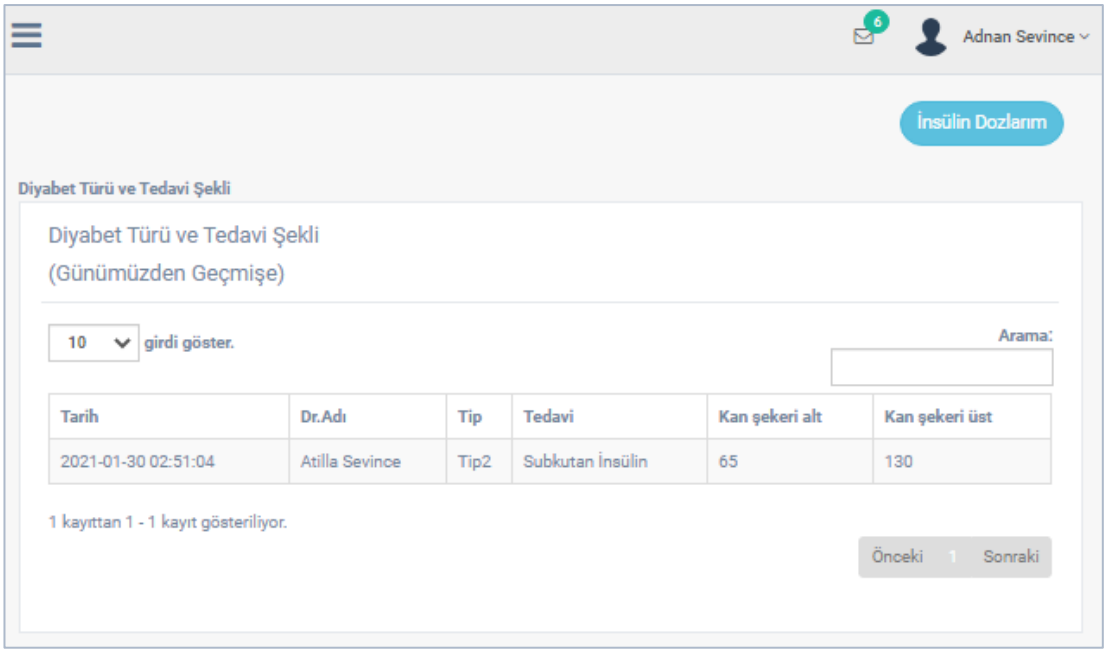


Figure 3.40: “Diyabet Türü ve Tedavi Şekli” page for patient

The patients who are being treated using insulin pump are able to display “Bazal Dozlarım” button to be redirected to the basal doses page. Also the patients who are

being treated using subcutaneous insulin are able to display “İnsülin Dozlarım” button to be redirected to the insulin doses page.

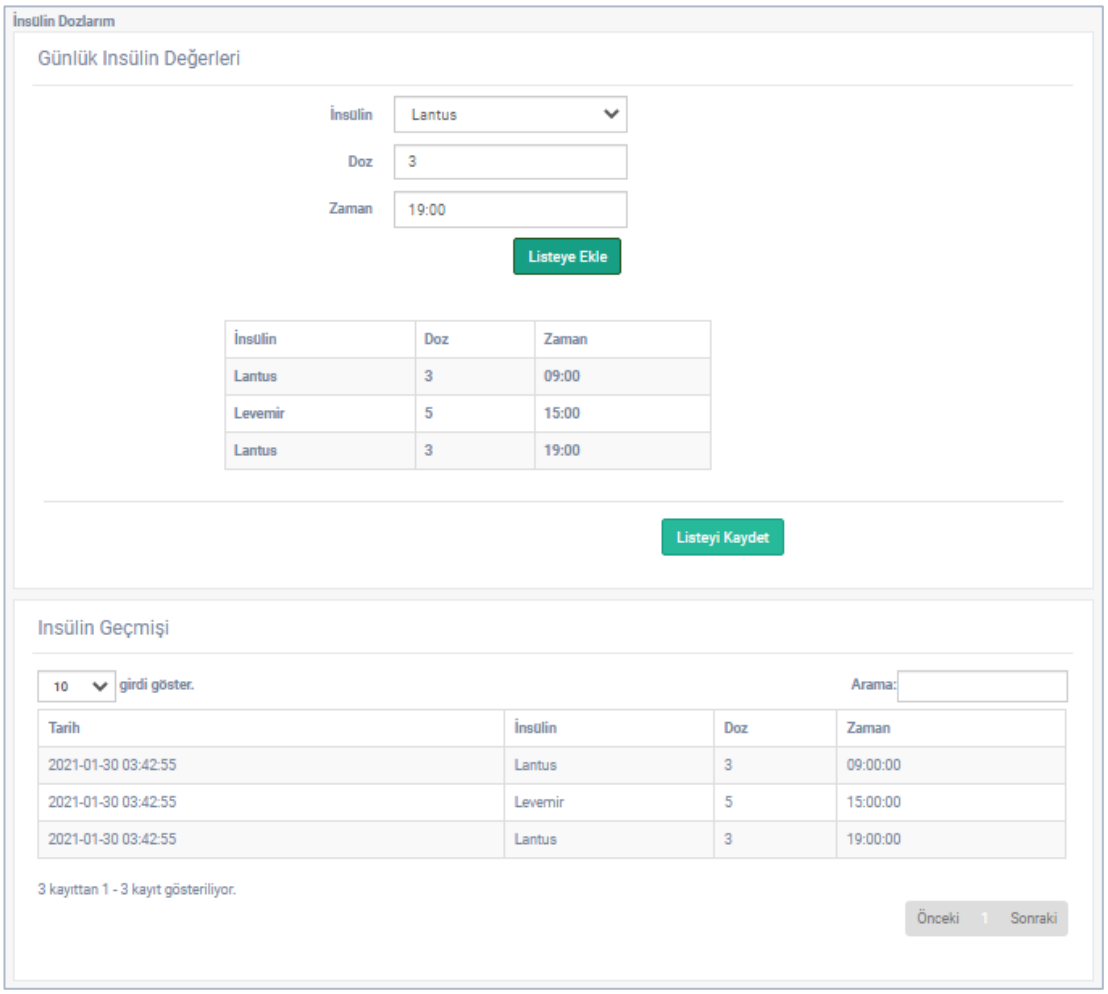


Figure 3.41: “İnsülin Dozlarım” page

The “Insulin Dozlarım” page is used to store the list of routine insulins used by a patient and it contsists of two fields that are a form and a table as shown in Figure 3.41. The form in this page contains three fields that are “İnsülin” which is a list of insulins, “Doz” to enter dose of insulin and “Zaman” to enter the time that the insulin will be injected. The list of insulins contains “Novorapid”, “Humolog”, “Apidra”, “Lantus”, “Levemir”, “Basaglar” and “Mixtard”. The patients can select the insulin, the dose and the time the insulin will be injected to create a list of injections. When “Listeye Ekle”

button is clicked, the entered values are transferred to the list under “Listeye Ekle” button. To save the injections list, “Listeyi Kaydet” button is clicked. The saved insjections list are displayed in the table at the bottom of the page. The patients are able to create multiple list of injectios, however the latest list entered by the patient is valid.

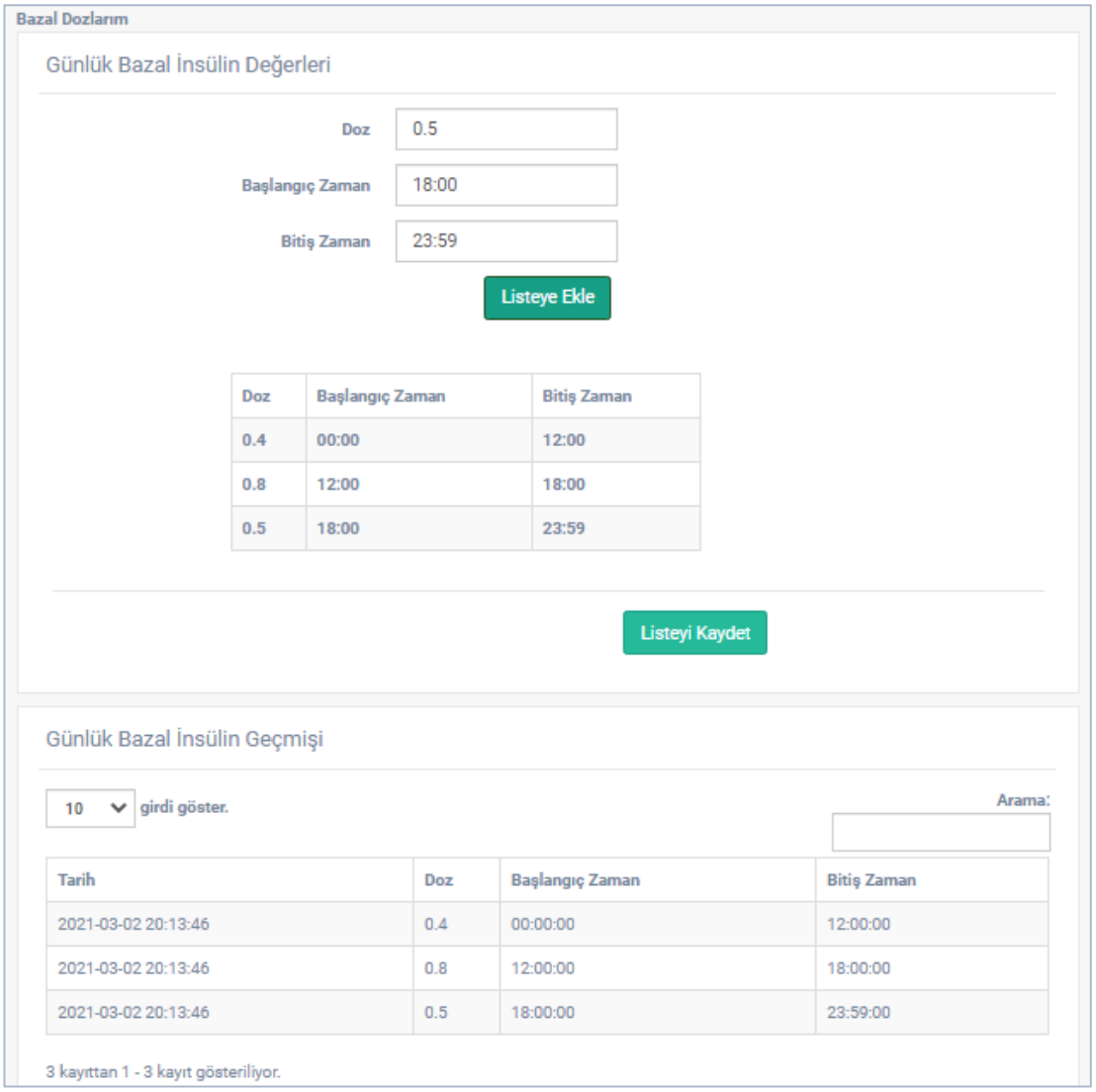


Figure 3.42: “Bazal Dozlarım” page

The “Bazal Dozlarım” page is used to store the list of basal insulins used in insulin pump of a patient and it contsists of two fields that are a form and a table as shown in Figure 3.42. The form in this page contains three fields that are “Doz” to enter the dose

of basal insulin, “Başlangıç Zamanı” to enter the time that the specified insulin dose will be started to use and “Bitiş Zamanı” to enter the time that the specified insulin dose will end. The patients can enter the dose, the start and the end time of a basal insulin to create a list of basal insulin doses. When “Listeye Ekle” button is clicked, the entered values are transferred to the list under “Listeye Ekle” button. Clicking “Listeyi Kaydet” button saves the basal insulin doses list. The saved basal insulin list are displayed in the table at the bottom of the page. The patients are able to create multiple list of basal insulin doses, however the latest list entered by the patient is valid.

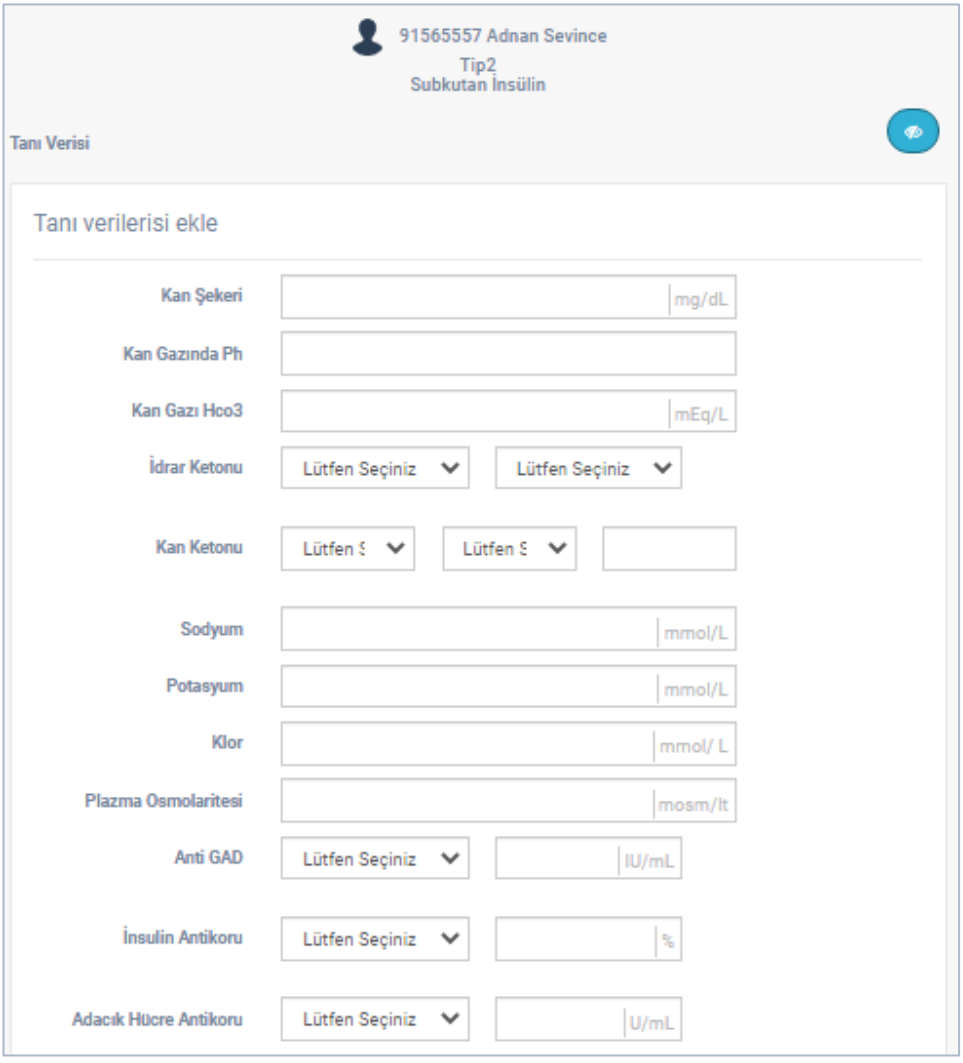


Figure 3.43: “Tanı Verisi” page form 1st piece

Figure 3.44: “Tanı Verisi” page form 2nd piece

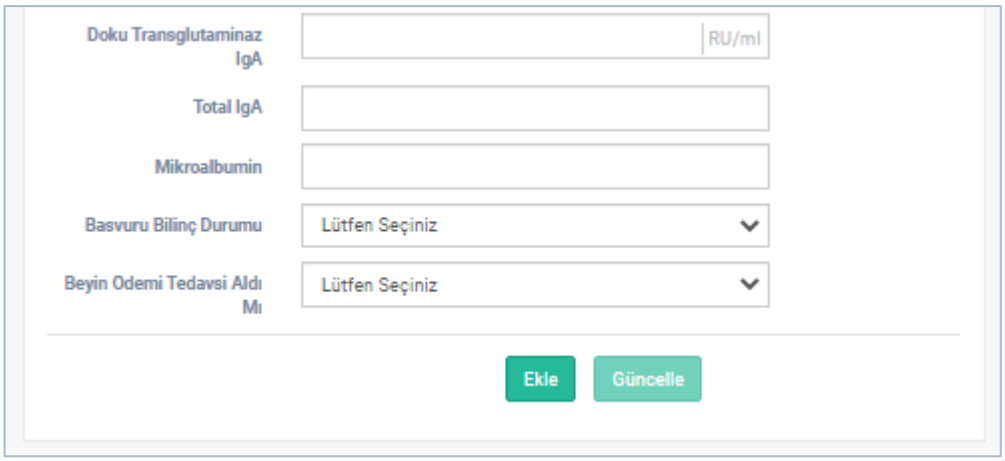
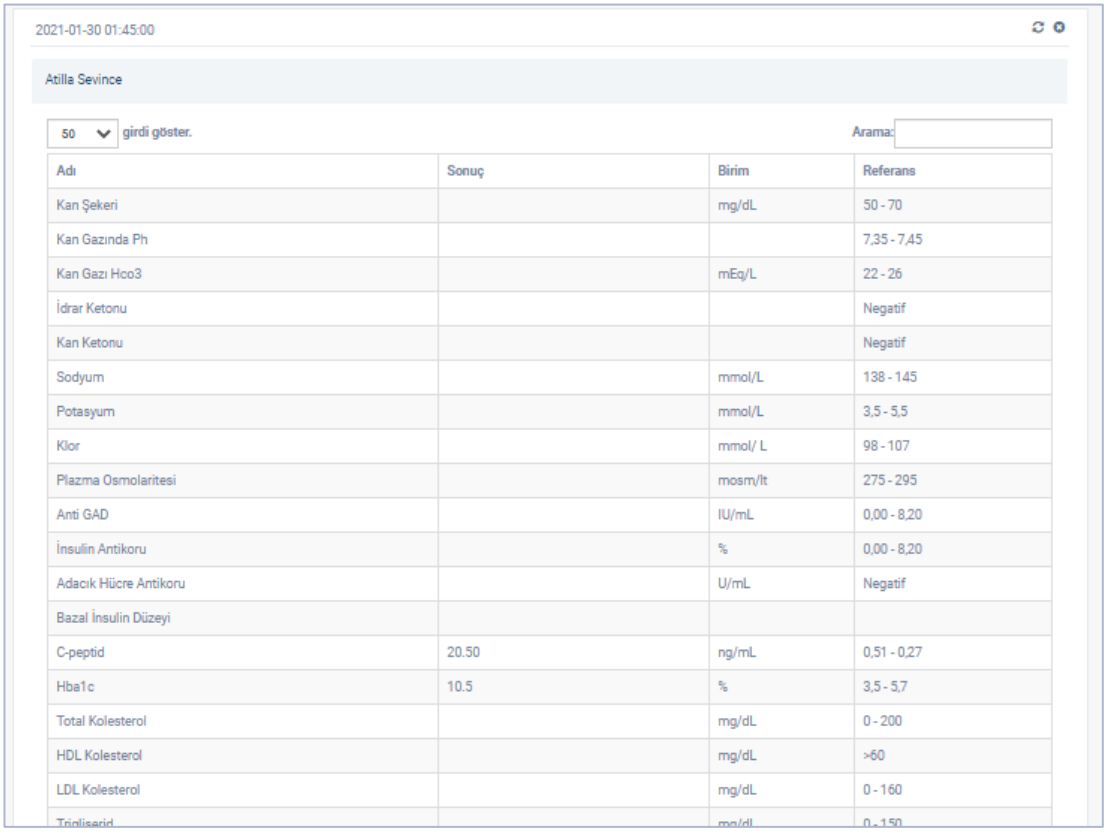


Figure 3.45: "Tanı Verisi" page form 3rd piece

Figure 3.43, Figure 3.44 and Figure 3.45 show "Tanı Verisi" diagnostic data form of "Tanı Verisi" diagnostic data page. The page is opened by clicking on "Tanı Verileri" diagnostic data item from the patient portal menu items. The page consists of two parts that are "Tanı verisi ekle" form and data blocks showing diagnostic data in which diagnostic data are sorted from present to past. This page is the area where the patient's diagnosis data is created. In this form, "Başvuru Bilinç Durumu" field is the application state of the consciousness list. The list values are "Bilinç açık koopere", "Uykuya meyilli" and "Kapalı". The other field is the "Beyin Ödemi Tedavisi Aldı Mı" field that contains the list of brain edema treatment conditions. This field has "Evet" and "Hayır" values. Other fields in the form are the tests that were determined from the "Sayfaya Tanımla" page in the management portal. Since they are not fixed form fields, they may differ. They are called as test forms. "Başvuru Bilinç Durumu" and "Beyin Ödemi Tedavisi Aldı Mı" fields are entered as test form. There is "Ekle" button to add the data shown in Figure 3.45 at the end of the form, and "Güncelle" button to update the data. If data is not added, an appropriate message is displayed. If data is added, a new data block is created on the page. The date that the data is added at the top of the block and the name of the doctor who added the data is displayed on

the block. Clicking on the doctor's name on the block displays the table containing the diagnostic data results. This table is shown in Figure 3.47. These blocks are created whenever diagnostic data is added and sorted from present to past. If the user who displays the page is the user who added the data, “ ”-update and “ ”-delete buttons are visible and usable for this user. “Patients” and “Other Doctors” cannot display the form on this page and cannot add data to the form. They can only display data blocks. “Diabetes Doctors” can both add data to the form and display data blocks.

Figure 3.46: “Tanı Verisi” page’s value block



Adı	Sonuç	Birim	Referans
Kan Şekeri		mg/dL	50 - 70
Kan Gazında Ph			7,35 - 7,45
Kan Gazı Hco3		mEq/L	22 - 26
İdrar Ketonu			Negatif
Kan Ketonu			Negatif
Sodyum		mmol/L	138 - 145
Potasyum		mmol/L	3,5 - 5,5
Klor		mmol/ L	98 - 107
Plazma Osmolaritesi		mosm/lt	275 - 295
Anti GAD		IU/mL	0,00 - 8,20
İnsulin Antikoru		%	0,00 - 8,20
Adacık Hücre Antikoru		U/mL	Negatif
Bazal İnsulin Düzeyi			
C-peptid	20.50	ng/mL	0,51 - 0,27
Hba1c	10.5	%	3,5 - 5,7
Total Kolesterol		mg/dL	0 - 200
HDL Kolesterol		mg/dL	>60
LDL Kolesterol		mg/dL	0 - 160
Trigliserid		mg/dL	0 - 150

Figure 3.47: “Tanı Verisi” page’s table of block value

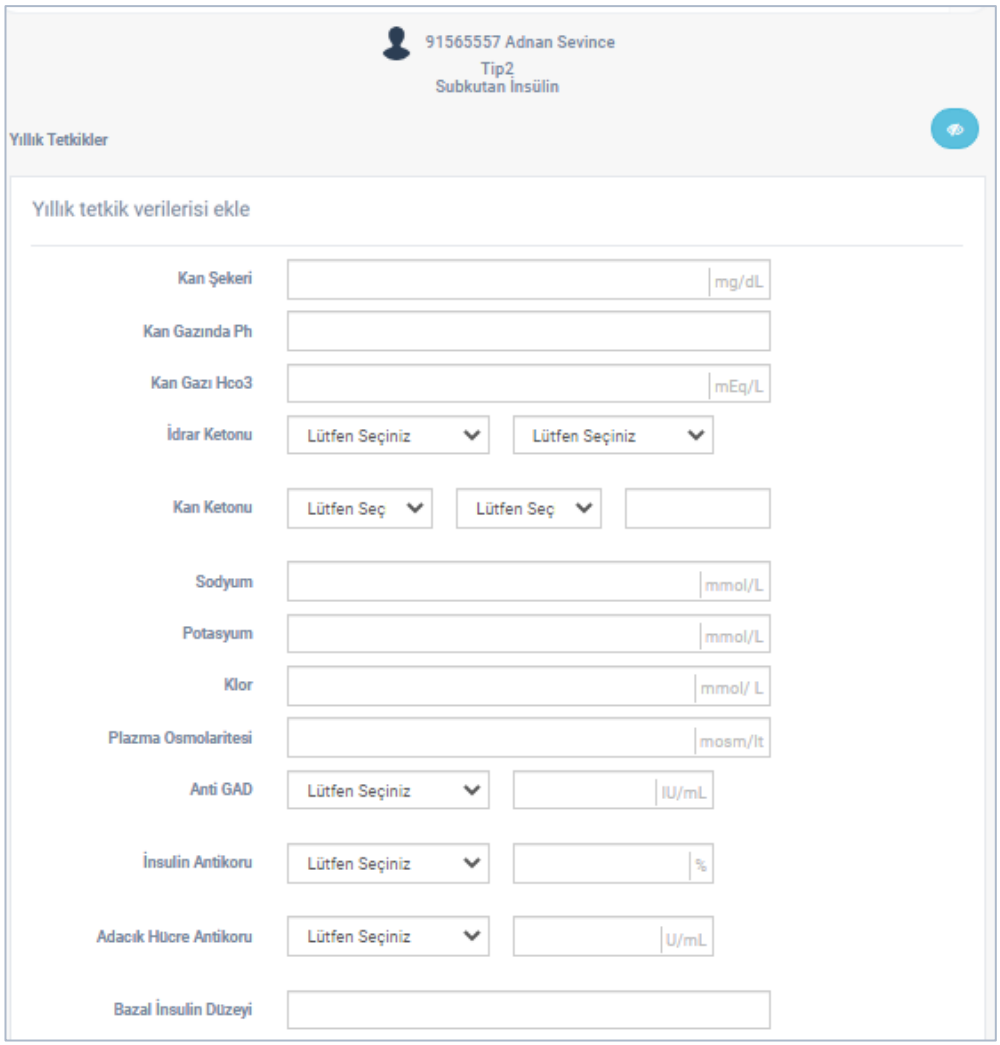


Figure 3.48: "Yıllık Tetkikler" page form 1st piece

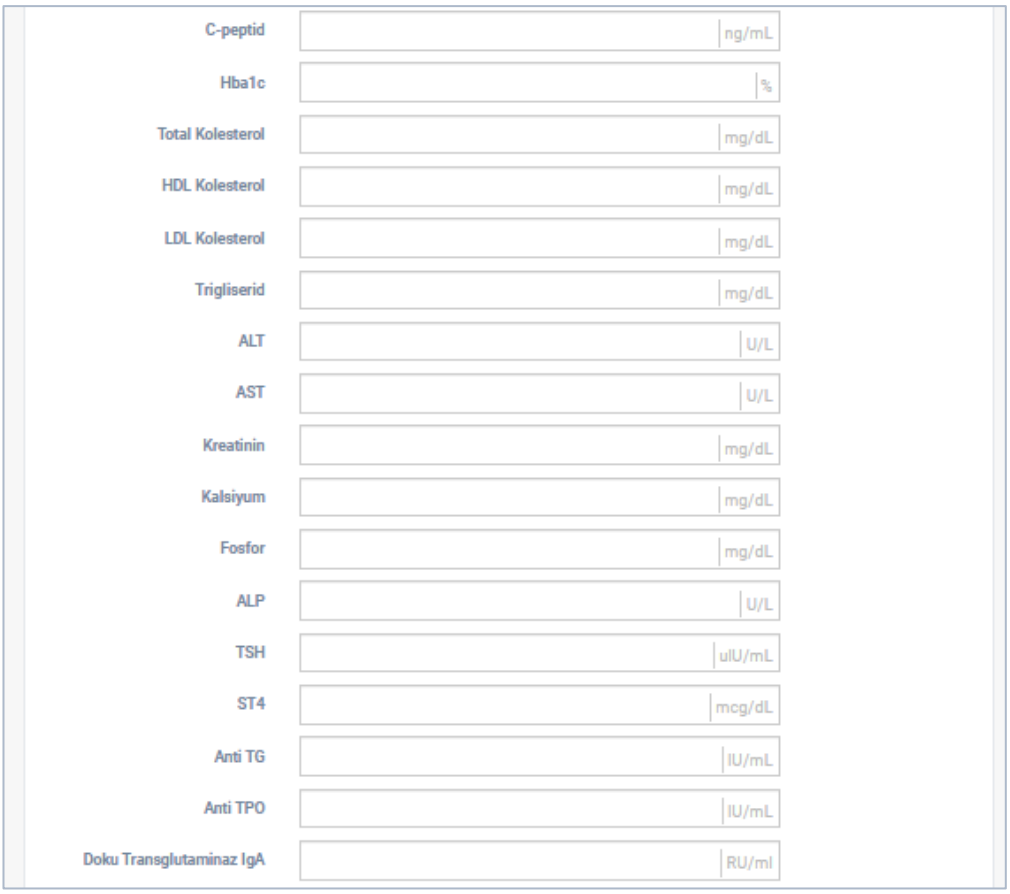


Figure 3.49: “Yıllık Tetkikler” page form 2nd piece

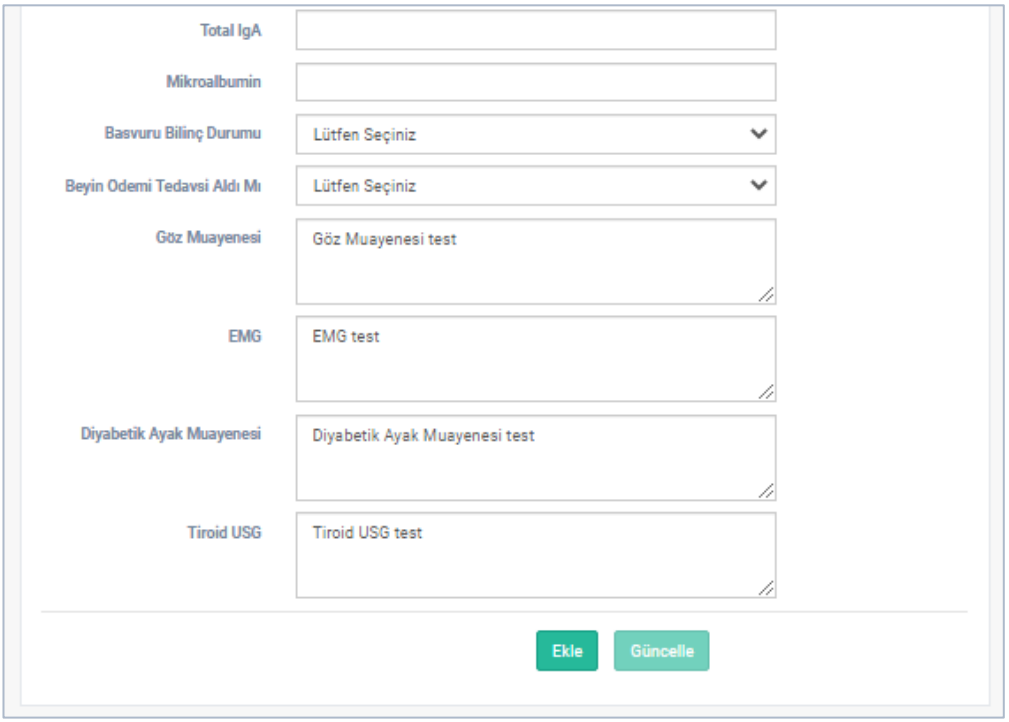


Figure 3.50: “Yıllık Tetkikler” page form 3rd piece

Figure 3.48, Figure 3.49 and Figure 3.50 show “Yıllık Tetkikler” page. This page is opened by clicking “Yıllık Tetkikler” item from the patient portal menu. This page is the page where the annual tests of the patient are kept. The page consists of two parts that are “Yıllık tetkik verisi ekle” form and data blocks showing yearly examination data in which yearly examinations are sorted from present to past. This form has same manner with “Tanı Verisi” page. The form has diagnostic data, “Başvuru Bilinç Durumu”, “Beyin Ödemi Tedavisi Aldı Mı”, “Göz muayenesi”, “EMG”, “Diyabetik Ayak Muayenesi” and “Tiroid USG” fields. Diagnostic data, “Başvuru Bilinç Durumu”, “Beyin Ödemi Tedavisi Aldı Mı” fields are same as in diagnostic data form. In addition to these, eye examination notes are entered into “Göz muayenesi” field, electromyography notes are entered into "EMG" field, diabetic foot examination notes entered into “Diyabetik Ayak Muayenesi” field and thyroid notes are entered into "Tiroid USG" field. There is “Ekle” button to add the data shown in Figure 3.49 at the end of the form, and “Güncelle” button to update the data. If data is not added, an appropriate message is displayed. If data is added, annual tests block is created on the page. This block has the same logic as the block on “Tanı Verisi” page. The block is shown in Figure 3.51. Each time annual tests are added, a new block is added to the page. The block structure is the same as the block structure on “Tanı Verisi” page, and the blocks are sorted from the present to the past in the same way. When the name of the doctor in the block is clicked, the table containing the annual examination results appears. This table is shown in Figure 3.52. “Patients” and “Other Doctors” cannot display the form on this page and cannot add data to the form. They can only see the data blocks. “Diabetes Doctors” can both add data to the form and display data blocks.

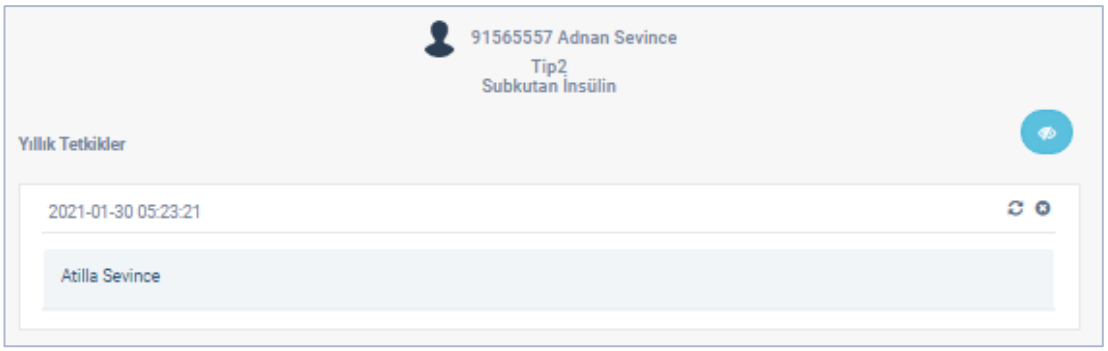


Figure 3.51: “Yıllık Tetkikler” block data

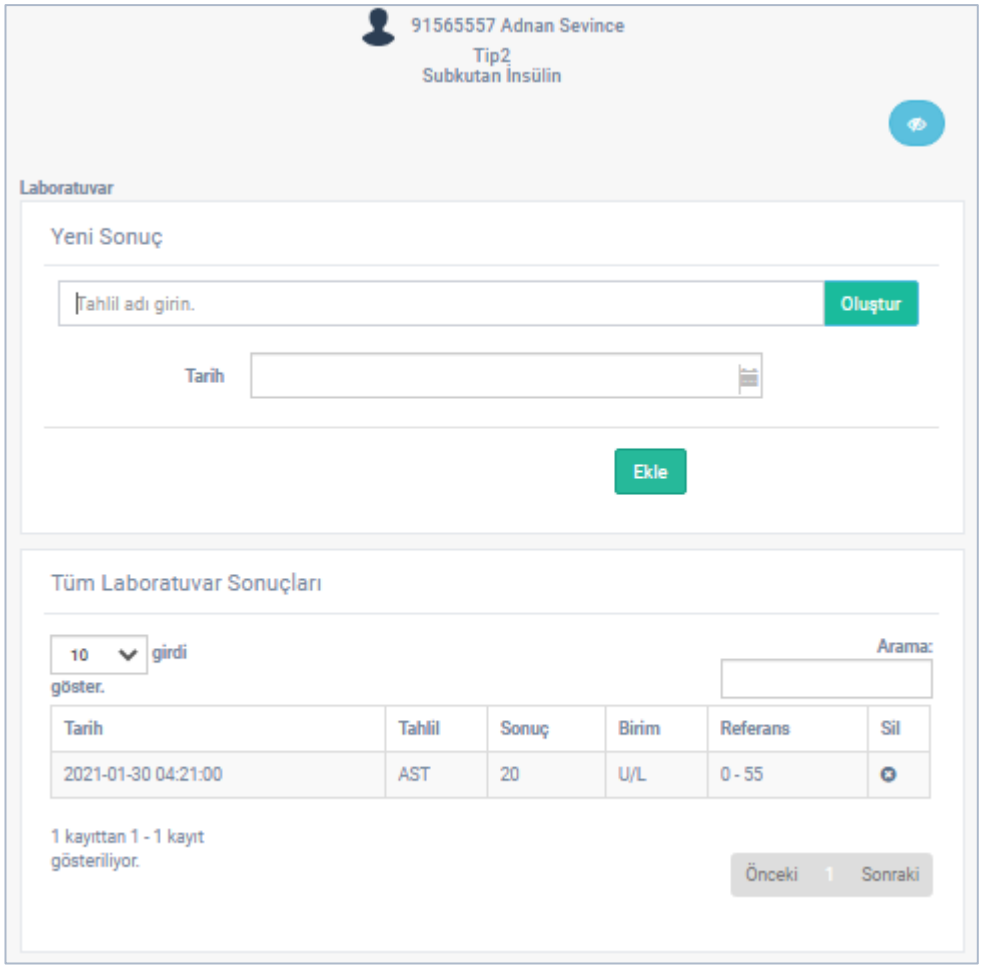


Figure 3.52: “Laboratuvar” page

Figure 3.52 shows “Laboratuvar” page of system. This page is opened by clicking on “Labotuvar” item from the patient portal menu items. This page has two parts which are “Laboratuvar” form and “Tüm Laboratuvar Sonuçları” table. This page is the page where test data can be entered, and all test data can be displayed independently from

other pages. A new test result can be added from “Yeni Sonuç” form and all test results are displayed in “Tüm Laboratuvar” table. A few characters of the name of the test to be added are entered into “Tahlil adı girin.” field on the form on the page, and a test list appears just below this field. This page is given in Figure 3.53. The test to be added is selected from this list and “Oluştur” button is clicked. The test form that was defined in the system is added to “Yeni Sonuç” form. As many test forms as desired, one for the same test at a time, can be added in this way as shown in Figure 3.54. If there is a test form added mistakenly, it can be removed with “×” button on the left of the test form. The added test forms fields are filled. Along with these, date data of the test results are entered into “Tarih” field in the “Yeni Sonuç” form. To save the results, “Ekle” button is clicked. Results are added to “Tüm Laboratuvar Sonuçları” table. This table is shown in Figure 3.55. “Diabetes Doctors”, "Patients" and “Other Doctors” can add new data using this page and all these users can only delete the laboratory data they have added.

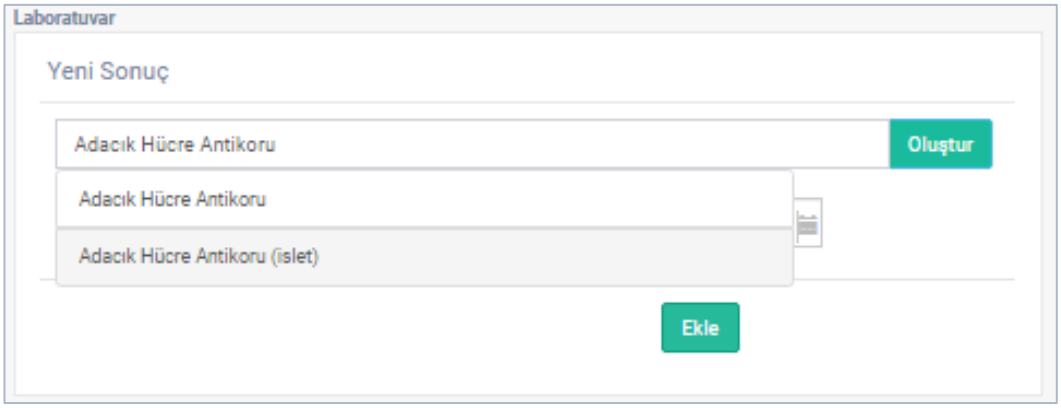


Figure 3.53: “Laboratuvar” page’s “Yeni Sonuç” Form Test List

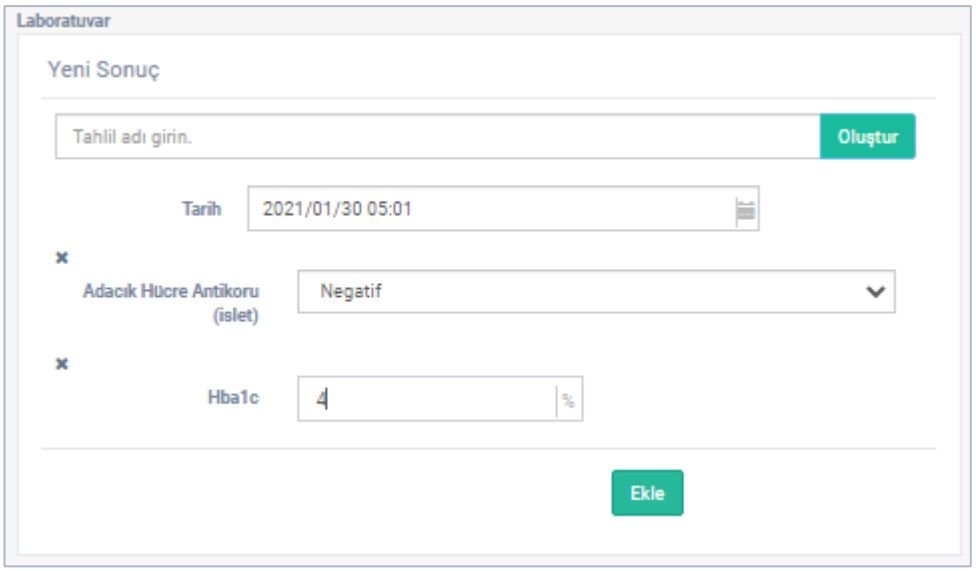


Figure 3.54: “Laboratuvar” page’s “Yeni Sonuç” Form

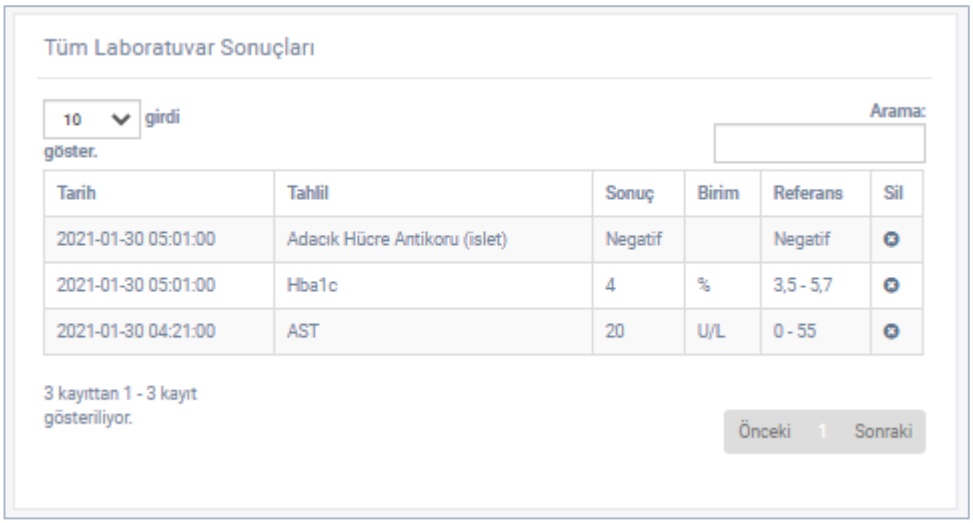


Figure 3.55: “Laboratory” page’s “Tüm Laboratuvar Sonuçları” Table

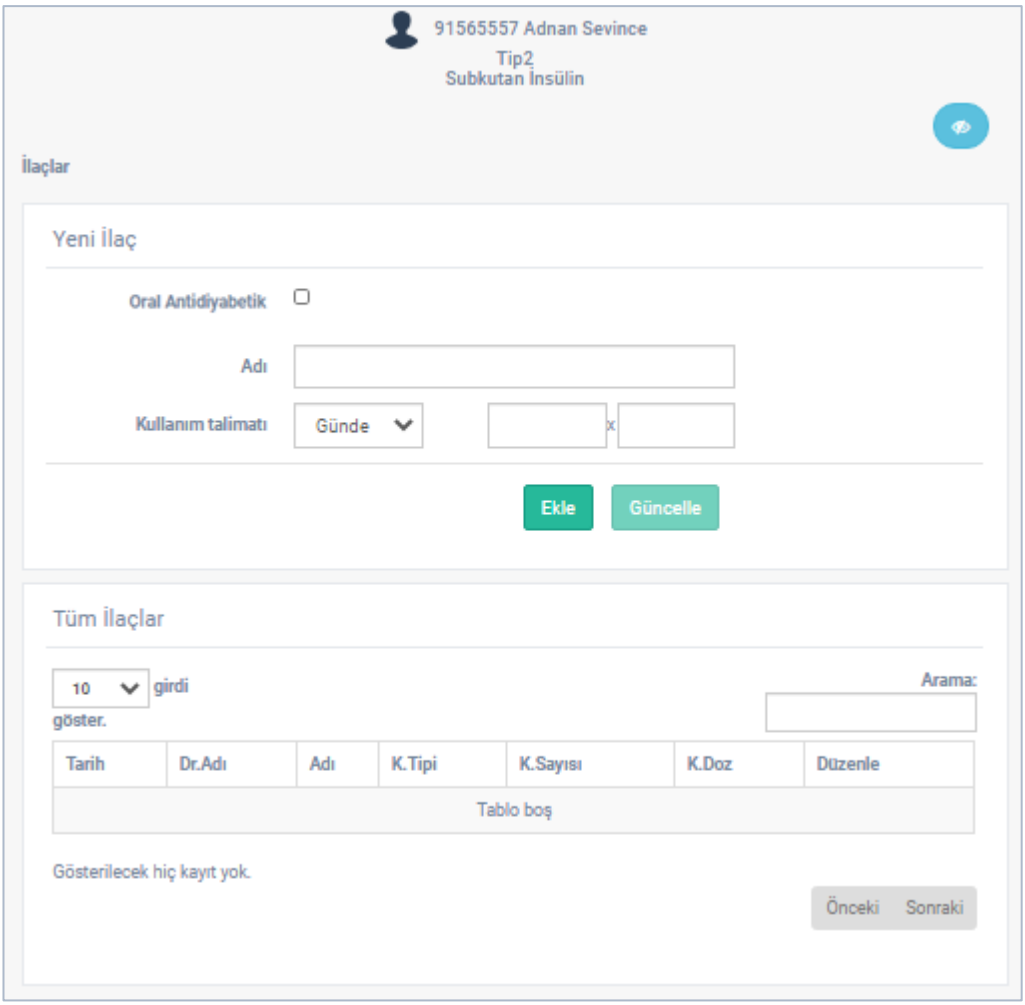


Figure 3.56: “İlaçlar” Page

Figure 3.56 shows “İlaçlar” page of the system. This page is opened from “İlaçlar” item under the patient portal menu’s “Tedavi” item. This page consists of two parts which are “Yeni İlaç” form and “Tüm İlaçlar” table. A new medicine can be added from “Yeni İlaç” form for patient. This form contains “Oral Antidiyabetik” checkbox component, “Adı” field for medicine name and “Kullanım Talimatı” field to enter medicine usage instructions. If “Oral Antidiyabetik” checkbox is checked, it means that diabetes medication will be entered in “Adı” field as the medicine name. In this case, a few characters of the desired medicine are entered in “Adı” field, the entered characters appear in red color and the medicine list appears just below the field as shown in Figure 3.57. If the desired medicine is on the list, it is selected from the list

and the selected medicine's name is moved to "Adı" field and the medicine name appears in green color. If the medicine to be added is not on the list, it is typed directly, and the medicine name appears in red color. Three separate data are entered to "Kullanım talimatı" field. The first one is the list in which the recurrence of usage will be entered. From this list, one of the data is selected from "Günlük", "Haftalık", "Aylık" and "Yıllık". The second and third data are number of use and dose. The number of use is entered in the second field and the dose value is entered in the third field. For example, number of use of medicine is entered as "2" and dose is entered as "1" in Figure 3.58. The medicine is added by clicking to "Ekle" button. The important point here is that if "Oral Antidiyabetik" checkbox is checked and the desired medicine is not exist in the list, a request to add a medicine is sent to the "Admin" and "Super Admin". If "Oral Antidiyabetik" checkbox is not checked, this medicine is not a diabetes medicine. The medicine list is not opened and the request to add medicine is not sent to the "Admin" and "Super Admin". Medicines defined for the patient are displayed in "Tüm İlaçlar" table as shown in Figure 3.59. "Patients" and "Other Doctors" cannot display "Yeni ilaç" form on "İlaçlar" page and cannot add medicines to the form.

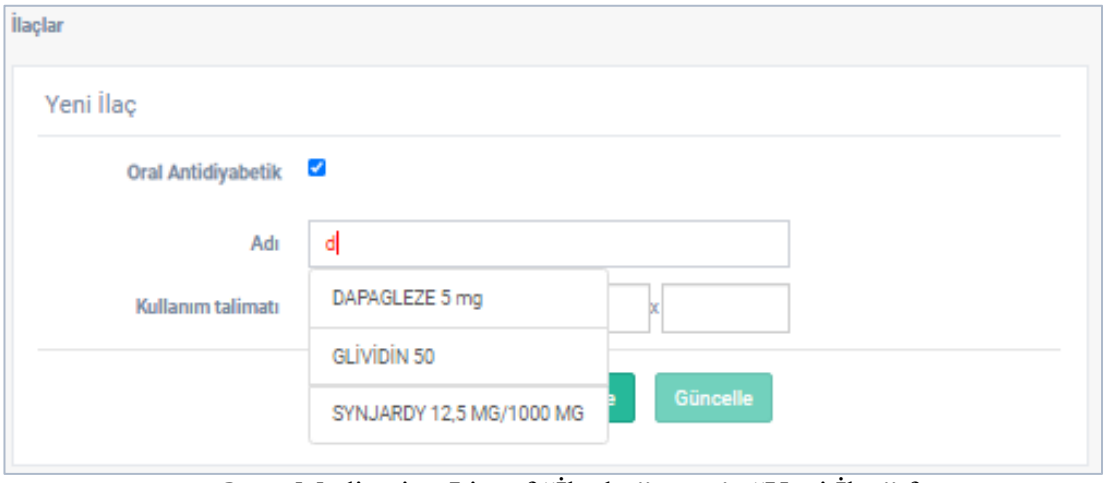


Figure 3.57: Medication List of "İlaçlar" page's "Yeni İlaç" form

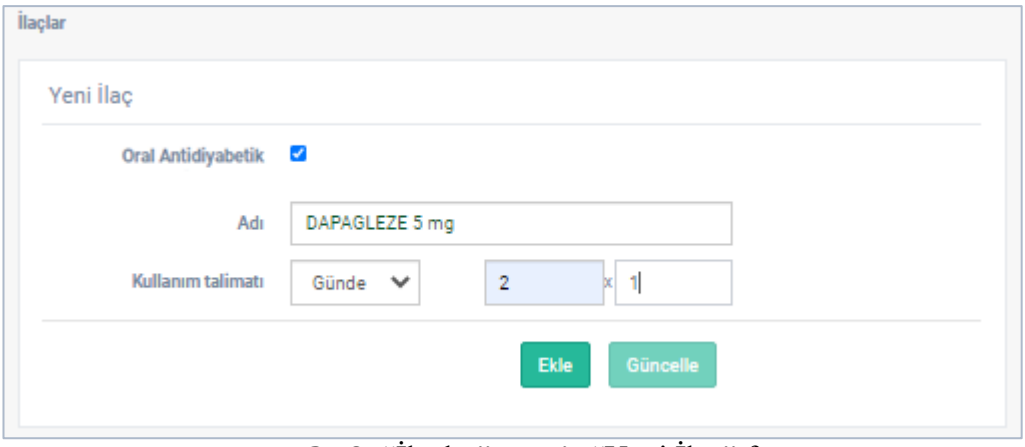


Figure 3.58: "İlaçlar" page's "Yeni İlaç" form

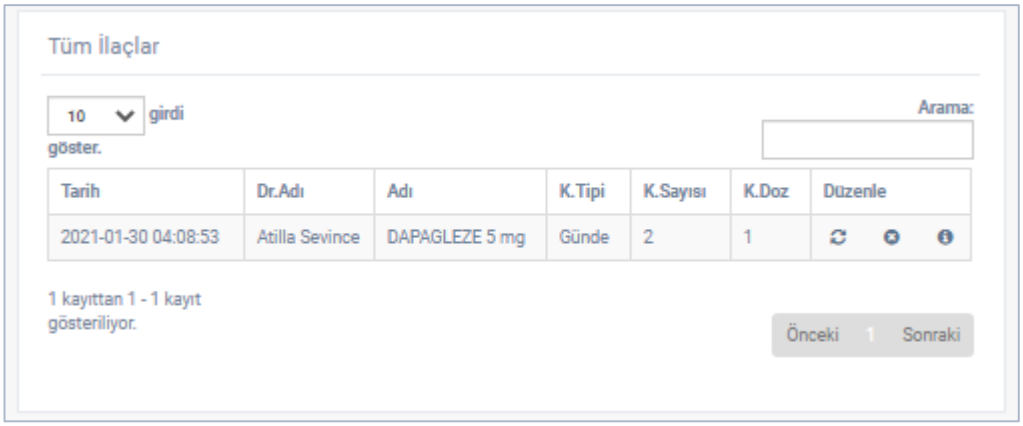


Figure 3.59: "İlaçlar" page's "Tüm İlaçlar" table

Figure 3.59 shows the "Tüm İlaçlar" table that is displayed for the doctors and Figure 3.60 shows "Tüm İlaçlar" table that is displayed for the patients. " " button that is placed in each medicine row in the table, displays the usage information of the medicine. This information contains when to start using the medication, how many times the medication was used and the date and time of the medication is used for a period as shown in Figure 3.62. This page can be displayed by all the users who use the patient portal.

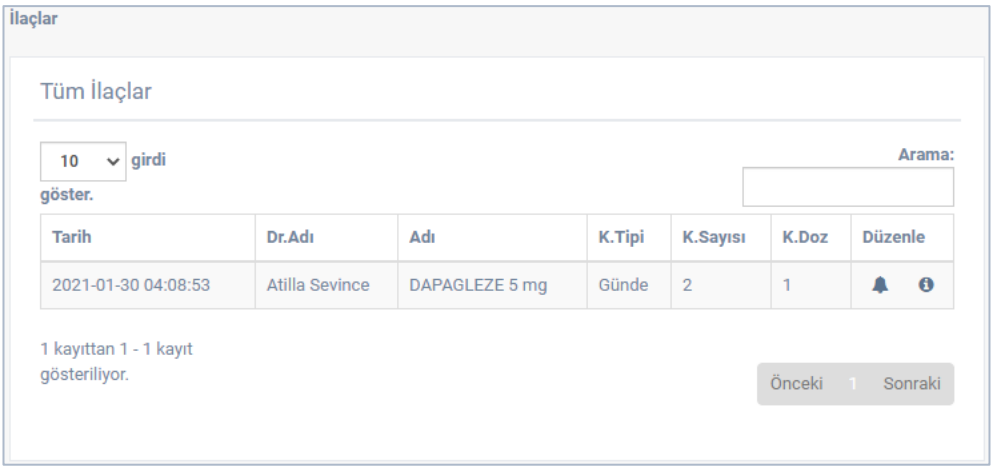


Figure 3.60: "İlaçlar" page's "Tüm İlaçlar" table for patient

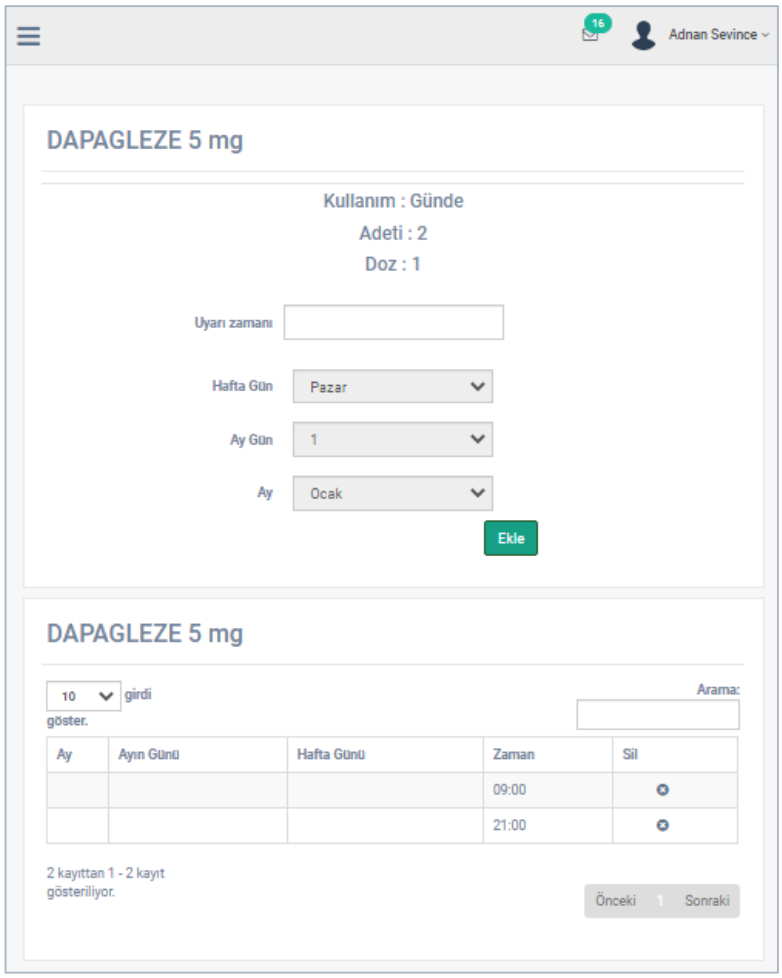


Figure 3.61: "Alarm" page

The patients can see his/her medications in "İlaçlar" page that is shown in Figure 3.60.

The patients can set an alarm for the medications by clicking "🔔" button which is

placed in the last column of each medication row of the medications table on this page. "🔔" button of a medication redirects to "Alarm" page that is shown in Figure 3.61 for a considering medication. This page consists of two parts which are a form to set a new alarm and a table to list the set alarms for the considering medication. There are four fields in the form that placed on this page. The first field "Uyarı zamanı" is used to select the time for the alarm; the second field "Hafta Gün" is used to select the day of a week from the days Sunday to Monday; the third field "Ay Gün" is used to select the day of a month between 1 to 31; and the last field is used to select the month among twelve months from January to December. Each medication has different usage periods such that daily, weekly, monthly, and yearly. For that reason, setting a medication alarm based on time only might not be fully correct. For the medications that their usage periods are daily base, time alarms would be set. Similarly, for week base usages the weekday and time alarm, for month base usages the day of the month and time alarm, for year base usages month, the day of the month and time alarms would be appropriate to set. The fields in the alarm form are set as active or passive programmatically according to the selected periods. For the alarms of medications that their usage period is daily, the time field which is "Uyarı Zamanı" is set as active only. Similarly, for weekly alarms the day of the week and time fields which are "Hafta Gün" and "Uyarı Zamanı", for monthly alarms the day of the month and time fields which are "Ay Gün" and "Uyarı Zamanı" and finally for yearly alarms the month, the day of the month and the time fields which are "Ay", "Ay Gün" and "Uyarı Zamanı" are set as active. As an example, for a medication its usage period is monthly base, the day of the month and the time can be selected. In this way, an alarm is set for the chosen day of each month at the selected time. All the set alarms can be seen in the table in "Alarm" page.

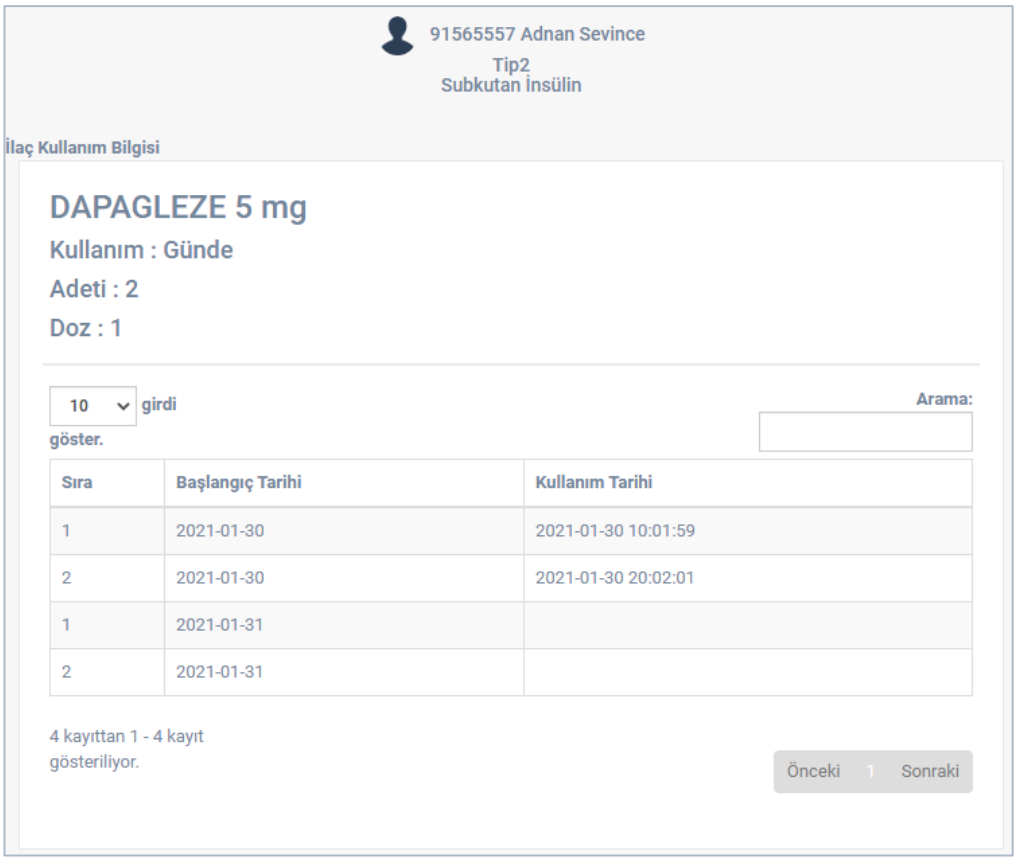


Figure 3.62: “İlaç Kullanım Bilgisi” page

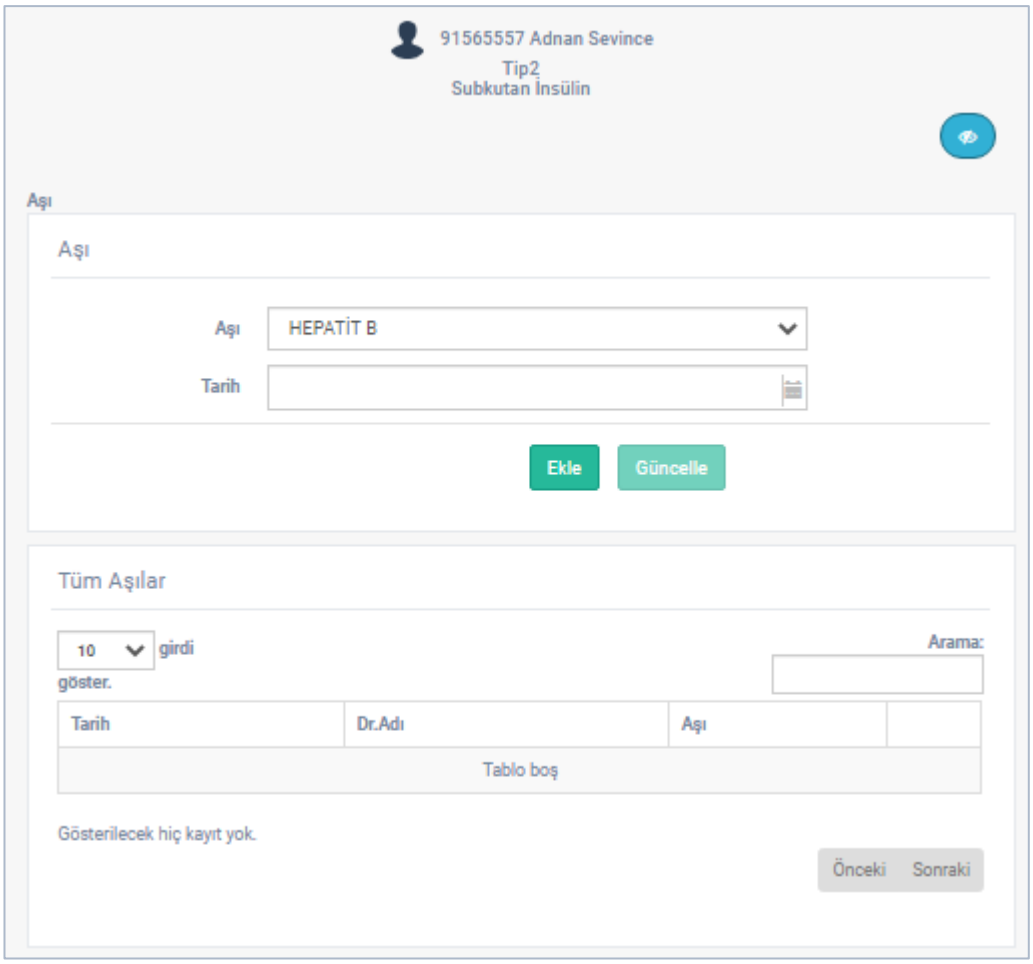


Figure 3.63: “Aşı” page

Figure 3.63 shows “Aşı” page. This page is the page where the vaccines given to the patient are described and displayed. “Aşı” page is opened by clicking on “Aşılar” item from the patient portal menu items. The page consists of two parts that are “Aşı” form and “Tüm Aşılar” table. “Aşı” form has two fields. In “Aşı” field of “Aşı” form, vaccine list is displayed and in “Tarih” field of “Aşı” form, the date of the given vaccine is kept. Vaccine list items are “HEPATİT B”, "BCG", “Beşli karma aşı”, “Pnömokok”, “KKK”, “Dörtlü karma aşı”, “Çocuk Felci”, “Difteri-Tetanoz”, “HEPATİT A” and “Su Çiçeği”. The vaccine is selected from the vaccine list and the date of the vaccine given is entered in the date field. Then, “Ekle” button is clicked to save the vaccine. Added vaccines are shown in “Tüm Aşılar” table. Only “Diabetes Doctors” can add the vaccine data to this page and they can display all vaccines added

for the patient from “Tüm Aşılar” table. “Patients” and “Other Doctors” can only display “Tüm Aşılar” table.

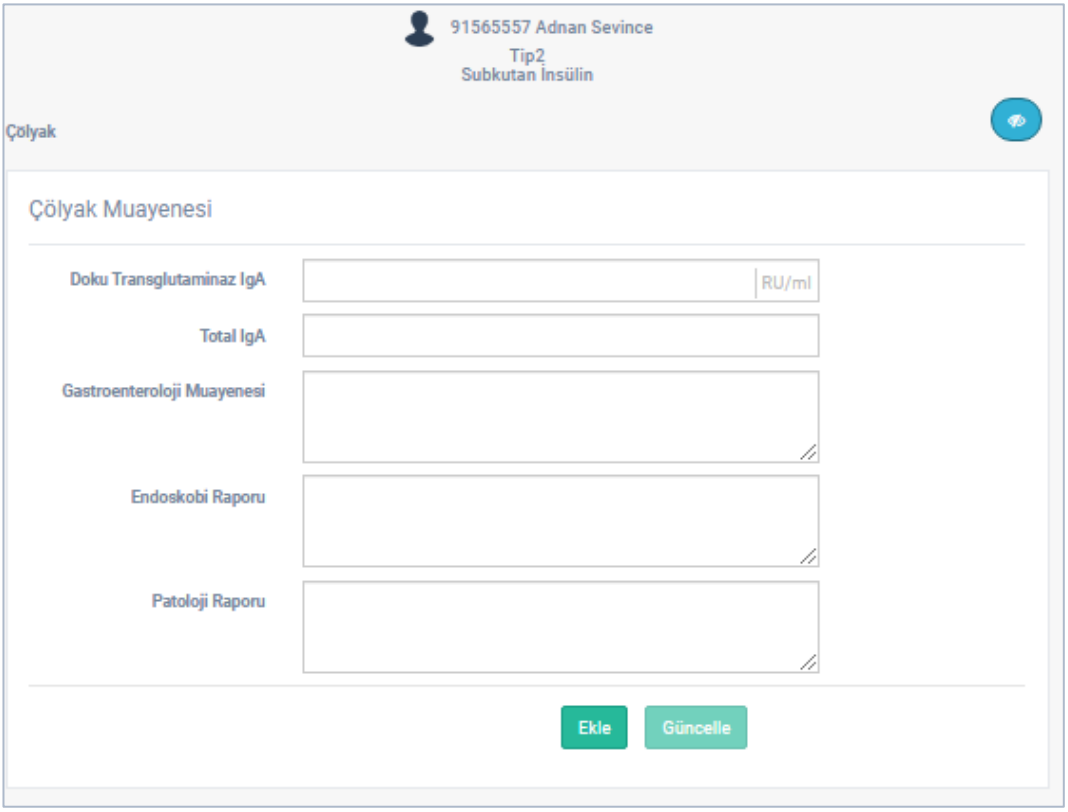


Figure 3.64: “Çölyak” page form

Figure 3.64 shows “Çölyak Muayenesi” form. This page is opened by clicking “Çölyak Hastalığı” sub-menu item under the “Eşlikeden Hastalıklar” item from the patient portal menu. “Çölyak” page keeps the data of the patient's celiac disease, if any. The page consists of two parts, that are “Çölyak Muayenesi” form and data blocks showing celiac examination data in which celiac examimations data are sorted from present to past. This form is for keeping the gastroenterology examination notes in “Gastroenteroloji Muayenesi” field, endoscopy reports in “Endoskopi Raporu” field, and pathology reports in “Patoloji Raporu” field. The required data is filled in these fields and “Ekle” button is clicked to add. The block of the added data is shown in Figure 3.65. The date added in this block and the name of the doctor who added it are

displayed on the block and the block consists of four separate fields. These fields are as the following; “Laboratuvar” shows data of defined tests, “Gastroenteroloji Muayenesi” shows gastroenterology examination notes, “Endoskopi Raporu” shows endoscopy report notes and “Patoloji Raporu” field shows pathology report notes. Clicking on the block with the data to be displayed and the relevant field opens. “Diabetes Doctors” can display “Çölyak Muayenesi” form and all celiac examination data blocks and fields. “Patients” and “Other Doctors” can only display “Laboratuvar” field of these blocks. Since displaying other blocks may cause anxiety in patients, these blocks are restricted.

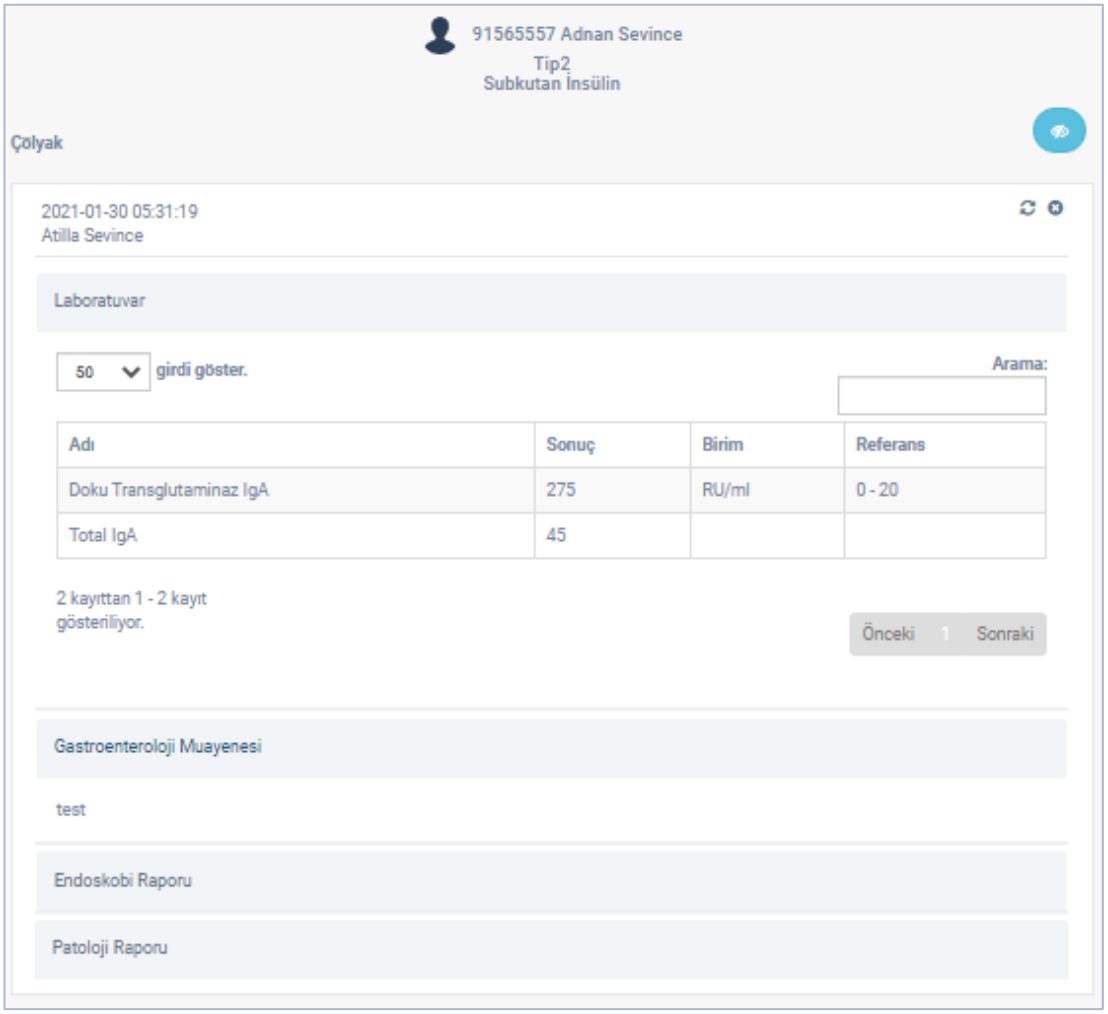


Figure 3.65: “Çölyak” page’s data block

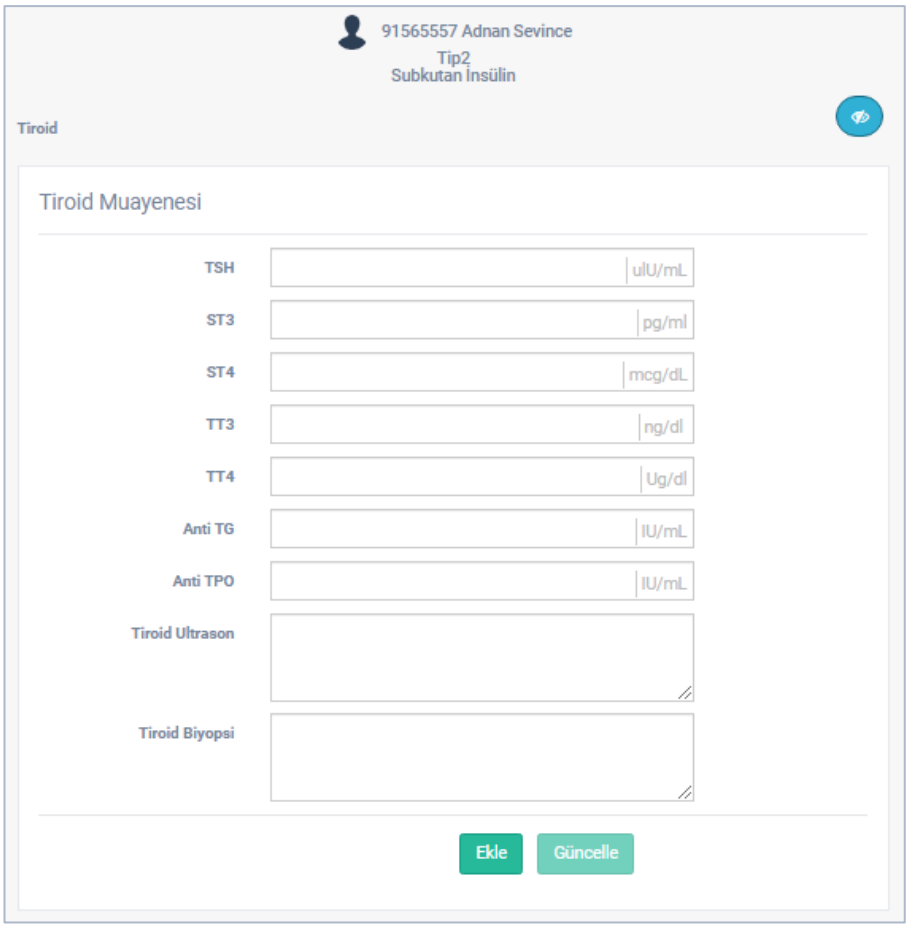


Figure 3.66: “Tiroid” page

Figure 3.66 shows “Tiroid” page. “Tiroid Hastalıkları” sub-menu item under the “Eşlikeden Hastalıklar” from patient portal menu opens “Tiroid” page. “Tiroid” page keeps data about the patient's thyroid disease, if any. The page consists of two sections, “Tiroid Muayenesi” form and data blocks showing thyroid examination data, in which the thyroid examination data are listed from present to past. The form is for keeping thyroid biopsy note data in “Tiroid Biyopsi” field and thyroid ultrasound note in “Tiroid Ultrason” field together with the tests defined for this page from the management panel. The data to be added is filled in and “Ekle” button is clicked to save. The block of the saved data is shown in Figure 3.67. In these blocks, the date that data added and the doctor's name who added the data are displayed above the block. The block consists of three separate areas. In these fields, the data of the tests defined

on “Laboratuvar” page are displayed. There are ultrasound notes in “Tiroid Ultrason” field and notes about the thyroid biopsy in “Tiroid Biyopsi” field. By clicking on the desired data of the block, the relevant field is opened. “Diabetes Doctors” can use the form on this page, add data to the form, and display all blocks and fields of blocks. “Patients” and “Other Doctors” can only display “Laboratuvar” field of these blocks. Since displaying other block fields may cause anxiety in patients, patients are not allowed to display these fields.

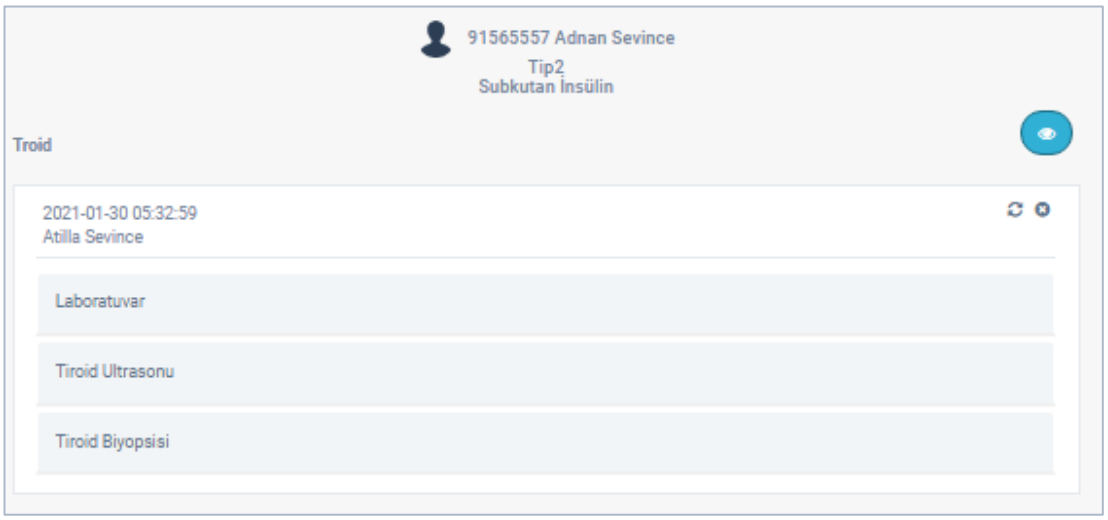


Figure 3.67: “Tiroid” page’s data block

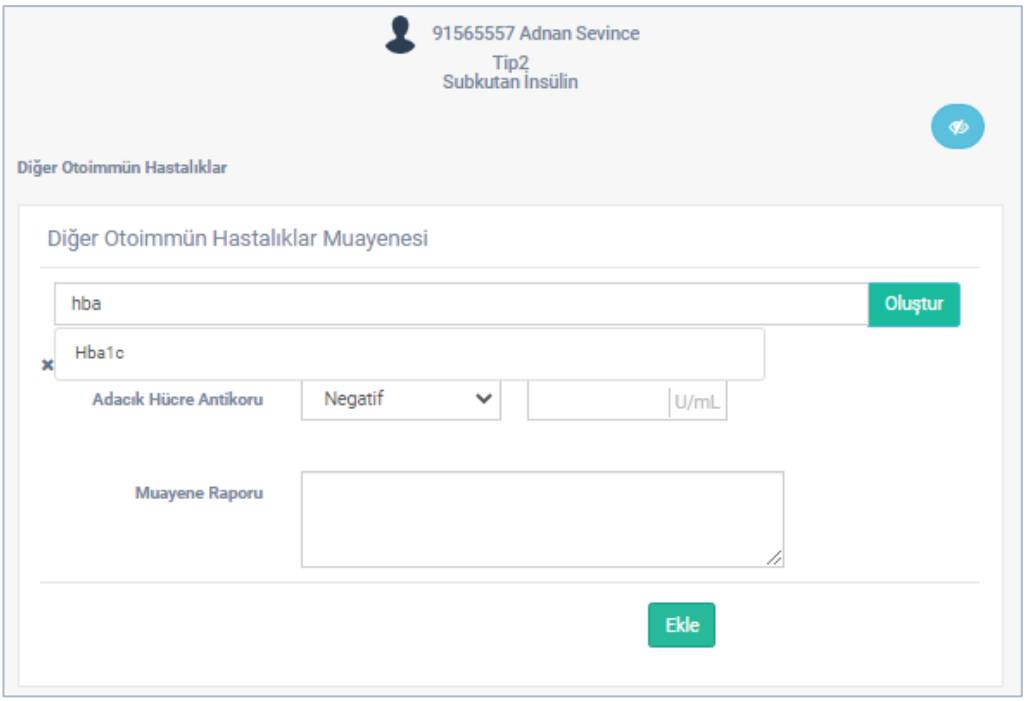


Figure 3.68: “Diğer Otoimmün Hastalıklar” page

Figure 3.68 shows “Diğer Otoimmün Hastalıklar” page. This page is opened by clicking “Diğer Otoimmün Hastalıklar” sub-menu item under the “Eşlikeden Hastalıklar” item from patient portal menu. On this page, if there is any other autoimmune disease to be registered other than thyroid and celiac disease, its record is kept. The page consists of two parts: “Diğer Otoimmün Hastalıklar Muayenesi” form and the data blocks field. In the form, there is a field for “Tahlil adı girin.” where a new test form can be added and an area for “Muayene Raporu” where an examination note can be added. A few characters of the name of the test to be added to “Tahlil adı girin.” field on the form are entered and a test list appears just below this field. This field is given in Figure 3.68. The test to be added is selected from this list and click “Oluştur” button. The test form defined in the system is added to “Diğer Otoimmün Hastalıklar Muayenesi” form. As many test forms as desired, one from the same test at a time, can be added. If there is a test form added mistakenly, it can be removed with “×” button on the left of that test form. After the added test form and “Muayene

Raporu” fields are filled “Ekle” button is clicked to save the data. Thus, a new data block is added into the data blocks field. In this block, the date that the data added and the doctor's name who added the data are displayed on the block. A data block consists of two separate fields. These are “Laboratuvar” field that contains the data of the tests added and “Muayene Raporu” field is the area that contains the examination report written during the examination as shown in Figure 3.69. Clicking on the name of the field on data blocks, displays the corresponding field’s data. Each added examination data is listed in blocks ordered from the present to the past. “Diabetes Doctors” can use the form to add data and display all data blocks and fields. “Patients” and “Other Doctors” can only display “Laboratuvar” field of data blocks.

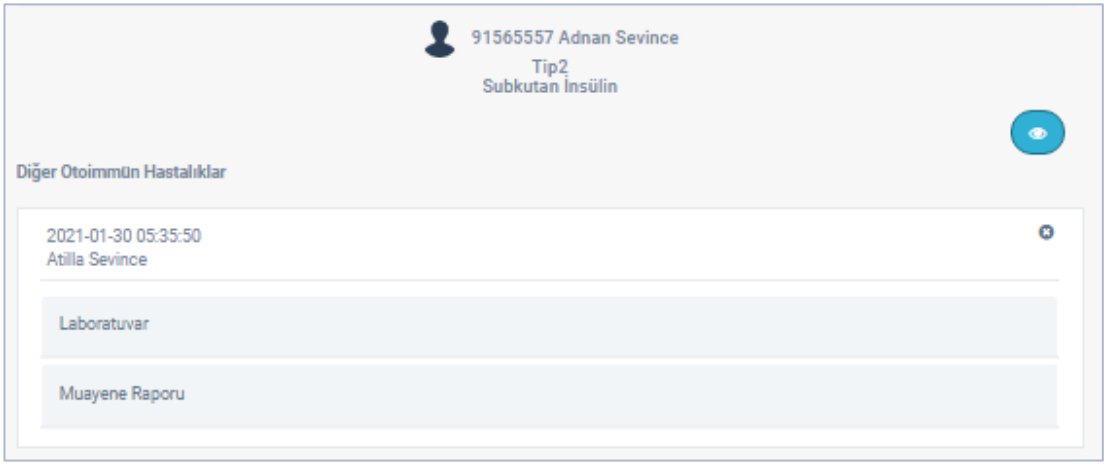


Figure 3.69: “Diğer Otoimmün Hastalıklar” page’s data block

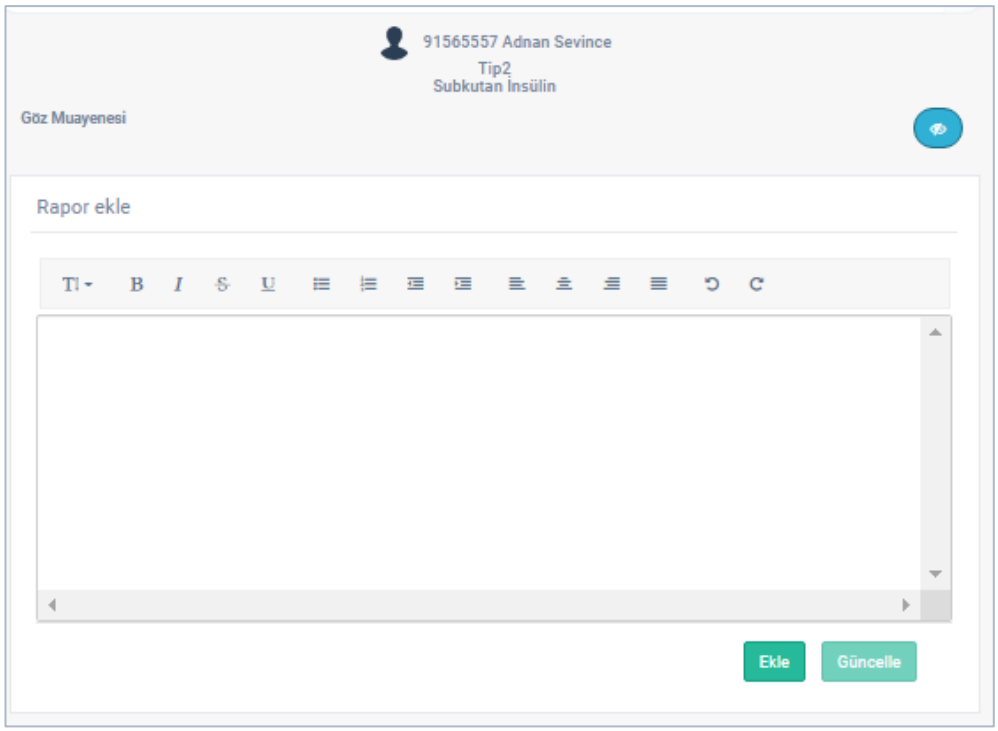


Figure 3.70: “Göz Muayenesi” page

To add a complication report for a patient, sub-menu items “Göz Muayenesi”, “Ayak Muayenesi”, “Diş Muayenesi”, “Nefroloji Muayenesi”, “Kardiyoloji Muayenesi” or “Psikoloji Muayenesi” under “Komplikasyonları” item from the patient portal menu can be selected. In Figure 3.70 shows “Göz Muayenesi” page is shown. This page is called as complications page and it is structured automatically according to the sub-menu item it is accessed from. This page is used for 7 different complication data that are “Göz Muayenesi” eye examination report, “Ayak Muayenesi” foot examination report, “Diş Muayenesi” dental examination report, “Nefroloji Muayenesi” nephrology examination report, “Kardiyoloji Muayenesi” cardiac examination report, “Psikoloji Muayenesi” psychology examination report and “Diğer Muayeneler” examination of other complications report. For example, if the page is accessed from “Göz Muayenesi” item, it will be structured as “Göz Muayenesi” page. The complications page consists of two parts, “Rapor Ekle” form for adding reports and the data blocks section where the added reports are shown. There is a text component

in the form which is on the page. Report is entered as text through that component and report data is added by clicking “Ekle” button. Blocks on this page have a single view and keep the examination report. At the top of the data blocks the date that the report was added and the name of the doctor who added the report is displayed. This block is shown in Figure 3.71.

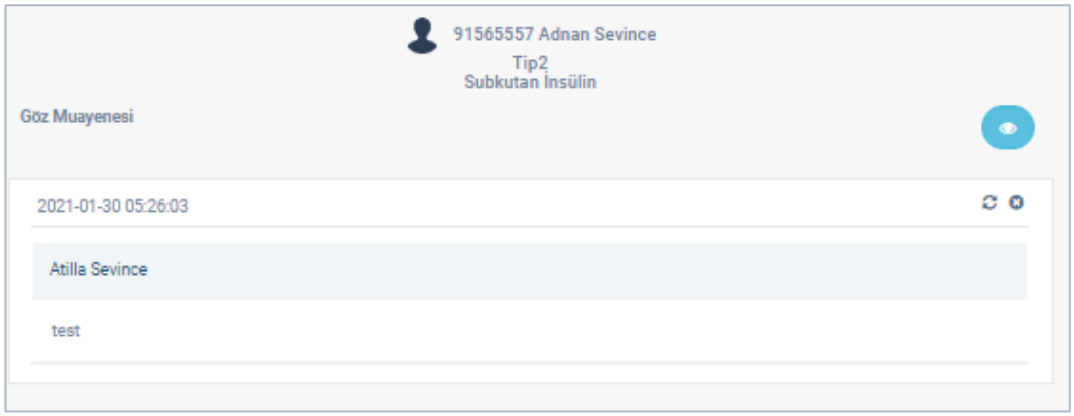


Figure 3.71: “Göz Muayenesi” page’s data block

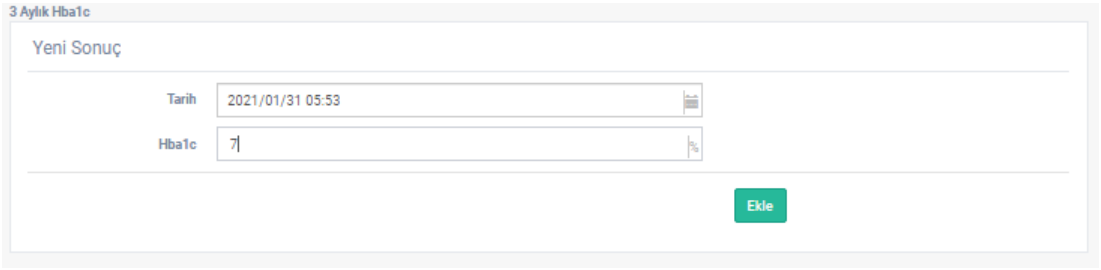


Figure 3.72: “3 Aylık HbA1c” page’s “Yeni Sonuç” form

“3 Aylık HbA1c” page is opened by clicking “3 Aylık HbA1c” item from the patient portal menu. This page is designed specifically for the patient's hemoglobin HbA1c test values. It is called HbA1c with its short name instead of hemoglobin HbA1c. This page has three parts. First part is “Yeni Sonuç” form which is used to enter a new result. The results are illustrated as a line chart in chronological order in the second part and all results are shown in tabular form in the third part. In “Yeni Sonuç” form there is a “Tarih” field to enter a result date and an HbA1c field to enter an HbA1c

result. The required values are entered in these fields and “Ekle” button is clicked to save a result. “Yeni Sonuç” form is shown in Figure 3.72. The added HbA1c results are added to “Tüm HbA1c Sonuçları” table and shown on the line chart which are shown in Figure 3.73.

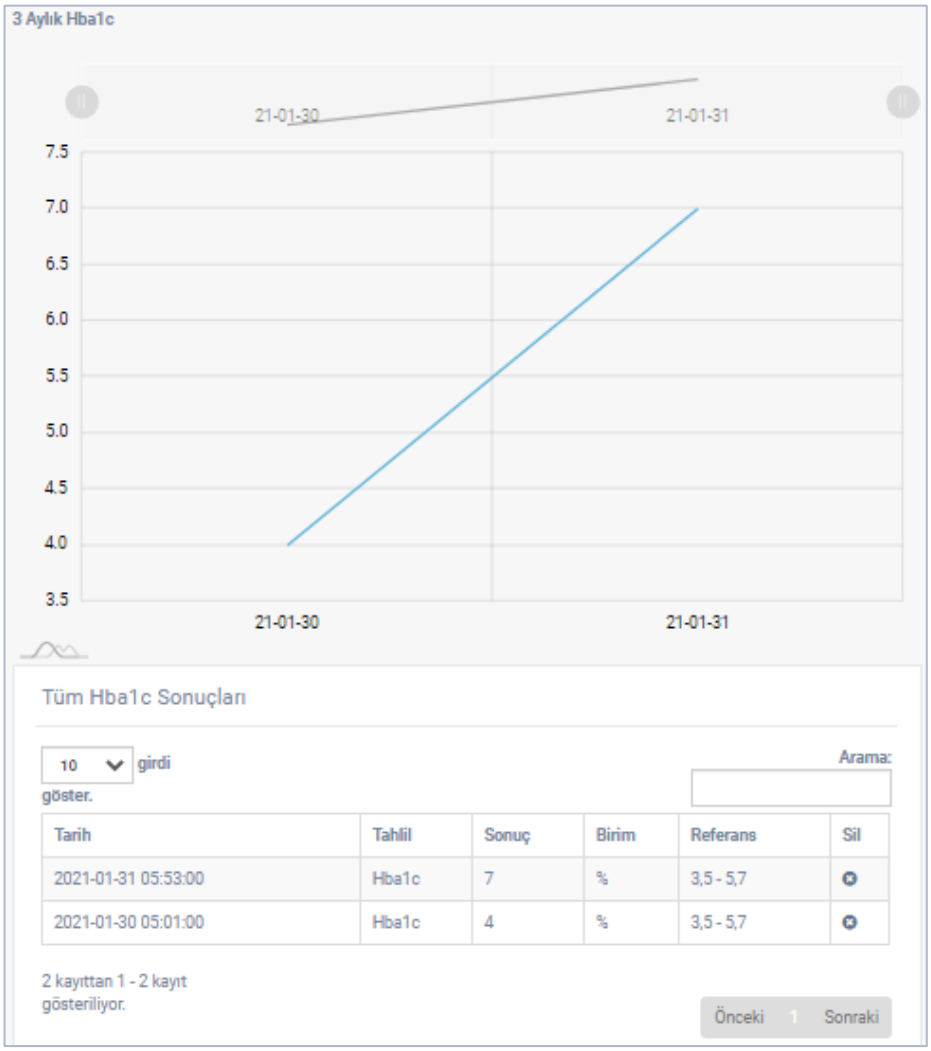


Figure 3.73: “3 Aylık HbA1c” page’s chart and table

Figure 3.74: “Muayeneler” page

Figure 3.74 shows “Muayeneler” page. The page is accessed by clicking “Muayeneler” item on the patient portal menu. In this page, all the diabetes examination data of a patient is listed as data blocks. On a data block, the examination date of the patient and the name of the doctor who added the considering data are placed. Other than that, a data block also contains 7 more fields such that “Seyir” for examination notes, “Genel Bilgiler” for general information about examination, “Puberte Muayenesi” for puberty examination details if the patient is male, “Komplikasyonlar” for the test results that are defined by admins, “Ek Testler” for the test data recorded during an examination other than standard tests, “Aşılar” for vaccines recorded during an examination, and “İlaçlar” for medications recorded during an examination. If one or more fields among these 7 fields are left empty while recording an examination data, the considering empty field(s) does not display in the data block. As shown in Figure 3.74 the fields “Aşılar” and “İlaçlar” are not exists in the data block. This shows that, when this examination data is created no data entered for the vaccines and the medications. To add an examination data, “Ekle” button is used. Clicking this button redirects to the

page “Muayene Genel Bilgiler” that contains the general examination form. This form is shown in Figure 3.75. This form contains the following fields: “Kilo” filed for body weight, “Boy” field for body height, “Seyir” field for examination report, “Lipohipertofi” field for lipohypertrophy data, “Lipoatrofi” field for lipoatrophy data, “Endoskopi raporu” field for endoscopy report, “Eklem Hareketleri” field for joint movements notes, and “Ayak Muayenesi” field for foot examination notes. “Lipohipertofi” and “Lipoatrofi” fields consist of a list and a text form items. These field’s list items contain “Var” and “Yok” values to indicate exist and not exist respectively. Their text items are for optional notes for considering field. After these fields are filled, the button “Ekle Devam Et” is clicked to save the entered data and continue to the next forms.

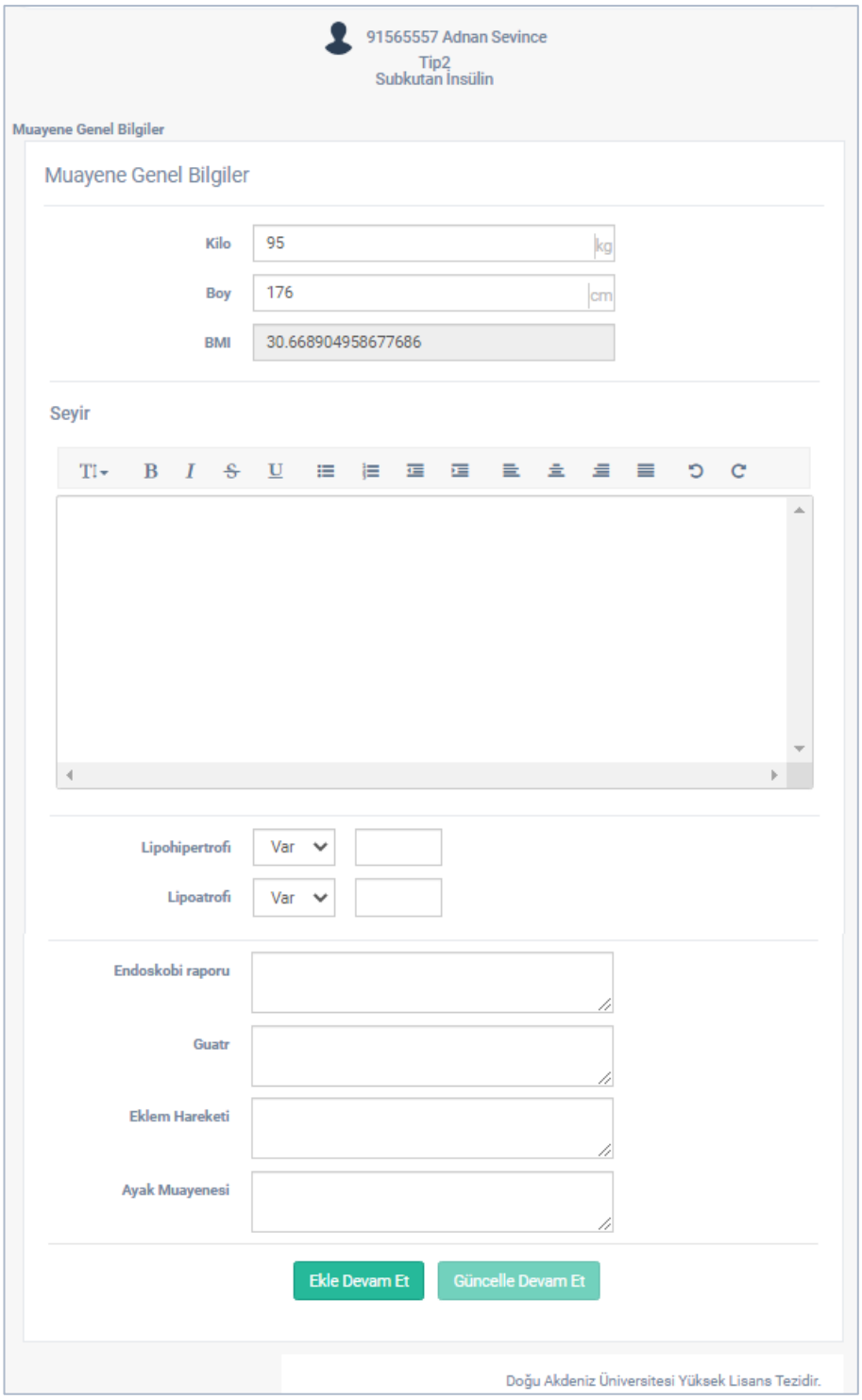


Figure 3.75: “Muayene Genel Bilgiler” form

The next page is “Puberte Muayenesi” contains a form to record puberty examination data for male patients. If the patient is female, this form skipped. The form of puberty examination is shown in Figure 3.76. This form contains a list item for tanner data named “Tanner” which contains values “1,2,3,4 and 5”, a text item for optional tanner

data note, and two text items named “Testis volum sağ” and “Testis volum sol” for left and right testicles’ volumes respectively. After these fields are filled with required information the button “Ekle Devam Et” is clicked to save the entered data and continue to next form “Komplikasyonlar” for examination tests.

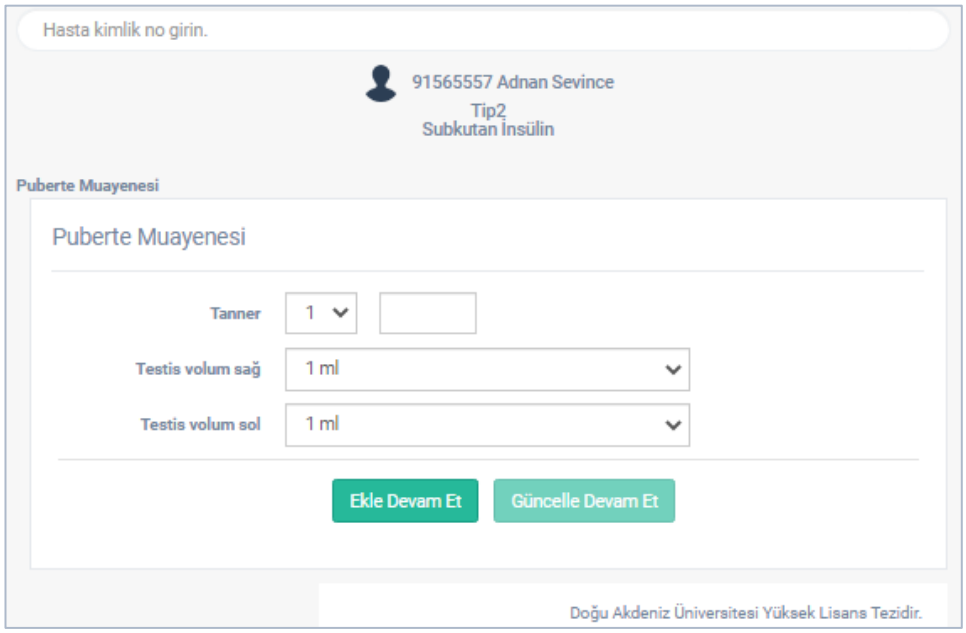


Figure 3.76: “Puberte Muayenesi” form

The form placed in “Komplikasyonlar” is dynamic and consists of variables. The fields in this form consist of the tests that were created by the admins for the examinations page. This form is shown in Figure 3.77. The predefined fields are filled and the button “Ekle Devam Et” is clicked to save the entered data and continue to next form “Muayene Ek Testleri” for additional examination tests.

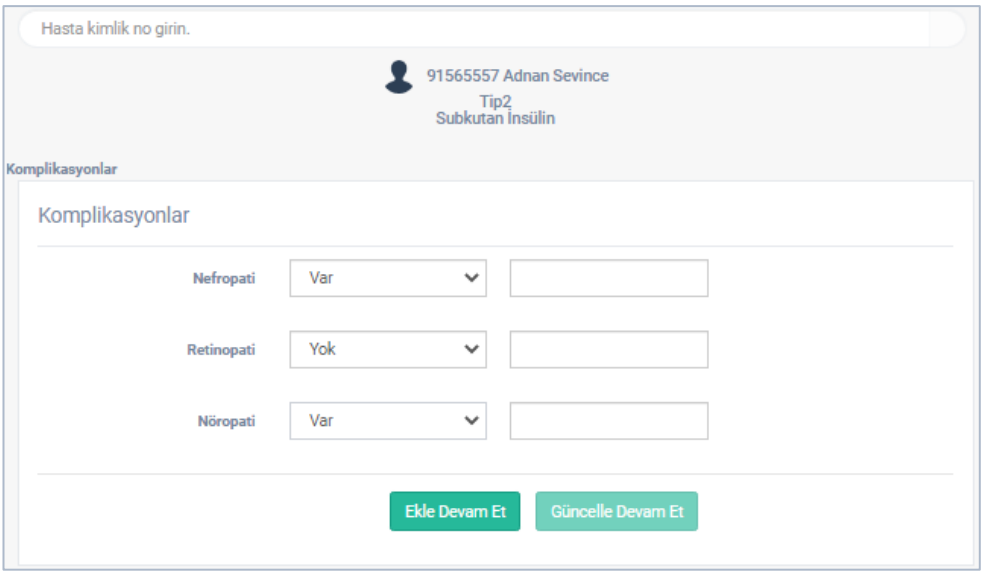


Figure 3.77: “Komplikasyonlar” form

The page “Muayene Ek Testler”, contains a form to allow doctors to add some other tests that are not defined in page “Muayene” but required for the considering examination. This form consists of two parts that “Ek Testler” for additional tests and “Ek Test Sonuçları” for the results table of the considering additional tests which are shown in Figure 3.78. This page is the same as the page “Laboratuvarlar” in terms of its functionality. Therewithal, in the table on this page, only the tests entered for the examination are displayed. The form in the page allows creating as much as the desired number of tests as if the test data is entered in “Laboratuvarlar” page. Then, the button “Devam Et” is clicked to save the entered data and continue to the next form.

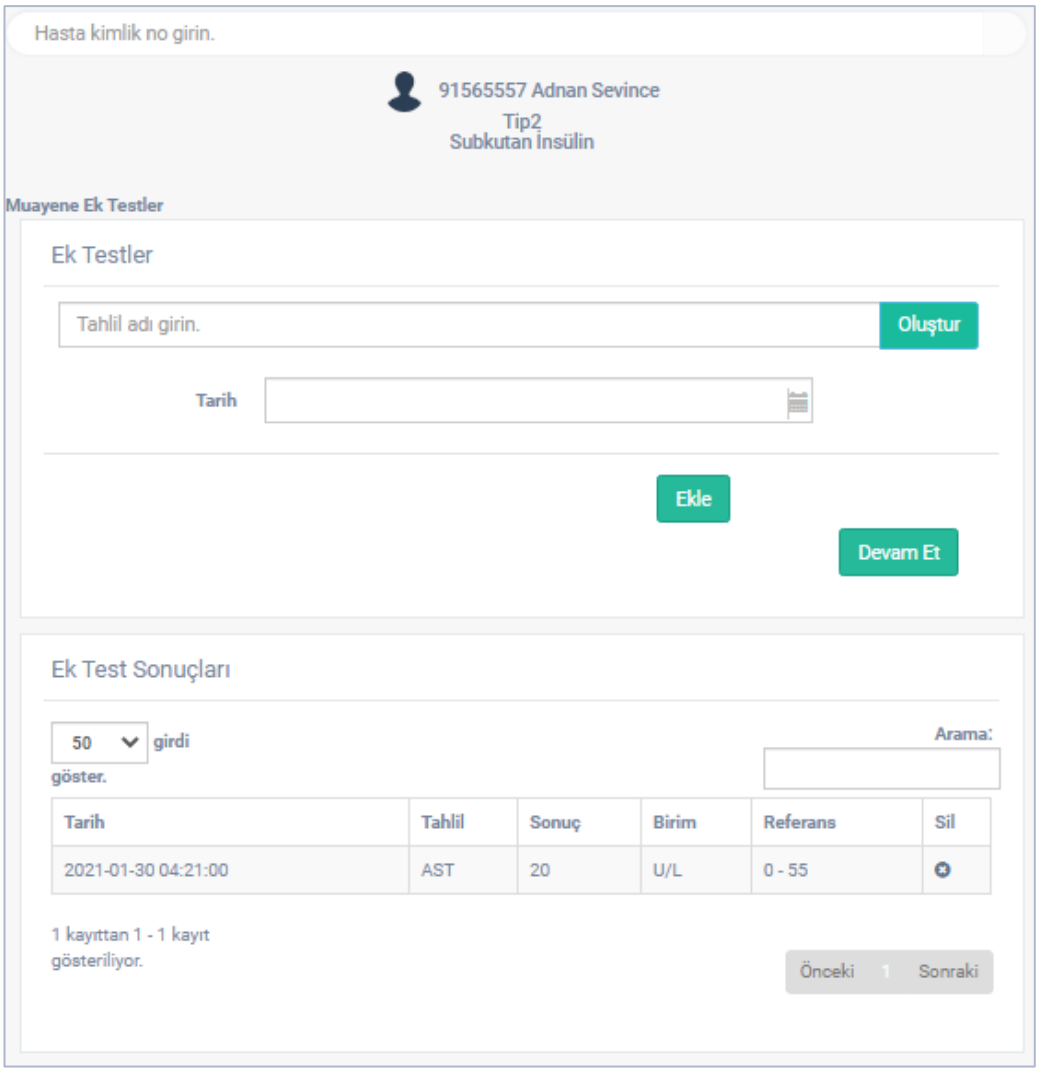


Figure 3.78: “Muayene Ek Testler” page

The page “Muayene İlaç” allows to record medications for the patient during the examination. This page consists of two parts that a form named “İlaçlar” to select a medication for the patient and a table named “Tüm İlaçlar” to list all the medications the patient using. This page has the same functionalities as the page “İlaçlar” as shown in Figure 3.79. The difference of it is that it allows to record medication(s) for a considering examination and the medication(s) can be displayed in page “İlaçlar” as well as in medications part of the page “Muayeneler”. After the required medications are added on this form, the button “Devam Et” is clicked to save the entered data and continue to the next form.

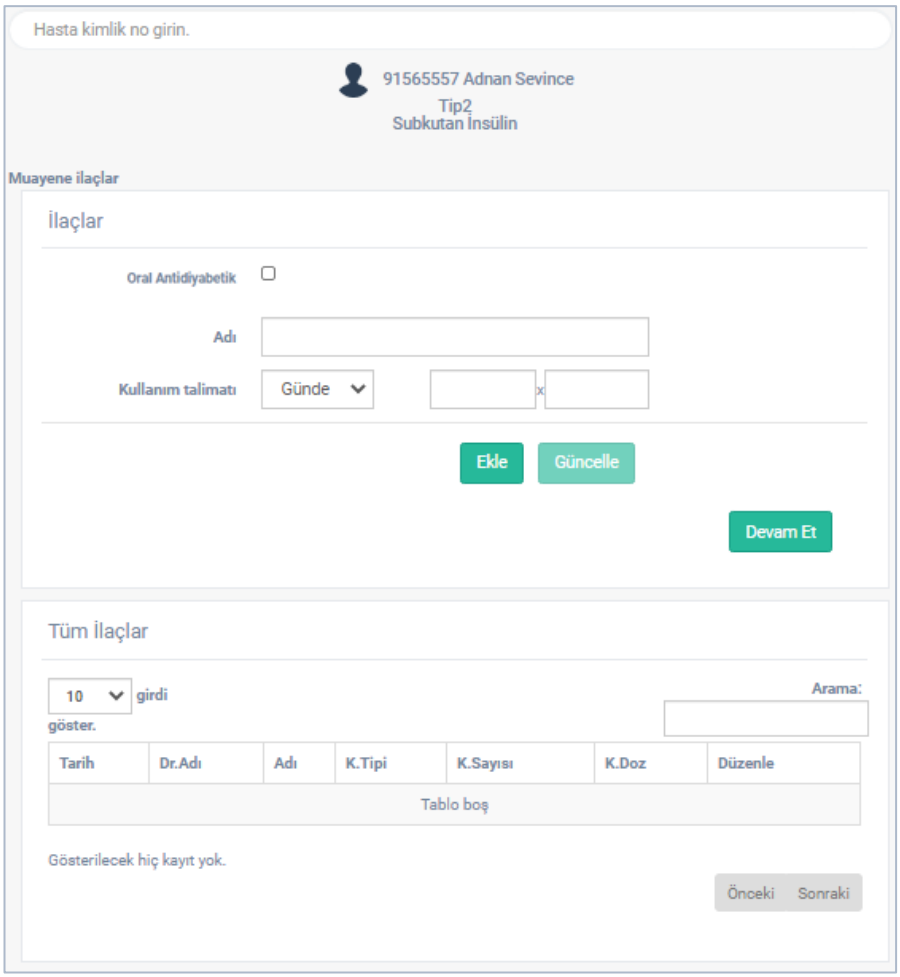


Figure 3.79: “Muayene İlaçlar” page

The page “Muayene Aşı”, allows adding vaccine to the patient during the examination, if required. This page consists of two parts that a form name “Aşı” to select a vaccine for the patient and a table named “Aşılar” to list all the vaccines of the patient. This page has the same functionally as the page “Aşılar” as shown in Figure 3.80. The difference of it is that it allows to record vaccine(s) for a considering examination and this vaccine(s) can be displayed in page “Aşılar” as well as in vaccines part of the page “Muayeneler”. After required vaccine(s) added on this form, the button “Tamamla” is clicked to save the entered data and finish the examination forms. After finishing these forms, it redirects to page “Muayeneler” and the lastly created examination data block is shown at the top of data blocks in the redirected page.

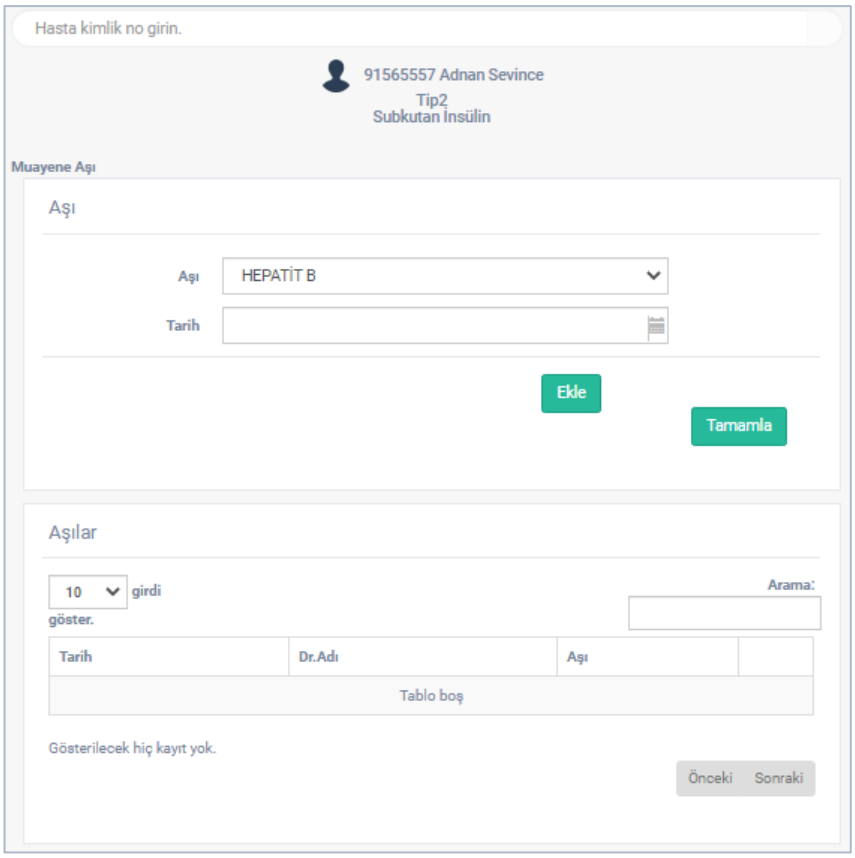


Figure 3.80: “Muayene Aşı” page

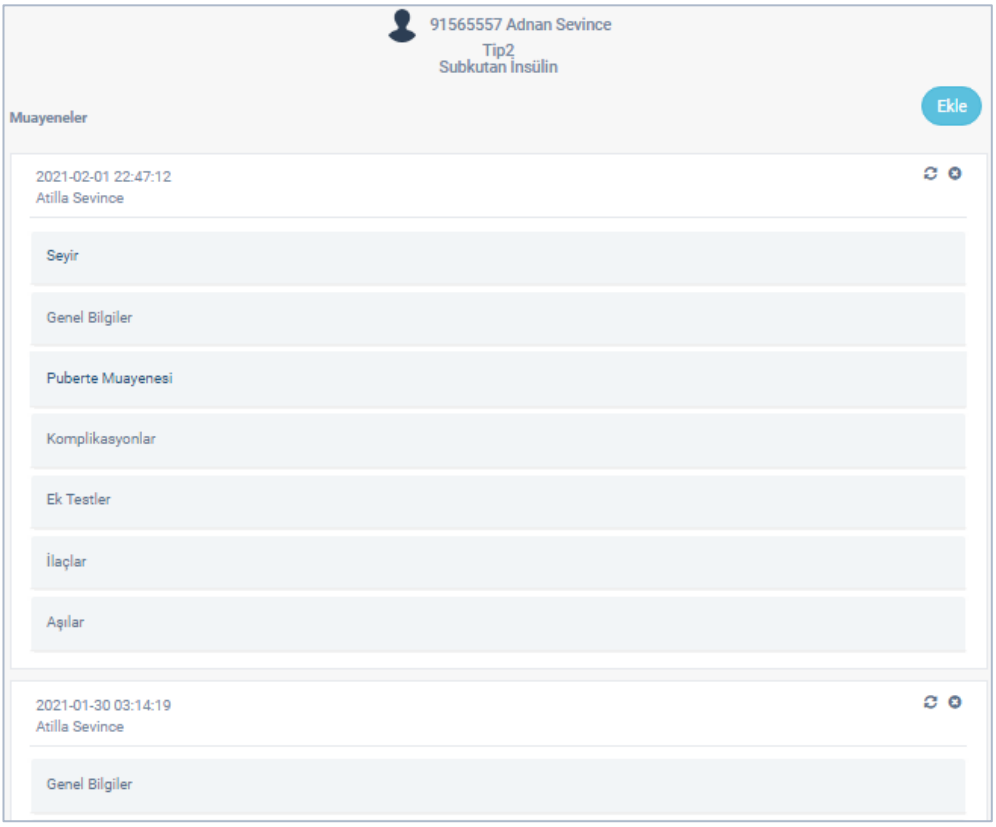


Figure 3.81: “Muayeneler” page’s data blocks

Figure 3.82: “Muayeneler” page data block “Seyir” area

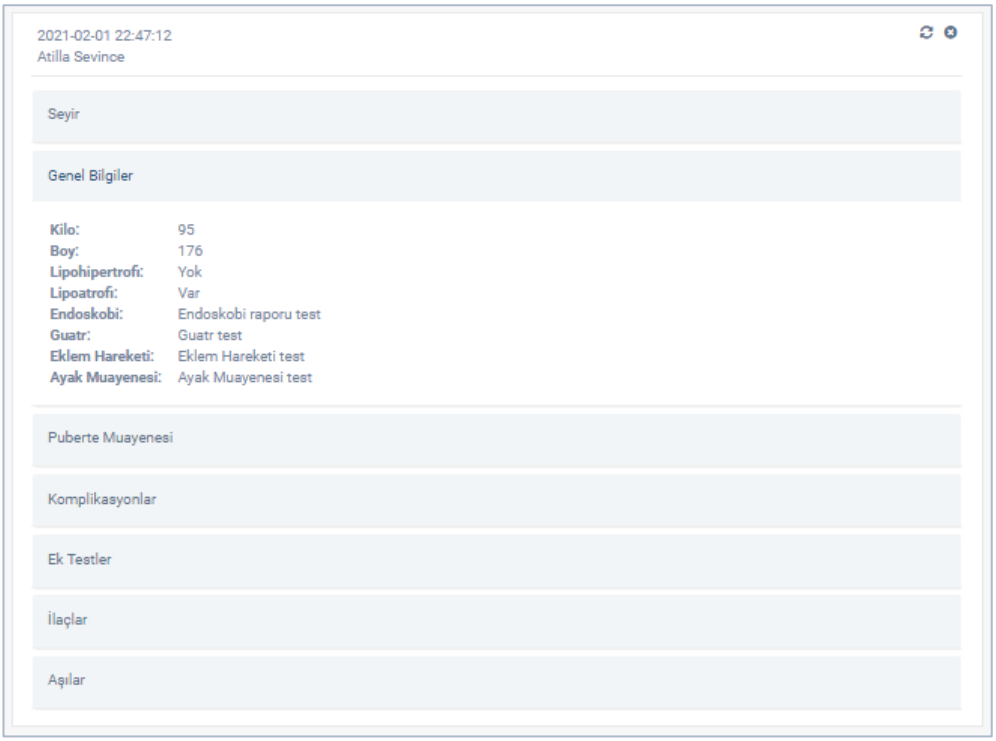


Figure 3.83: “Muayeneler” page’s data block “Genel Bilgiler” area

Figure 3.84: “Muayeneler” page’s data block “Puperte Muayenesi” area

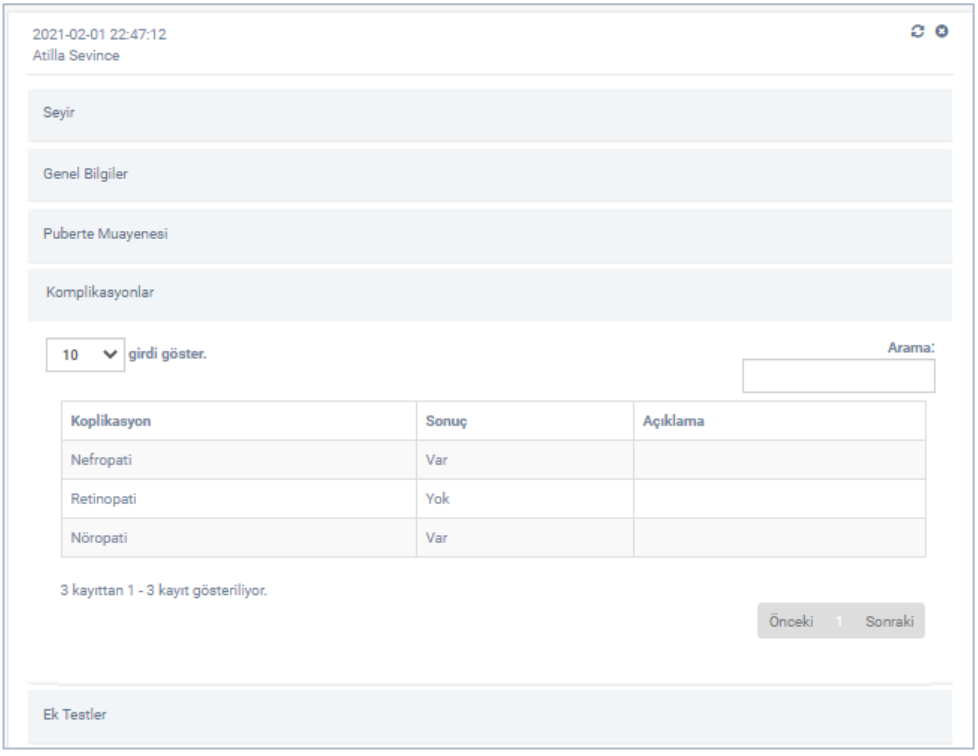


Figure 3.85: “Muayeneler” page’s data block “Komplikasyonlar” area

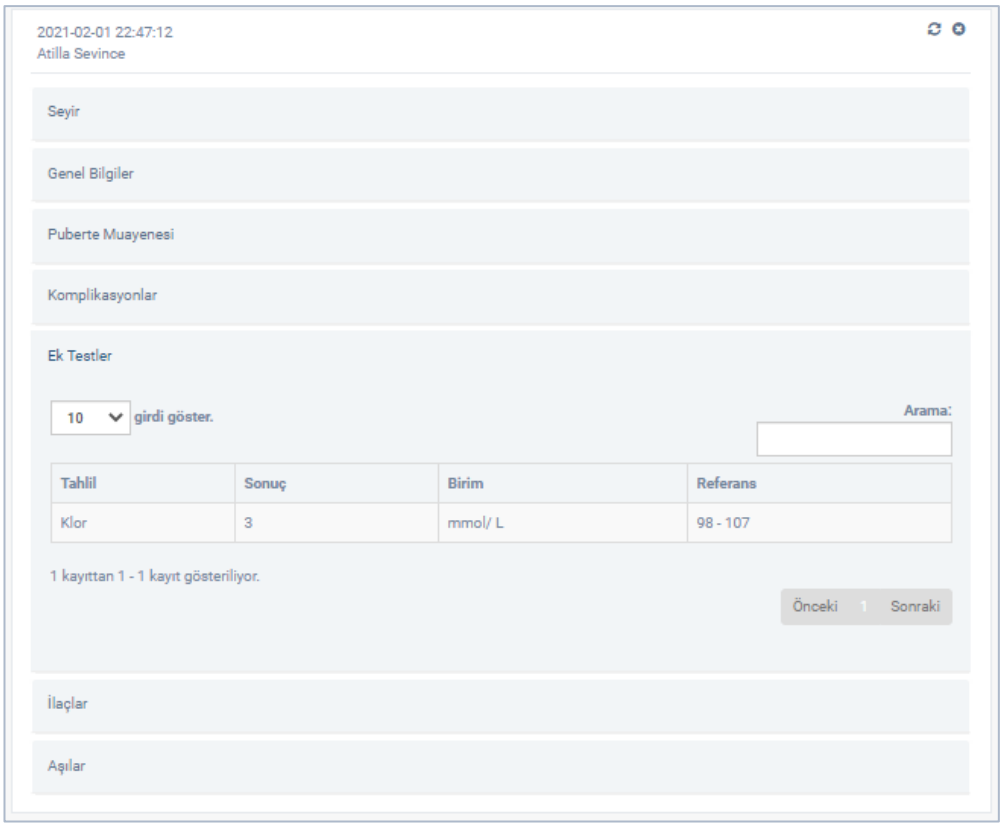


Figure 3.86: “Muayeneler” page’s data block “Ek Testler” area

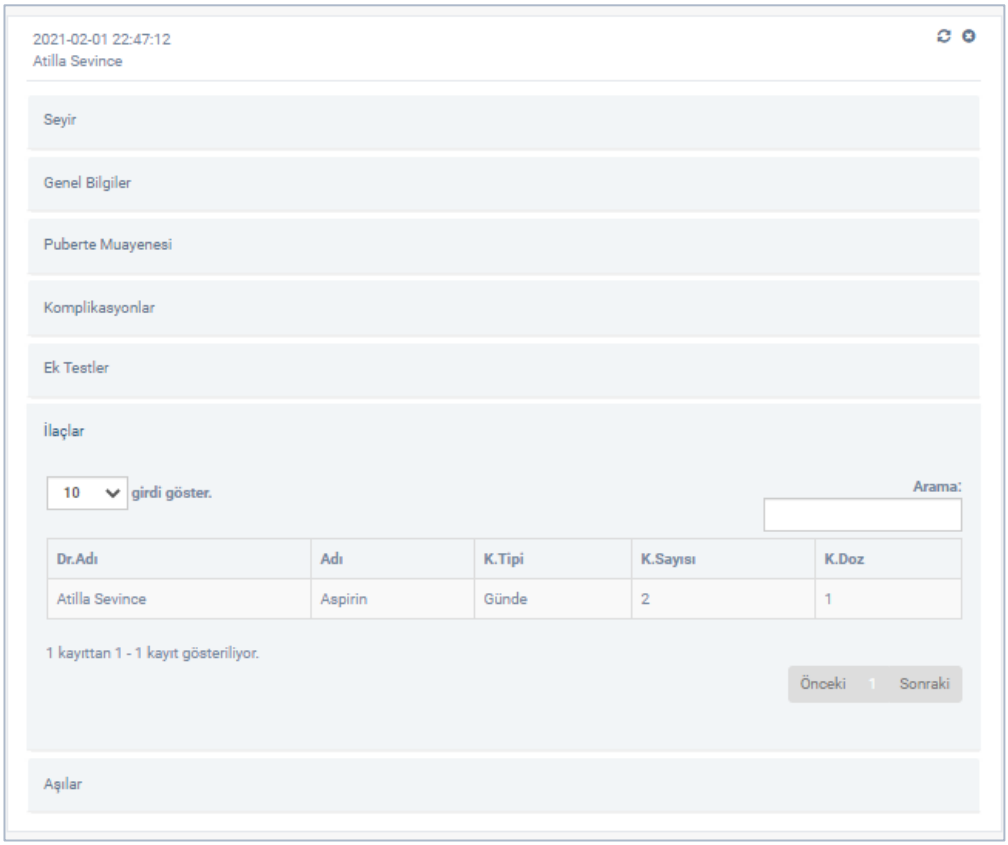


Figure 3.87: “Muayeneler” page’s data block “İlaçlar” area

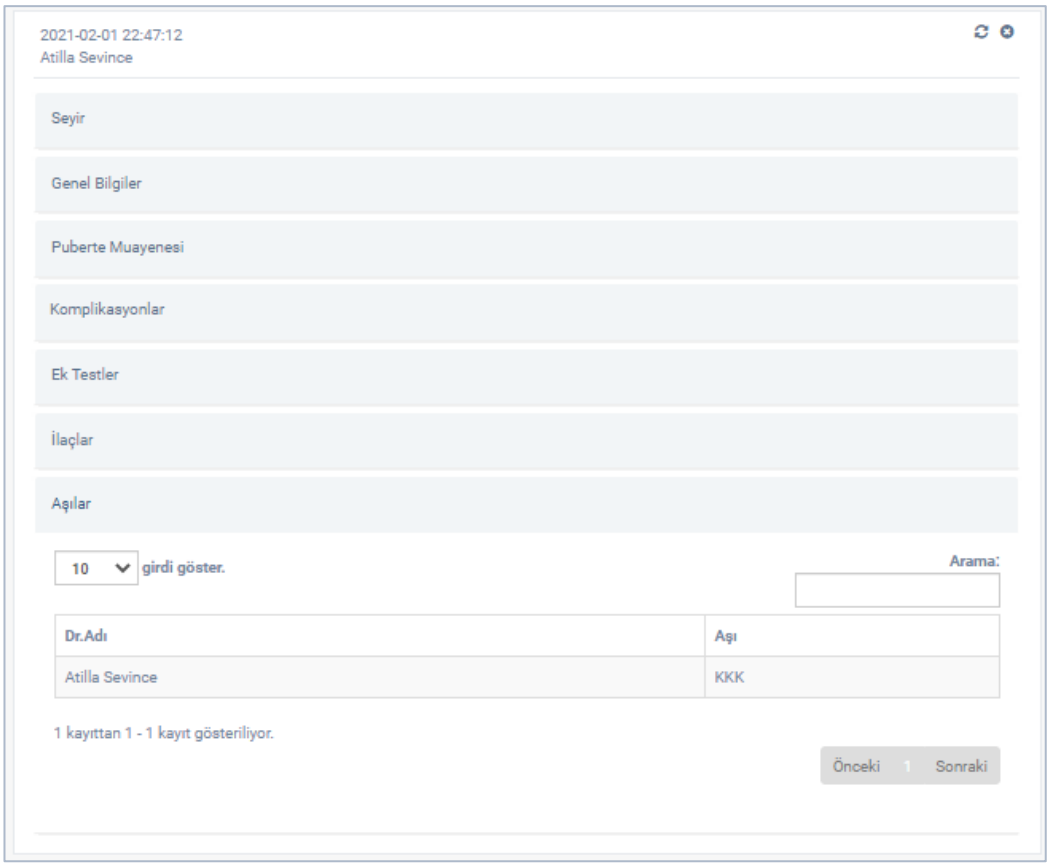


Figure 3.88: "Muayeneler" page's data block "Aşılar" area

The data blocks on the page "Muayeneler" are shown in Figure 3.81. To edit and update an examination data "↻" button is clicked, and it redirects to the forms that are filled with the data of the considering examination. However, the buttons "Ekle Devam Et" are not active anymore but instead "Güncelle Devam Et" button is active to update the data and continue. While updating the examination data, on the pages "Muayene Ek Testler" and "Muayene İlaçlar" the required data can be edited and button "Devam Et" is clicked. The last form of the update process is updating vaccines on "Muayene Aşı" page. On this page, after edited required fields the button "Tamam" is clicked to finish update process. The data block "Seyir" of an examination is shown in Figure 3.82, the general information field "Genel Bilgiler" is shown in Figure 3.83, puberty examination block "Puberte Muayenesi" is shown in Figure 3.84, the standard test field "Komplikasyonlar" is shown in Figure 3.85, the additional tests field "Ek

Testler” is shown in Figure 3.86, the medications field “İlaçlar” is shown in Figure 3.87 and the vaccines field “Aşılar” is shown in Figure 3.88.

Figure 3.89: “Diyabet Günlüğü” page

The page for diabetes diary which is named “Diyabet Günlüğü” can be accessed by clicking the menu item “Diyabet Günlüğü” from the patient portal menu. This page is shown in Figure 3.89 and it consists of four parts such that information cards, a line graph that shows weekly blood glucose, pie chart that displays the percentage of aimed blood glucose and second pie chart that displays Hypoglycemia(70 mg/dl) and Hyperglycemia(250 mg/dl) - “Hipoglisemi(70 mg/dl) Hiperglisemi (250 mg/dl)”. The information card “Açlık Şekeri” displays the latest fasting blood glucose, the

information card “Tokluk Şekeri” displays the latest postprandial blood glucose, the information card “Karbonhidrat” displays the latest carbohydrate level of a patient, “Egzersiz” displays the latest exercise time in minutes, “Duyarlılık Faktörü” displays the insulin sensitivity factor and “Karbonhidrat/İnsülin” displays carbohydrate insulin ratio. The information cards “Açlık Şekeri” and “Tokluk Şekeri” display the blood glucose value either in red color or green color according to the minimum and maximum blood glucose values defined in “Diyabet Türü ve Tedavi Şekli” page. If the fasting or postprandial blood glucose value is below the minimum or above the maximum, the values are displayed in red color, otherwise, they are displayed in green color. The line graph named “Haftalık Kan Şekeri Grafigi” shows all the blood glucose values of the last 7 days of a patient. The data points on the horizontal axis are labeled as “1. gün”, “2. gün”, “3. gün”, “4. gün” “5. gün”, “6. gün”, “7. gün” to show the day number of the value such that current day, previous day, 2 days ago, 3 days ago, 4 days ago, 5 days ago and 6 days ago respectively. To be able to display a day’s blood glucose values, the day label is clicked, and the line graph displays the corresponding day’s values, and the corresponding label becomes active. If a clicked day label is clicked again, the corresponding day’s values disappear on the graph and day label becomes passive. In Figure 3.89, only “1. Gün”, “2. Gün”, “3. Gün” labels are active, and the graph shows current day’s values. In addition, when any data point which is on the line graph of weekly blood glucose is clicked, a new card that displays blood glucose, carbohydrate, exercise values, appears for corresponding date and time. Additionally, if a patient is taking “İnsulin Pompası” insuline pump treatment, “bazal” basal and “bolus” bolus dosages are shown on the card. Otherwise, for “Subkutan insülin” subcutaneous insulin treatment, insulin dosages are shown. However, in Figure 3.90, “1. Gün” and “4. Gün” labels are active and the current day’s and fourth

day's blood glucose values are shown on the line graph. Also, the red and gray colored straight lines parallel to the horizontal axis on the graph indicates the minimum (red line) and the maximum (gray line) blood glucose values of a patient.

The third part on this page is aimed blood glucose percentage that named as "Kan Şekeri Hedef Yüzdeliği". The pie chart on this part shows that the percentage of blood glucose value is below, above and between the aimed value intervals for a patient. The percentage of the values below the aimed interval is labeled as "Düşük" and represented with red color, the percentage of the values between the aimed intervals is labeled as "Normal" and represented with green color, and the percentage of the values above the aimed interval is labeled as "Yüksek" and represented with blue color. Additionally, "Ölçüm adeti" number of measurements, "Ortalama" average blood glucose value, "En yüksek" the maximum blood glucose value and "En düşük" the minimum blood glucose value is shown as text above that pie chart. This chart can show the aimed blood glucose value percentage according to the four different periods as daily, weekly, monthly, and yearly by clicking "" button and selecting options "Günlük", "Haftalık", "Aylık" and "Yıllık" respectively, as shown in Figure 3.89. Then, the pie chart is reconstructed according to the selected period automatically. The last part on this page is aimed to "Hipoglisemi(70 mg/dl) Hiperglisemi(250 mg/dl)" hypoglycemia(70 mg/dl) hyperglycemia(250 mg/dl) but, the only difference from the third part is that the normal minimum blood glucose and the normal maximum blood glucose values are taken as 70mg/dl and 250 mg/dl respectively for all patients. "Diabetes Doctors", "Other Doctors" and "Patients" can display this page but the "Patients" can add new data only.

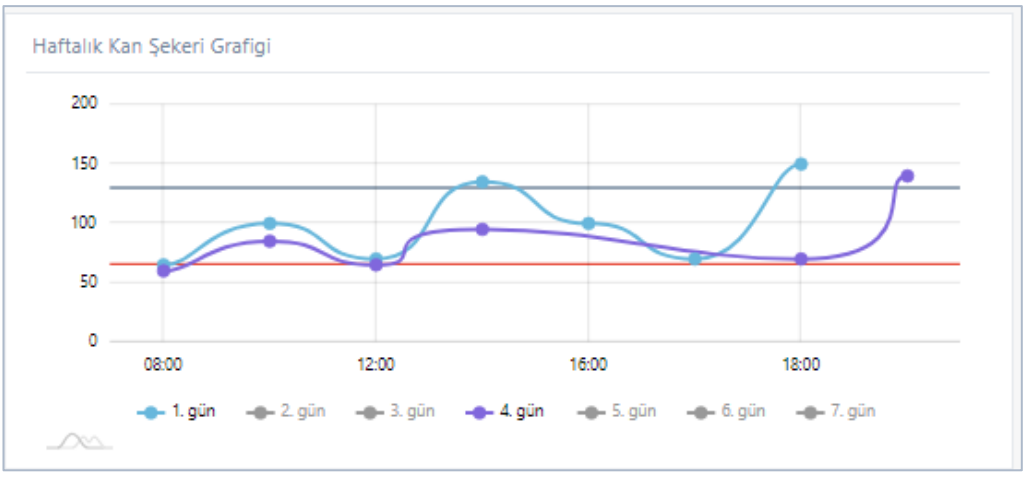


Figure 3.90: “Haftalık Kan Şekeri Grafigi” line chart

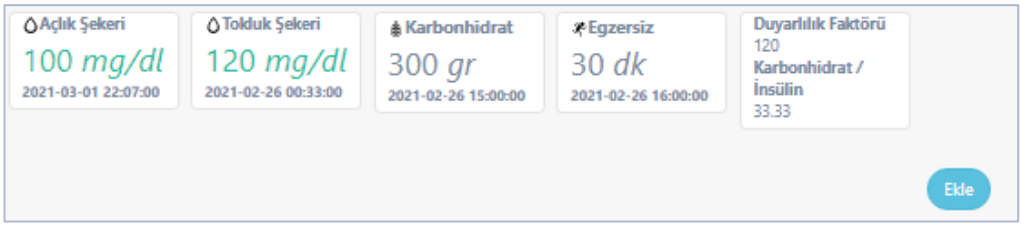


Figure 3.91: “Diyabet Günlüğü” page’s “Ekle” button

In Figure 3.91, “Diyabet Günlüğü” page’s “Ekle” button is shown. To add new data on this page, the button “Ekle” which is shown to the patients only is clicked. Clicking this button redirects to the form that is shown in Figure 3.92. This form contains four fields that “Açlık Şekeri” to enter new fasting blood glucose data, “Tokluk Şekeri” to enter new postprandial blood glucose data, “Karbonhidrat” to enter carbohydrate data, “Egzersiz” to enter new exercise data, “Oral” to check the medicine usage. Clicking a block on the form displays the input fields as shown in Figure 3.93. The first four fields contain two input fields, one information card and one button. The information card displays that last added value and its adding date. The input fields are used to enter a value for considering the field and select the date that this value recorded. Then the button “Ekle” is used to save the entered data. The fifth field “Oral” shows the list of medicines which should be taken in current time. There are checkboxes as many times

as the number of uses for each medicine. The relevant checkbox of the medicine which is taken is checked by clicking. As shown in Figure 3.94, the first use of medicine “Parol 500 mg Günde” was performed and the relevant checkbox was marked. The sixth field “Bolus” is used for entering bolus value in insulin pump treatment. It has two input fields that are “Doz” for entering dose value and “Tarih” for entering the date of used dose. The “Bolus” field is shown in Figure 3.95. If the patient is being treated using subcutaneous insulin, instead of “Bolus” field “İnsülin” field is displayed and it is allowed the patient to enter additional insulin dose.

Figure 3.92: “Diyabet Günlüğü” page's form blocks

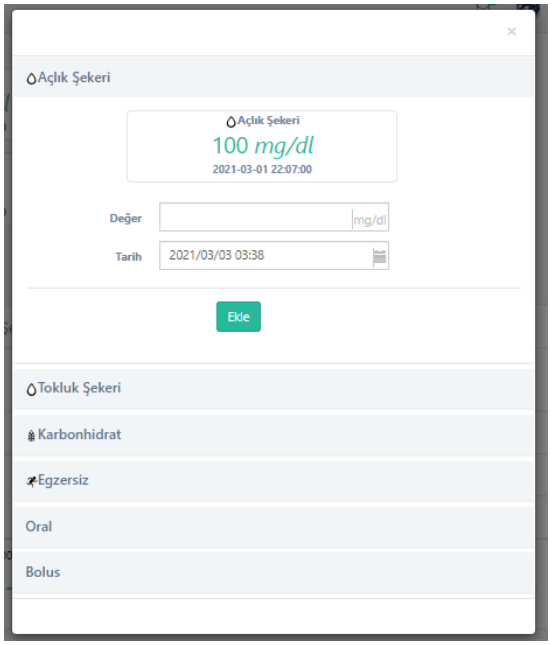


Figure 3.93: “Diyabet Günlüğü” page's “Açlık Şekeri”form

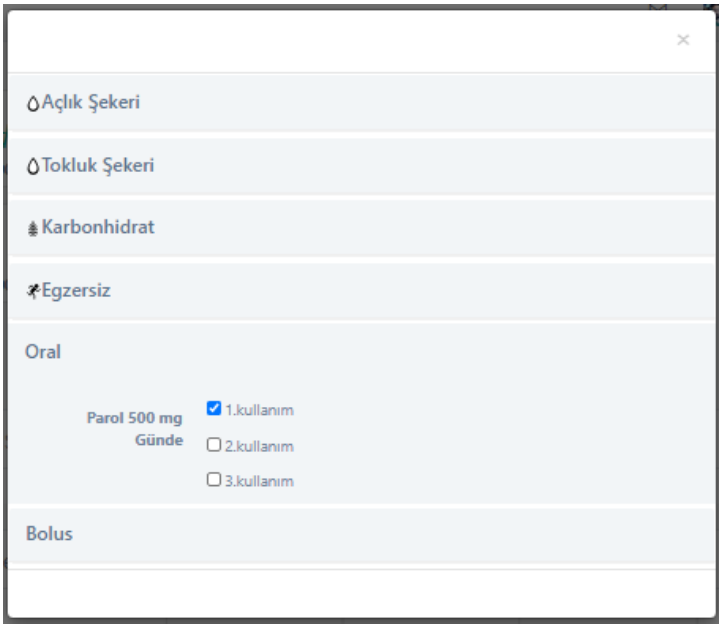


Figure 3.94: “Diyabet Günlüğü” page’s oral form

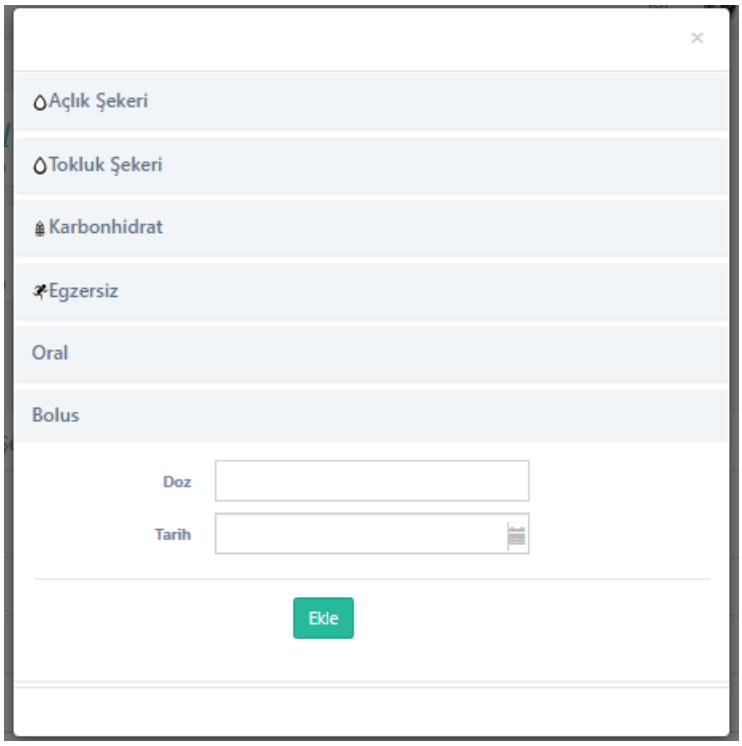


Figure 3.95: “Diyabet Günlüğü” page’s bolus form

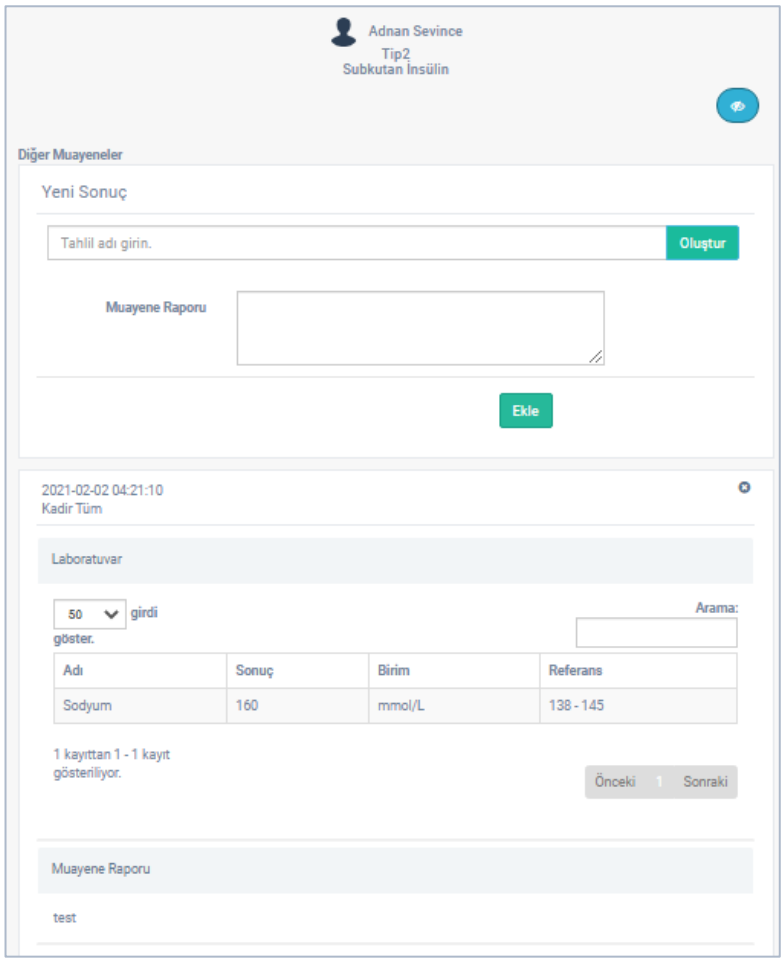


Figure 3.96: “Diğer Muayeneler” page

The other examinations page can be accessed by selecting “Diğer Muayeneler” item on patient portal menu. This page is designed to record a patient’s examinations data other than diabetes examination by “Other Doctors”. This page consists of two parts such that a form named “Yeni Sonuç” to enter new examination data and data blocks. This page is shown in Figure 3.96. In the form on this page, the field “Tahlil adı girin” is used to add a new test form and a field named “Muayene Raporu” to be able to write the examination notes are placed. When a keyword is typed in “Tahlil adı girin” field, it lists all related tests with the typed keyword. As shown in Figure 3.97, the keyword “so” is typed in the field and related test “Sodyum” is listed below the field. The desired test is selected from this list and “Oluştur” button is clicked. A predefined test form appears in the form. In that way, as many tests forms as desired can be added such that one from each test at a time. If any test form is desired to be removed, “” button is clicked to remove the considering test form. After filling fields in the added forms and “Muayene Raporu” field form examination report, “Ekle” button is clicked to save the data entered. By this process, a new data block that displays the record date and the doctor’s name who adds the records is added to the data blocks. This data block contains two different fields such that “Labotatuvar” to display the added test data and “Muayene Raporu” to display the examination report typed during the examination. This process is shown in Figure 3.96. To be able to display the desired field, the block of considering field is clicked. Each examination data is displayed in descending order according to the dates they recorded. “Other Doctors” can use this form to add new data and can display all laboratory fields of data blocks. But they can only display the examination reports that are recorded by themselves. The diabetes doctors cannot add data on this form but they can display all the recorded data on this form. And the patients can only display “Laboratuvar” fields in blocks.

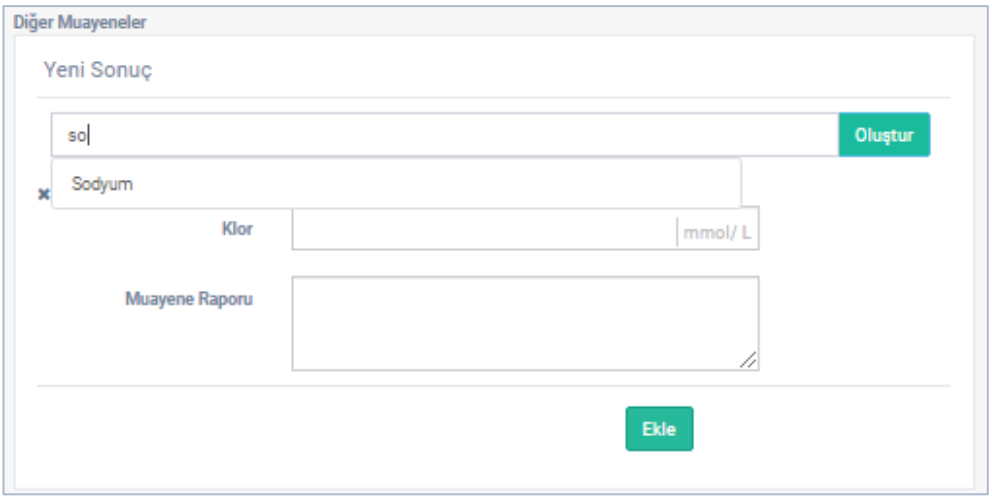


Figure 3.97: “Diğer Muayeneler” page’s form

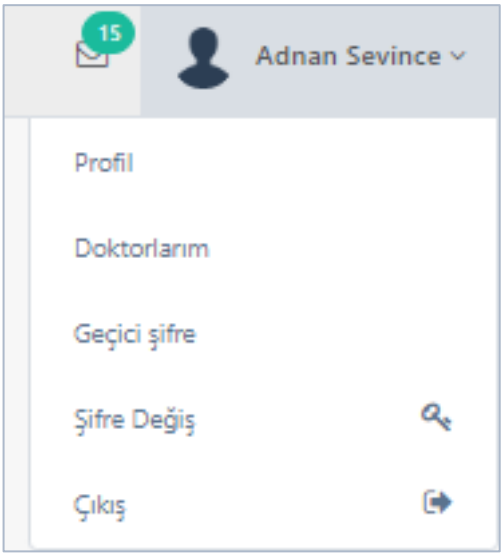


Figure 3.98: Patient portal top menu for patient

When a patient is registered to system, they can access their portals by entering the password that his/her doctor assigned and the email address they registered via sign-in form named “Giriş Formu”. All the pages that the patients can access, display or enter data are explained in the considering page’s part in this document. The patients have a top menu on their portals as shown in Figure 3.98. This menu contains five items such that “Profil” to display his/her profile, “Doktorlarım” to display his/her doctor(s), “Geçici Şifre” to create a temporary password for other doctors, “Şifre Değişir” to change his/her password and “Çıkış” to sign out. “Şifre Değiştir” item

redirects to a page that allows users to change password and this page is explained in Figure 3.21. This page has the same functionalities as the password change page on management portal. “Çıkış” item ends the patient’s session on the browser and signs the user out. “Geçici Şifre” item creates a temporary password for temporary doctors as shown in Figure 3.99. Each time that this item clicked a new password is created and the previous password cannot be used anymore. Also, the temporary passwords have an expiration time of 30 minutes starting from the time they are created. “Doktorlarım” item redirects to the page that doctor(s) of the patient is displayed. On this page, the patient can allow or deny the doctors who want to follow the patient up. The patient’s data can only be displayed by the diabetes doctors that the patient allowed. This page is shown in Figure 3.100. “Profile” item redirects to his/her profile page that is shown in Figure 3.101. This page contains the profile image, identification number, email address, name, surname, date of birth, gender, phone number, mother name and father name fields. The identification number and email address fields cannot be changed but the rest of the fields can be changed as desired. To change the profile image, the current image placed on top of the page is clicked and a new image is selected from popup window. The editable fields can be filled as desired and they can be saved by clicking the “Kaydet” button. If the saving process is failed, an appropriate message is displayed for the user.

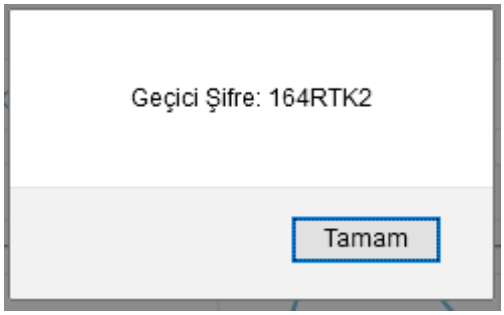


Figure 3.99: Patient temp password

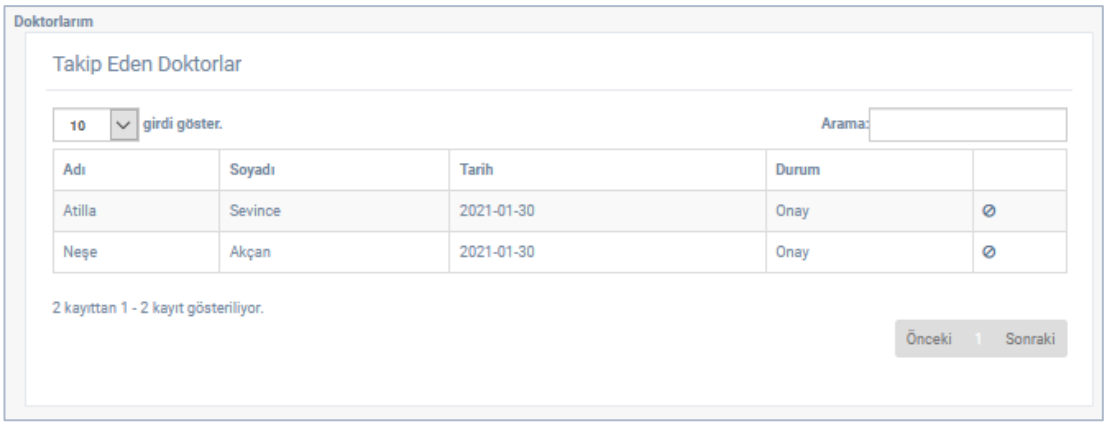


Figure 3.100: “Doktorlarım” page

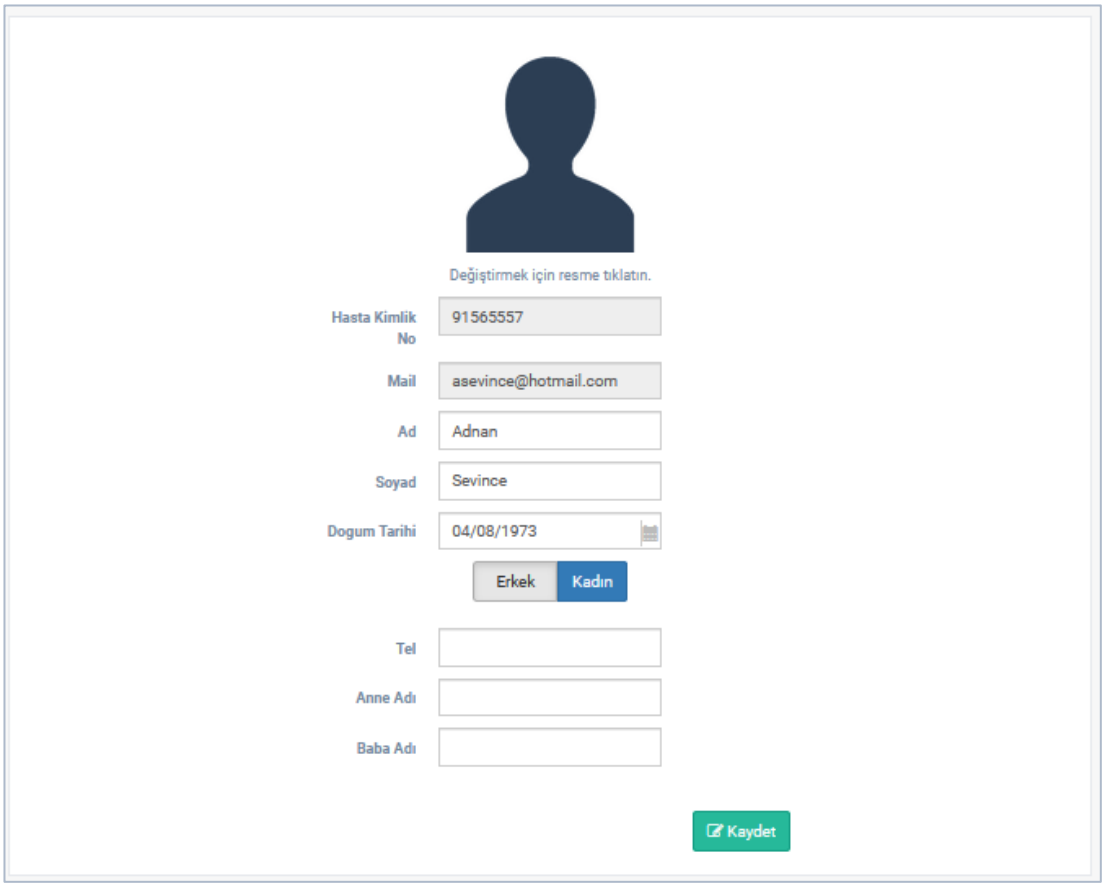


Figure 3.101: “Profil” page for patient

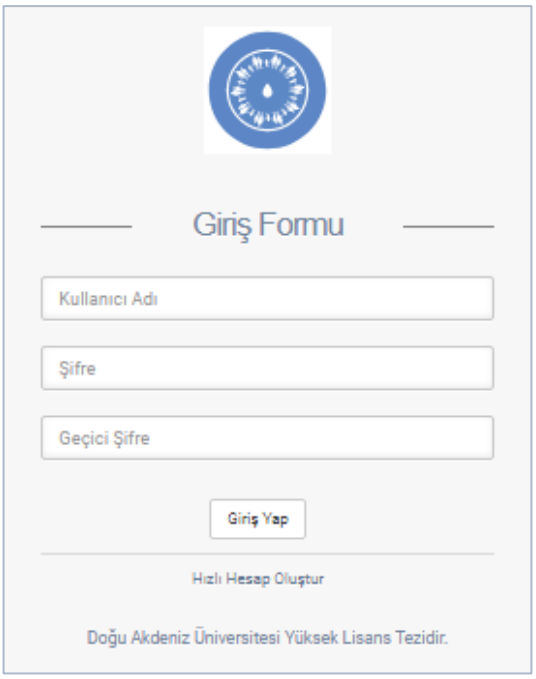


Figure 3.102: "Other Doctor's" sign-in page

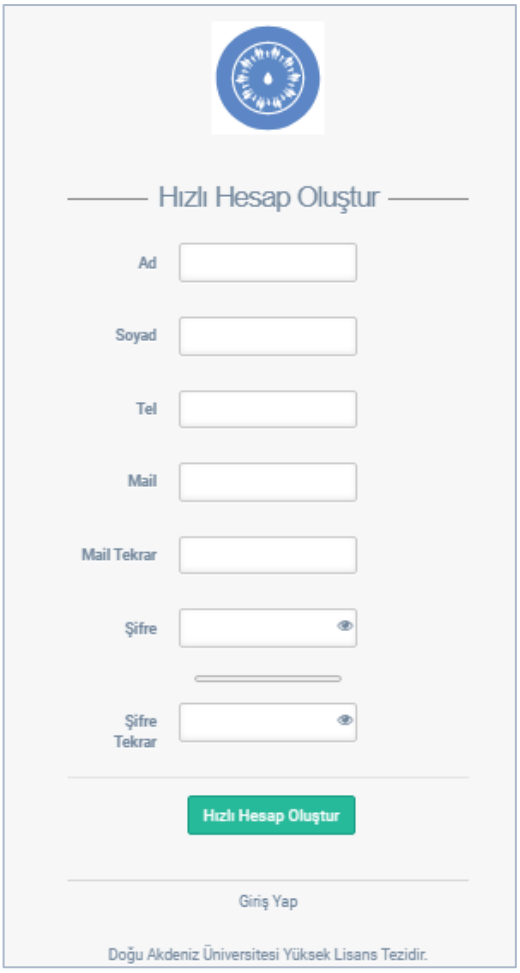


Figure 3.103: "Other Doctor's" registration page

When the patients see a doctor other than diabetes doctors, in case of emergency or other examinations, the examination data can be recorded using “Diğer Muayeneler” page. This kind of examination data is entered by doctors who registered as “Other Doctor” to the system. These registrations do not require the admin or super admin confirmation since they are temporary. “Other Doctors” can sign-in to the system via the page shown in Figure 3.102. If the doctor is not registered yet, an account must be created first. To create the other doctor account, the registration form that is shown in Figure 3.103 is used. To create a new account on this page, name, surname, phone number, email address and password is entered and “Hızlı Hesap Oluştur” button is clicked. The password, which is entered while creating an account, must have at least 8 and max 15 characters. However, even if the “Other Doctors” are registered to the system, they cannot sign-in unless having a temporary password that is given by a patient. Here a patient who registered to the system, creates a temporary password and gives it to the other who will check the considering patient’s information. An “Other Doctor” who has a temporary password can sign-in to the system using the page shown in Figure 3.102 and entering his/her username, password and temporary password. “Other Doctors” can only display the information of patients who give the temporary password. But sign-in of other doctors has an expiration time of 30 minutes starting from the time that temporary password is created. After 30 minutes, the other doctor’s session expires, to continue to display a patient’s information, considering patient needs to create another temporary password and give it to the doctor.

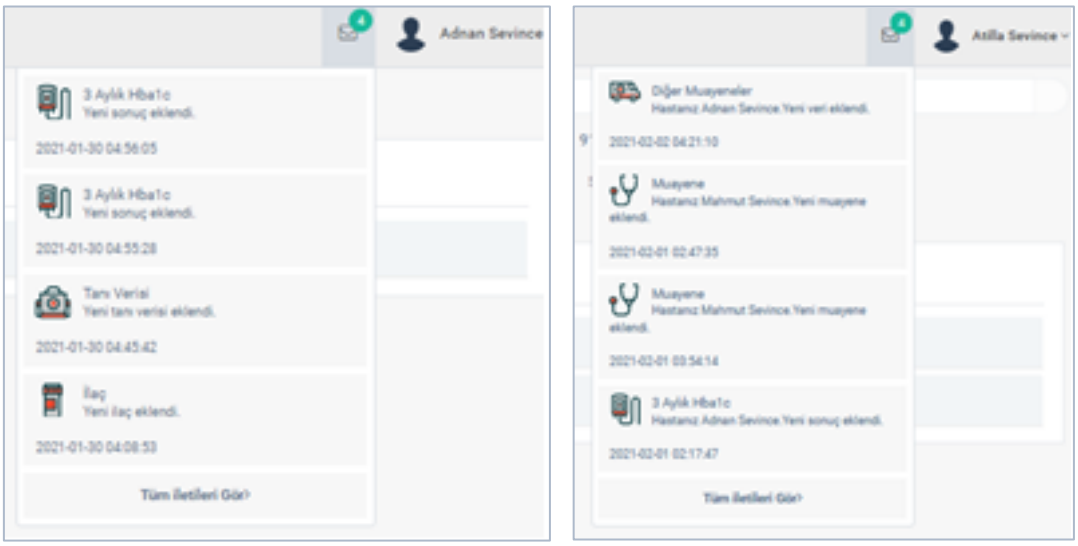
Figure 3.104: Patient portal top menu for “Other Doctor”

The top menu of other doctor portal has two items such that “Şifre Değiştir” to change his/her password and “Çıkış” to sign out from the portal. These two items are shown in Figure 3.104 and their functionalities are the same with “Şifre Değiş” and “Çıkış” items on the management portal that are previously explained in Figure 3.21.

The patients and diabetes doctors are informed by the notification created by the system. These notifications can be accessed “” button that is placed on the top menu of their portals. If new unseen notification(s) exist(s), then a green-colored badge that shows the number of new notifications, appears on the notification button as “”. When this button clicked the list, which contains the notifications is displayed and the notifications are listed in descending order according to the date they created as shown in Figure 3.98 and. If a notification on this list is clicked, it is removed from the notification list. All of the notifications can be displayed by clicking “Tüm İletileri Gör” button that is placed at the bottom of the notification list. In Figure 3.106 the notification pages for patient and diabetes doctor are shown. If the notifications page is displayed, all the new notifications on notification list are also removed.

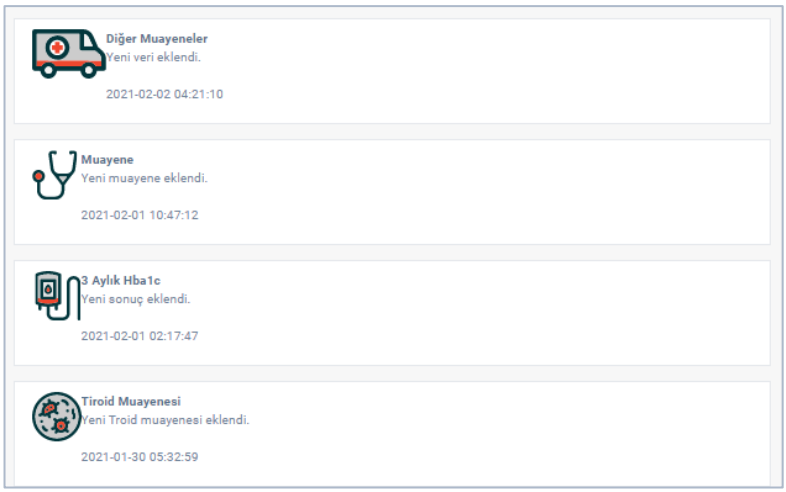
If a new data is added to the patient on pages “Muayeneler”, “3 Aylık HbA1c”, “Yıllık Tetkikler”, “Komplikasyonlar”, “Eşlikeden Hastalıklar”, “Laboratuvar”, “Tedavi”, “Aşılar”, “Tanı Verileri” and “Diğer Muayeneler”, a new notification is created for the

considering patient and for the doctors who follow the patient up except the doctor who adds the data. A notification has four fields such that image, title, message and date. The image and title of a notification are assigned as the same image and the same name of portal menu item that the notification is created for. As the message content of a notification, proper messages are created according to the process. For example, when a new examination is added on “Muayeneler” page, the notification contains “A new examination added” is created. The notifications that were created for a patient is shown in Figure 3.105(a) and Figure 3.105(b). These notifications for a doctor are designed as notifying the doctor about his/her patient. For example, when the diabetes doctor named “Neşe Akçan” added an examination data for the patient named “Adnan Sevince”, the notification message for doctors who follow this patient up see a notification such that “A new examination has been added for your patient Adnan Sevince”. In Figure 3.105(a) and Figure 3.105(b), the notifications that contain these kinds of messages, are shown. If a notification is related to a page, the notification redirects to the related page when the notification is clicked.



(a) (b)

Figure 3.105: The notifications menu. (a) Notifications menu on patient portal. (b) Notifications menu on diabetes doctor portal



(a)

(b)

Figure 3.106: The notifications page. (a) Notifications page on patient portal. (b) Notifications page on diabetes doctor portal

When a diabetes doctor sent a follow-up request for a patient, the patient is informed with a notification. This notification consists of title “announcement” and message “Yeni Doktor Takibi İsteğiniz Var” as shown in Figure 3.107. When this notification is clicked, it redirects to the page “Doktorlarım” to display the doctors.

Figure 3.107: Patient notification for “Diabetes Doctor” follow-up request

The patients also get informed with the notifications when a set alarm time has reached. For instance, let a patient has set an alarm for medication “dapagleze 5 mg” at time 09:00 am. Then, the patient receives a notification about this alarm when the time 09:00 a.m. to take the medication approaches. This notification is shown in Figure 3.108.

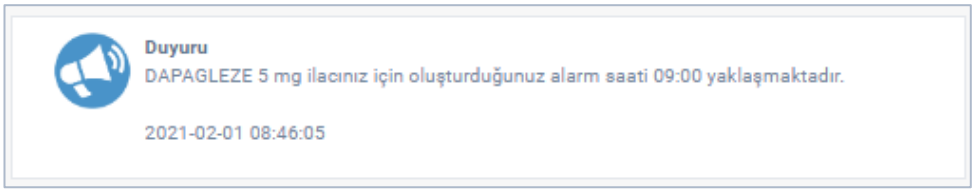


Figure 3.108: Patient notification for medication alarm

Besides that, a patient and the doctors who follows the patient up are informed with the notifications about yearly examinations and 3-month HbA1c tests such that one week before an examination or test, on the day of the examination or test, and one month after the day of examination or test.

3.2 Mobile Application

An Android-based mobile application was developed. In the mobile application, a "WebView" component was used to display the interface of the system. All the pages in the mobile application have the same functionalities with the responsive Web application which was explained in section 3.1. Some screenshots of the mobile application are given in Figure 3.109. All the application pages are re-sized in mobile application. For that reason, if a page contains a table, some columns of this table may

be hidden since they are not fit in the page. These hidden columns can be displayed by clicking "⊕" button and the button becomes "⊖". When "⊖" button was clicked, all the displayed columns that are not fit, can be hidden back. This process is shown in Figure 3.109(f).

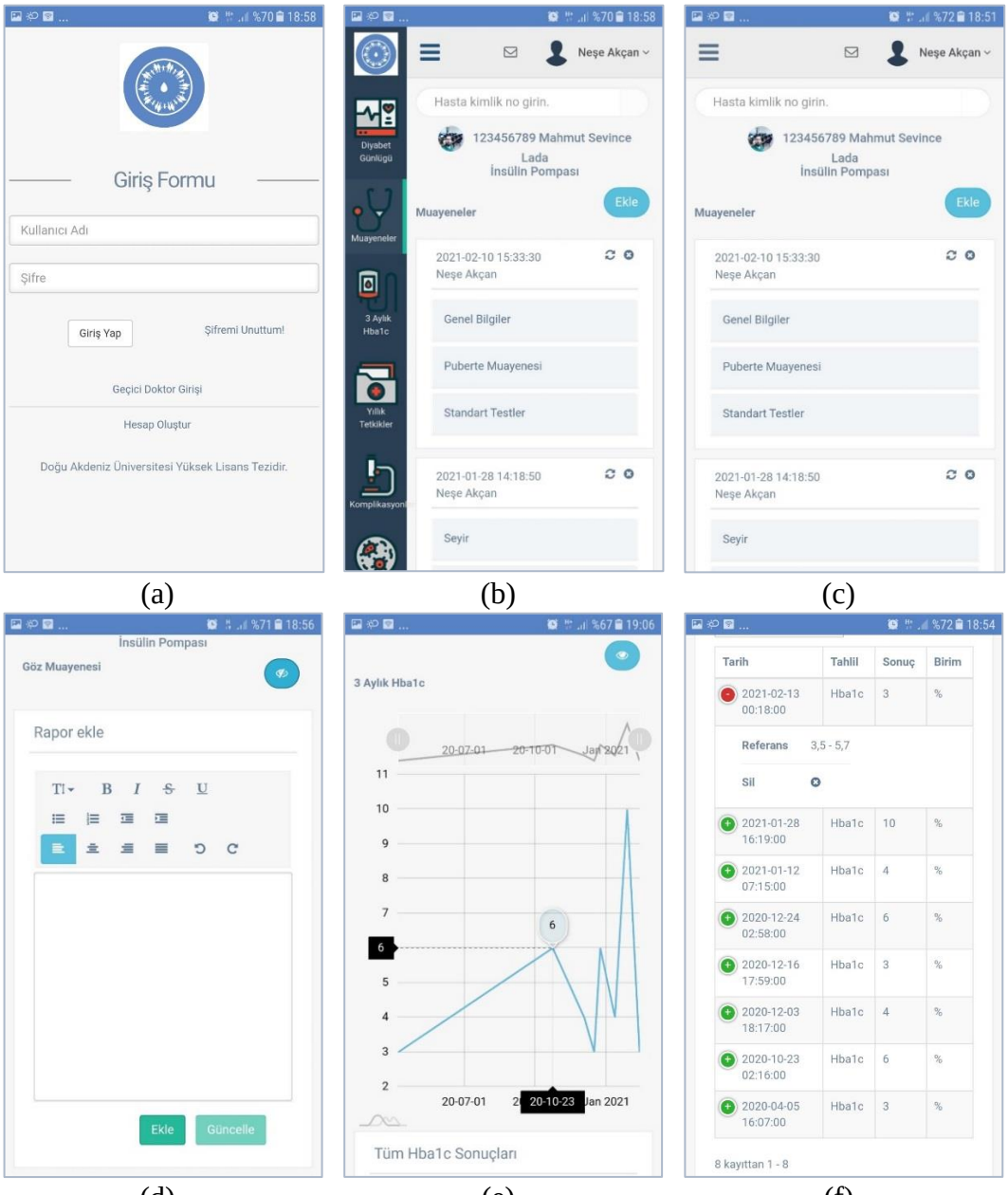


Figure 3.109: Some views of mobile application. (a) Sign-in page. (b) “Muayaneler” page with patient portal menu. (c) “Muayeneler” page”. (d) “Göz Muayenesi” page. (e) “3 Aylık HbA1c” page’s line chart. (f) “3 Aylık HbA1c” page’s table.

3.3 Tools and Utilities Used and System Requirements

For the graphical user interface (GUI) of the system, an open-source HTML5 dashboard template “Gentelella Alela” which was provided by Colorlib under the MIT license [7] is used. The icons used in the menu of GUI were downloaded from Iconstore [8] that provides them for free. The icons that are used for the system notifications are also free content which is provided by Freepik [9]. For the data charts in the system a JavaScript based library “Amcharts” [10] is used.

All the system data is stored in the database created by using phpMyAdmin version 5.0.3. The database management system is MySQL version 10.4.14-MariaDB. The system and REST APIs were coded with PHP version 7.2.34. The mobile application was developed with Android Studio 4.4.1 by targeting Android 11 (API Level 30).

The responsive Web application can be displayed by the web browsers that support HTML5, CSS3.0 and JavaScript. For the mobile application, the devices must have at least Android 4.1.1 (API Level 16).

Chapter 4

COMPARISON

In the study of Kwon et al. [1] (will be referred as S1 hereafter), the patients were registered to the system after their medical histories were taken. The patients sent their daily blood glucose, medication dose and hypoglycemic data to the system using SMS. And then, the patients received recommendations from experts on diabetes management, such as adjusting the medication dose and improving their lifestyle, via the Web based system of S1. This process continued for 3 months and at the end of this period, a positive improvements in the medical test results of the patients were observed.

In the study of McMahon et al. [2] (will be referred as S2 hereafter), diabetic patients and doctors who would follow the patients up were included in S2. The patients uploaded their data measured by blood pressure and glucose monitoring devices to the Web application of S2 for 12 months. Besides that, patients were also allowed to send their questions to the system for feedback from the doctors or specialists in the system. The medical data uploaded by the patients were transformed into graphs and tables that were monitored by the doctors. In this way, the doctors answered patients' questions according to their data via the system. The patients managed their treatments and medications according to the feedbacks received from the system doctors. As the result of the study, improvements were observed in the patients' medical data.

In the study of Quinn et al. [3] (will be referred as S3 hereafter), the authors studied with type-2 diabetic patients between the ages of 45-64 for 12 months. These patients divided into two groups such that the first group continued their usual diabetic controls and the second group used the system proposed in the study. The patients in the second group sent their blood glucose, carbohydrate intake, medications and other diabetic information to the system by using smartphones. By using the patients' data, the patients were responded by sending real-time messages to the patient's Web portal. The patients' additional diabetes data such as laboratory test results, eye and foot examinations of the patients was also stored in the S3 to review historical data. After a year, they concluded that the mobile health intervention has positive effects on managing type-2 diabetes.

In the study of Menon et al. [4] (will be referred as S4 hereafter), a system was proposed to manage the dose of insulin of diabetic patients. S4 contained a mobile application to allow patients take their injections on time with correct insulin doses, and a Web application to allow doctors to display patients' data. The system also warned the patients by messages when their blood glucose values are too low or too high. The Web application also allowed patients to monitor their own medical data and receive messages containing recommendations on adjusting insulin doses and general diabetes management. As the result of the study, improvement on the patients' diabetes data of the patients was observed.

In S1, the patients sent their medical data to the system using SMS. But, in our study, patients record their medical data directly to the system. The systems in S1, S2 and S4 do not include any examination data, the systems in S2 and S4 do not include any laboratory data. However, most of the patients' medical data such as complications,

examinations, laboratory and autoimmune diseases related to diabetes are included in our proposed system. Patients who uses our proposed system can share their medical data with other doctors who are not yet registered in the system by assigning them a temporary password. These doctors can add examination notes and laboratory results related to their examinations to the system. Such a case is not available in the systems of S1, S2 S3 and S4.

In general, in systems of S1, S2, S3 and S4, patients send their medical data to the system and then, the doctor(s) in the system respond the patient back to inform him about his/her medical status. In our proposed system, patients are followed up by their own doctors.

A summary of the comparison between the proposed system and other studies is shown in Table 4.1 below. Facilities are following:

- F1: Patients can enter data to system through sms or directly
- F2: Storing examination data in system
- F3: Storing laboratory data in system
- F4: Medical data sharing with other doctors in emergency situations
- F5: Patients are tracked by soctors performing their medical examinations

Table 4.1: Comparison Between Proposed System and Other Studies

Study / Facility	S1 Kwon et al. [1]	S2 McMahon et al. [2]	S3 Quinn et al. [3]	S4 Menon et al. [4]	Proposed System
F1	SMS	Direct	Direct	Direct	Direct
F2	×	×	✓	×	✓
F3	×	×	✓	✓	✓
F4	×	×	×	×	✓
F5	×	×	×	×	✓

Other than these academic studies, there are also variety of mobile applications that allow diabetic patients to track their diabetes. Since most common used mobile operating system is Android [11] and Google Play Store (that is an only online store for Android-based mobile application) was used to select the mobile applications to compare with the proposed system. The applications which have above 4.5 user rating and above 500,000 downloads were selected. These applications are namely "MySugr", "Diabetes: M", "Blood Glucose Tracker" and "Diabetes" where their details are given below.

The mobile application "MySugr" [12] (will be referred as A1 hereafter) is provided by MySugr GmbH and designed as a logbook of a diabetic patient. By using this application, a diabetic patient can store and track his/her diabetes related data such that diet, medications, carbohydrate intake and blood glucose values. It has an insulin bolus calculator with insulin dose recommendations and has ability to estimate patient's HbA1c value. It also offers basal rates for insulin pump users. In addition to these, several reports can be exported to PDF and Excel files.

Another mobile application is named "Diabetes: M" [13] (will be referred as A2 hereafter) is provided by Sirma Medical Systems. This application can be also considered as a logbook for diabetic patients to track their course of diabetes. This application allows users to record their medications, carbohydrate intake, blood glucose value, body weight, ketones, HbA1c value, cholesterol, blood pressure, heart rate and physical activities. It has an insulin bolus calculator and a database that is consisted of a list of meals categorized by their ingredients. User can add their own food and portions to the food list, export PDF/Excel/HTML reports and import existing reports.

"Blood Glucose Tracker" [14] (will be referred as A3 hereafter) is another mobile application provided by Little Bytes Software for use of diabetic patients. By this application, a patient can record data of his/her medications, blood glucose value, HbA1c value, carbohydrate intake and exercises. It also has the ability of importing and exporting data reports in HTML format.

Klimaszewski Szymon has also provided a mobile application named "Diabetes" [15] (will be referred as A3 hereafter) for the use of diabetic patients. Similarly to the previous three mobile applications, it also record a patient's medications, blood glucose value, HbA1c value, exercises and carbohydrate intake data. It also allows users to import and export data reports to CSV and XML formats.

None of the mobile applications A1, A2, A3 and A4 has the capability of storing laboratory tests or examinations data of a patient. However, our proposed system is capable to store patients' all laboratory tests and examinations data. Importing and exporting data reports in several file formats are also not available in our system, unlike in other applications. Since patients and patients' doctors are in direct communication in our system, there is no need to have an insulin calculator. Thus, our proposed system does not have an insulin bolus calculator that was included in A1 and A2. The most important feature that distinguishes our proposed system from the aforementioned mobile applications is the doctor support that is not offered in these mobile applications. These mobile applications help patients to follow up their own personal diabetes.

A summary of the comparison between the proposed system and selected mobile applications is shown in Table 4.2 below. Facilities are following:

- F1: Storing laboratory tests and/or examination data
- F2: Importing and exporting data in various file formats
- F3: Insulin bolus calculator
- F4: Doctor support
- F5: Self tracking

Table 4.2: Comparison Between Proposed System and Mobile Applications

Application / Facility	A1 [12]	A2 [13]	A3 [14]	A4 [15]	Proposed System
F1	×	×	×	×	✓
F2	✓	✓	✓	✓	×
F3	✓	✓	×	×	×
F4	×	×	×	×	✓
F5	✓	✓	✓	✓	✓

Chapter 5

CONCLUSION & FUTURE WORK

In this thesis, a tracking system that provides management and control mechanisms for diabetic patients in North Cyprus was proposed. The academic studies in the literature [1, 2, 3, 4] have shown that the systems used as ancillary tools in the treatment of diabetes have positive effects on the clinical data of patients with diabetes. For that reason, it is believed that, our proposed system has promising outcomes on behalf of the treatments of diabetes of the patients in North Cyprus. The main properties of our proposed system are as follows;

- The ability of the system to allow the doctor to see all the medical data of the patient provides a wider perspective in patient follow-up.
- Providing the medical history of a patient to a doctor, allows the doctor to obtain effective information about the patient.
- The dynamic definition of the laboratory test forms in the system allows new developments in laboratory tests to be easily adapted into the system.
- Dynamically adding test data to laboratory test forms increases the variety of information that can be obtained from patients.
- “Other Doctor” type users can view patient data and add new data related with their own examinations by a temporary password given by patients. Hence, that allows patients to share their diabetic history with doctors other than diabetes doctors and allows “Diabetes Doctor” who follows the patient up get informed about the “Other Doctor” type users' examinations .

- The ability of the system to make necessary warnings and announcements to the users with notifications facilitates patient follow-up and provides information for the patients and the doctors.
- To allow “Super Admin” type users to list patients according to their BMI, frequency of patients using the system, diabetes type, HbA1c result, age and how long the patient suffers from diabetes provides to monitor the diabetes patients’ status in North Cyprus.
- Due to the system is responsive Web-based, it can be used by various devices such as desktop computers and smartphones. This nature of the system affects the number of users positively.

As a future work the followings would be studied: (*) an option for allowing “Super Admin” type users to filter patients based on regions of North Cyprus, (*) an option for importing and exporting of laboratory results as file.

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