System to Direct People to Appropriate Medical Care

Part I: System and functional data points

1.1 Problem Scenario

Due to lack of medical knowledge, some people do not know when to seek medical care and which medical service is appropriate for their needs. This results in unnecessary calls to emergency services, false alarms and in appropriate use of these emergency facilities, which might mean that those with a greater need do not receive urgent care. This can also result in people failing to save themselves from suffering acute situations.

In this project, a software application that can direct people to proper medical services is proposed, to help those lacking medical knowledge to decide the proper type of medical service they can refer to.

1.2 Application objectives

- Give patients proper advice according to the symptoms they are suffering.
- Recommendation to patients about medical services based on the information they provided.
- As an additional outcome, the application is able to tell the patient about the closest spot they can get the corresponding type of recommended medical service.

1.3 Function Specifications:

- Data establishment:

  To build this application, several data sources are required:

  a. **Data about typical symptoms**: Data about typical symptoms, actions that are proper to those symptoms and services types that are able to deal with those symptoms should be collected. But this needs to be checked by a clinical team to ensure its accuracy.
  b. **Data about medical organizations**: Data about type of each medical organization (ED, GP, Specialist, Poison center, Public hospital or Private hospital...) should be gathered. As a second point, information about clinicians in charge of medical services in the organization should be gathered, in terms of clinicians' names and type of symptoms they are able to react to.
  c. **Data about the patient:** Data of the age and sex of each patient should be given. Also, data about what advice given to which patients at what time should also be recorded.

After the establishment of the application, in order to target at the problem, the application should have certain inputs for capturing user inputs. It should also have certain checking mechanisms and the response to user inputs according to the retrieved data.

- Data capture:

After a user starts the application, users' data about symptoms, age and sex should be captured:

1. The application starts by asking a question "Are you entering data for yourself", aiming at checking whether the patient is conscious or old enough for entering the data. If the answer is yes, then it is assumed that the patient is conscious and then the application displays user information input page as its first function. It accepts 2 user inputs, namely user's age and sex. If the answer is not, a quick button on the starting page named "UNCONSCIOUS" will pop up, if user click the button, the application will direct patient to "000" page, so the user can click the button and call an ambulance.

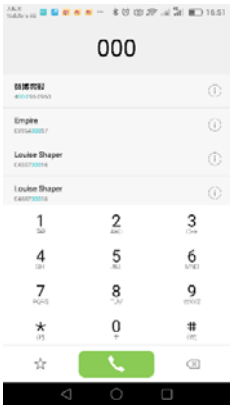


Fig 1.2-1: Demonstrated interface for calling ambulances, from my Android screen shot, for demonstration purposes only.

2. Self-diagnostic input page: A graph of anatomic human bodies of male or female, based on the sex input from function 1.

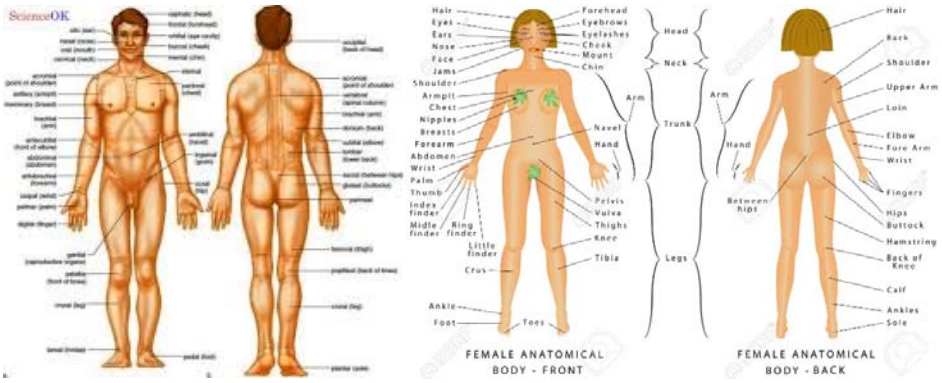


Fig 1.2-2: Front and back side of human bodies, of types of both sex, obtained from Google Image, for demonstration purposes only.

3. Users can click on the corresponding body parts displayed by the system from the figure 1.2-2 that he or she feels uncomfortable.
4. The application equates the parts that user clicked to specific coded body parts.

5. For each equated body part, the application looks for the knowledge base and retrieves possible symptoms for each of the body parts.
6. User sees the symptom lists for each body part, and is able to indicate which of these symptoms are present. If user cannot find the corresponding symptom in the list, the system can then link to its consultation service during the day, or link to the National's 13 SICK system at nights.

- Data check and correction:

7. For each of the symptom chosen by user, the application checks the symptom table:
   7.1 If the symptom has action advice and service type that associated with that symptom, the system fetches action advice and service type data and returns the advice and service type to users.
   7.2 If the chosen symptom does not have action advice and service type associated with it, the system checks what questions to ask in order to update the symptom to a more specific one; For the updated symptom, it still checks whether there is a piece of advice and service associated with it, and ask questions if needed. The system loops this procedure until the symptom is associated with a piece of advice and service, and go to step 7.1.

- Data retrieval and process:

8. The advice is given based on rules defined in step 7, however, to retrieval those data and proceed results to patients, a table storing symptoms and a table storing what questions to ask when the symptom is too general need to be finished before the application runs, the formats of two tables are shown as below. An identified issue here is that those tables need to be filled up by clinicians, to ensure that the symptoms, actions, services and questions to ask can correspond to each other in the context of the system.

701-8-1: Sample of data table of symptoms

Symptom ID	Symptom	Action advice	Service type
195967001	Asthma		
704098003	Asthma with an inhaler	Use the inhaler, and if you still have problems, seek help at the emergency department	Emergency Department
No specific code for this, have to make up own ID for this system.	Asthma without an inhaler	Go to the emergency department to obtain treatment	Emergency Department
21522001	Abdominal pain		
…and so on			

1-8-2: Sample of questions should be asked to specify symptoms

General symptom	Question	Numerical answer	Answer content	Updated symptom
Asthma	Do you have an inhaler?	1	Yes	Asthma with an inhaler
		2	No	Asthma without an inhaler
Abdominal pain	21522001	1	Upper right	Upper right abdominal pain
		2	Upper left	Upper left abdominal pain
		3	Lower right	Lower right abdominal pain
		4	Lower left	Lower left abdominal pain
… and so on				

- Function rule requirements & Potential issues identified:

1) The whole application needs a clinical team to support its data establishment and running, which is the first identified issue of the application. During data establishment, it needs clinical person to help collect enter the data and check the correctness of the data, while it is put into usage, it potentially needs clinical people to work as the "day-time consultants".
2) The system needs to be linked to the national's 13 SICK service. The trigger will be the time at each day when the "day-tie consultants" leaving their jobs.
3) In terms of checking the locations for the services, the application should be able to link to Google Map services (by using Google Map API, for instance).
4) In the case of users being (nearly) unconscious (suggested by user clicking the "UNCONSCIOUS" button or selecting certain acute symptoms in some body parts, e.g. a cut in artery / losing blood for more than a cup) or in an emergency situation, it is obvious that the system need to link them to the emergency system. But in order to prevent false-alarm in due to users' accidents or kids playing with the application, users still have to press the green button to call the ambulance. This is the second identified potential issue of the system.
5) Data maintenance issues: The governance needs to constantly check the update of medical knowledge data stored in the database. Namely, those data needs to be constantly maintained, checked and updated:
    a) Australia National Data about clinicians and medical organizations, and type of treatment services they can provide.
    b) A professional collage of clinicians who check about medical knowledge about diseases and their treatments. Also they should check types of questions to ask to decide possible disease types.
6) In order to enhance user experiences (Ux) in the future, the system might need to be linked to My Health Record, using patient's ID provided by that system. But till this stage, in order to control the scale and budget of the system, this requirement can be implemented later.

1.4 Data Required for the Application

Data elements required for this application are shown in fig 1.3-1. The figure demonstrates data entities and data elements that are associated with each data entity.

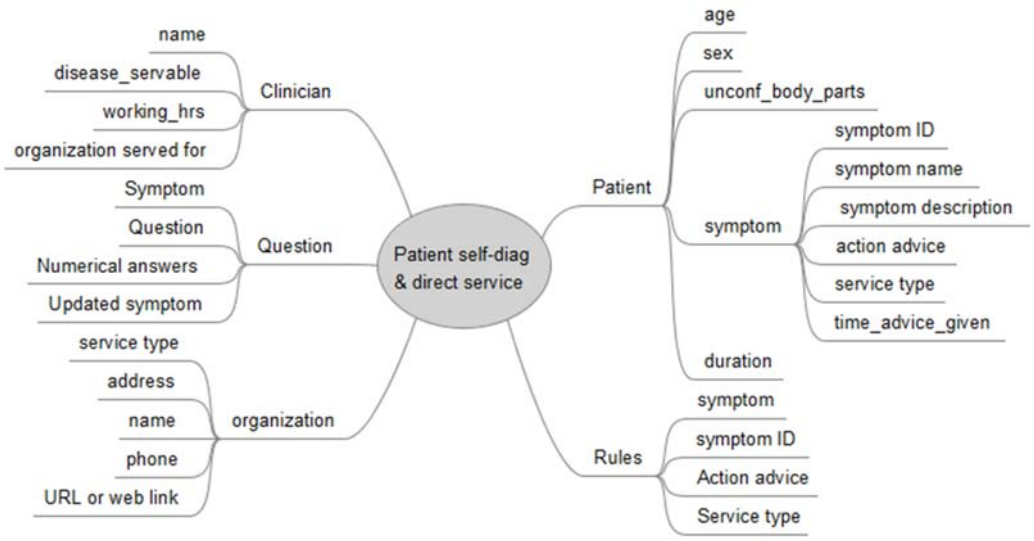


Fig 1.3-1: Mind map of data elements needed for this application, made by FreeMind on Windows 10, for demonstration purposes

According to the functions specified in part 1.2, patient data is collected for the systems to that the patient suffers, and what advice to give in term of actions and types of services. Since users' age and sex can be input by each user at the time when the application starts, so actual data does not need to be stored in the database of this application is demonstrated in fig 1.3 – 2.

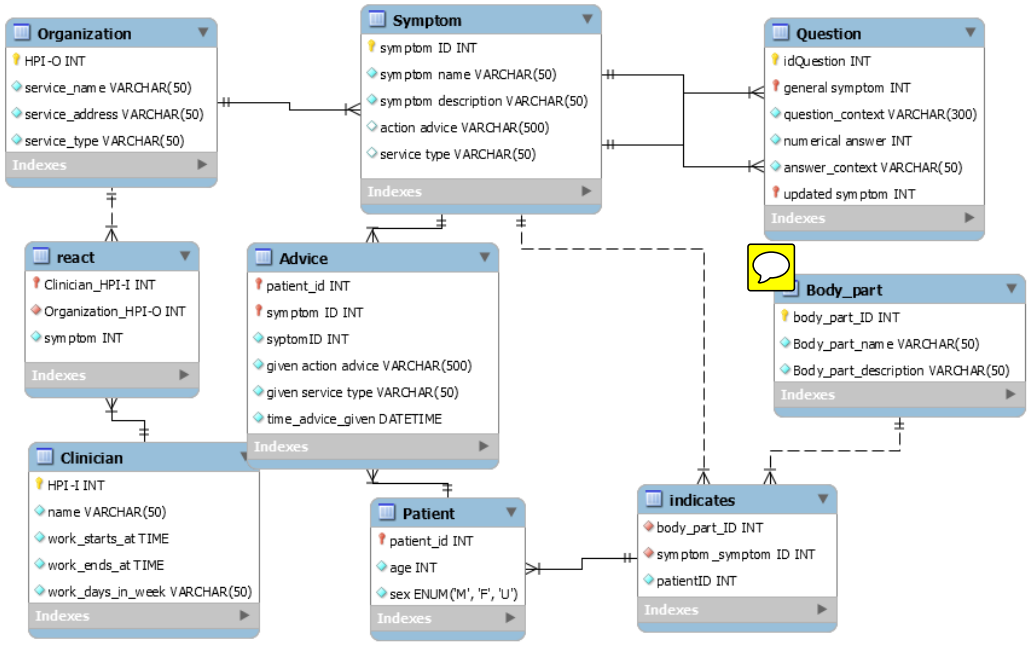
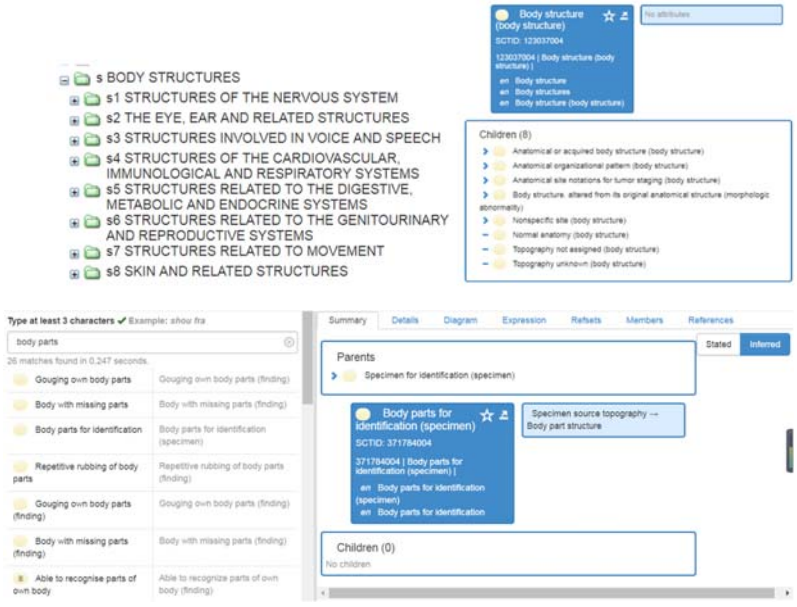


Fig 1.3-2: Data model of the database for the application to run, made by MySQL on Windows 10, for demonstration purposes. Note that the system does not users to actually input username or an id, the patient id is identified by the devices they are using. The key here is to record what the system did at what time and given advice shown on which device, as forensic evidences.

Part II: System and functional data points

Data element 1: Body Part ID:

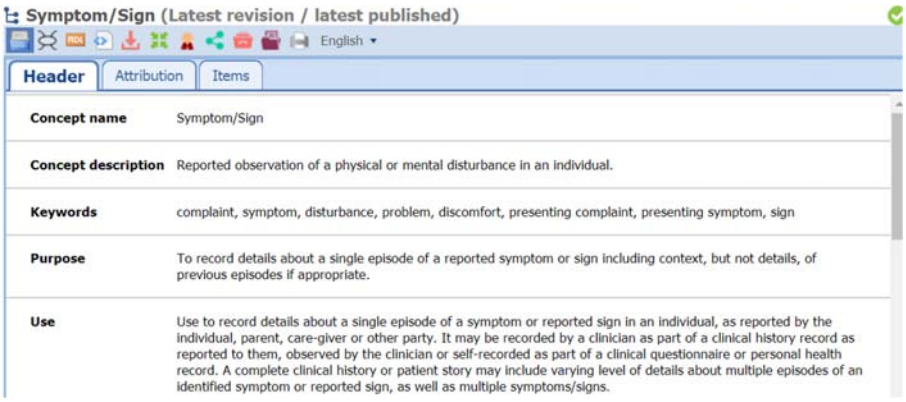
- Definition: Anatomical section of a person represented by a unique integer.
- Why to choose this definition: The original definition of "body parts" from METeOR is "An anatomical part of a person's body such as organs, limbs or their components. " [1], which is a synonym to this is "body structure". However, in the context of this system, I would like to adapt it to representing the integer ID of that part. The ID should describe "anatomical parts such as organs, limbs and their components."
- Collection of data: Clinical groups have to be involved in collecting this data and its related data elements, including body part name, body part description, symptoms can happen on this body part and distinguishing questions to be asked. Multiple resources have been checked and it is decided that the "Code" column in "Identifier Systems 4.2.13.550HL7 Version 2 Table 0550" standards should be collected as the dataset for body part IDs in this system, for several reasons:
  - In the scale of this application, it is only designed for giving very basic suggestions to patients. In this case, the application has to control the scopes to avoid "scope creep" in collecting data. However, it still needs parameters and images to certain level of granularity.
  - As a comparison to this collection, SNOMED-CT term "body structures" and "body parts" have been searched, also, ICF-browser version 2017 English has been looked up, they all do not fit the scope of the purpose of collection.
  - ICF-Browser provides a too detailed structure in the purpose of this application, similar as "body structures" specified by SNOMED-CT. However, definitions of terminologies of "body parts" in SNOMED-CT does not meet the meaning in this context. [1], [2]

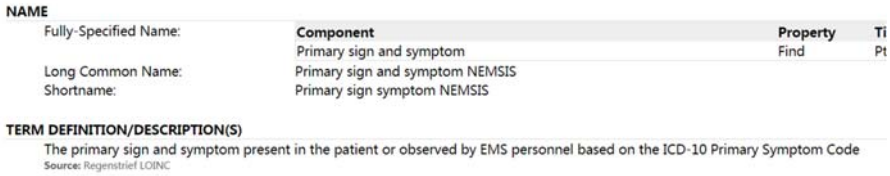


- Use of data:
  - Correct use of this data: This ID IS ONLY USED IN THIS APPLICATION FOR 3 PURPOSES:
    - In searching the name and description of the body part, according to its HL7 v2 Table 0550 identifier.
    - To equate users' chosen part in image into coded anatomical body parts that may indicate various symptoms.
    - To uniquely identify symptoms associated with chosen body parts in the knowledge system.
  - Misuse of this data: Any other purposes specified out of the correct use are misuses of this data. For example, this data element is **NOT** used for linking patients' treatment of certain diseases on certain body parts; it is **NOT INTENDED TO** be used to m[illegible]ecord clinical anatomical data stored by other standards; **NEITHER** can it be [illegible]ed for other administrative purposes or billing purposes.
- Value sets: Including all the code sets of the data set: http://hl7.org/fhir/v2/0550/index.html
- Identified issues: Needs clinical governance to review the definitions of collected data.

Data element 2: Symptom Name:

- Definition: A brief nomination of "an apparent physical or mental feature which is regarded as indicating a condition of disease". [3]
- Why to choose this definition: Symptom name might mean various things from findings, observations to signals. After checking OpenEHR, LONIC, ICD-11 browser and SNOMED-CT, I decided in this context "symptom name" [illegible]uld be meaning a brief description of an "OBSERVATION" of "the already presented or observed primary signs that lead to uncomforted or indicate a disease of the patient. " [4], [5] Definition from LONIC is not proper because it repeats the word "symptom" in its definition, and the standard is used for laboratory purposes, which does not suit the content of this application. Definition from Oxford nearly fits the purposes, but it needs further specification that the information about the name, namely the nomination of the symptom. Definition from OpenEHR nearly fits my purpose, especially the "disturbance in an individual" part, but it is not a clinical r[illegible]rting system that I aim to design, so the definition needs to be modified to fit my purpose.

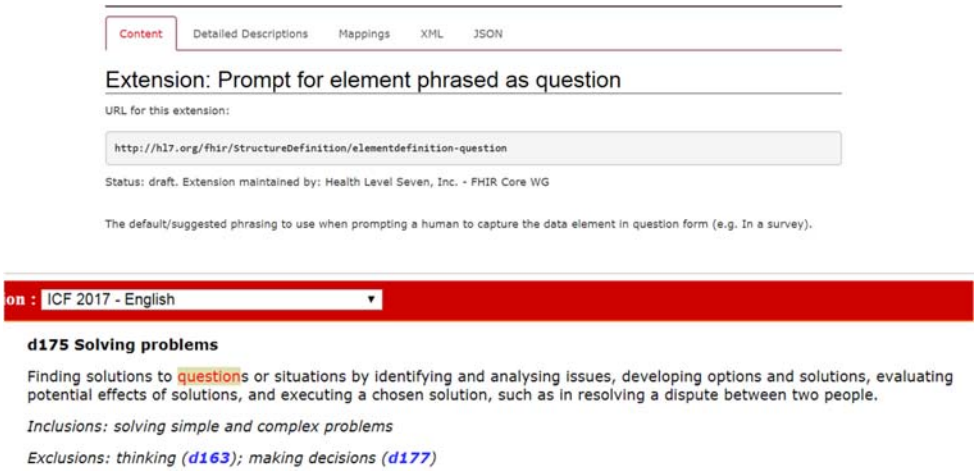




- Collection of data: Some of the data is available from the SNOMED-CT "manifestation-or-symptom" dataset, which is recorded on the website of HL7 of "manifestation-or-symptom", which is available at: https://www.hl7.org/fhir/valueset-manifestation-or-symptom.html. However, due to the requirements of detailed granularity to associate symptoms to help associate to questions to ask (see table 1-8-1 and 1-8-2), this data set needs to be expanded by clinicians in this domain.
- Use of data:
  - Correct use of this data: This data is only used to combine with the body part information that the user inputs into the system, to query about distinguishing questions that should be put forward. Namely, after user clicks a body part, only certain symptom names displayed as defined will be shown to the user for choose, and the system takes user entered choices, combine with body part, age and sex of the user to query about distinguishing questions to help to give corresponding suggestions about proper referring this user.
  - Misuse of this data: Any other usages of this data element other than specified in the correct use are regarded as misuse of the data.
- Value sets: The value sets contains 2 parts, one is all the symptoms of the "display" column at URL: https://www.hl7.org/fhir/valueset-manifestation-or-symptom.html for the coding of the symptoms, the data is originally from SNOMED-CT. Another part is the set of symptoms combined with actions and service types entered by clinicians. (see table 1-8-1 and 1-8-2)
- Identified issues: This data column contains manifests as well as displayed symptoms, so the data collection needs clinical help to make sure only data related to symptoms are collected, rather than the whole set of data. Secondly, I need to work with clinical person to ensure that the displays are in plain English for ordinary users of this application.

Data element 3: Question:

- Definition: "Interrogative sentences" used to clarify type and severity of the symptom to conclude advices and services. [6]
- Why to choose this definition: I have searched METeOR, HL7, SONMED-CD, ICF, Oxford English Dictionary, and LONIC using key words such as "question", "questions", "clinical question(s)" and "differential diagnosis", but cannot find any exact definition about this this word. HL7 proposed a description of elements should be asked in a question that is slightly helpful for defining this word in this context, but it is not a proper definition. The "identifying and analyzing" piece from ICF-browser, which talks about "solving problems" is slightly helpful, but it is also not a proper definition in this content. Based on my content, questions are entered by clinicians in order to infer more detailed symptoms or to respond corresponding advices and services. Therefore, this definition is finally chosen by combining pieces from different sources and considering the usage in my content.



- Collection of data: I have searched METeOR, HL7, ICD-11, openEHR, SONMED-CD and ICF, by using key words such as “question”, “questions”, “questionnaire”, and “surveys”, and unfortunately, none of the data fits my purpose in my context. No standard found out that is related to ask what questions by what symptoms reflected, it is really professional clinical knowledge from various sources of clinical guidelines and clinical textbooks. Therefore, I decided that in terms of this application, question data have to be manually collected and entered by clinicians. The questions should be organized in ways such that they are able to be understood by non-medical people, and those questions should be short. No repetitive questions related to patient inputs should be asked. For example, if the patient is already detected as symptom “asthma”, then the question “Are you having an asthma” should obviously not be asked.

- Use of data:
  - Correct use of this data: Data collected in this scenario can only be used when user input symptoms are not detailed enough to put forward actions and find types of services proper, to decide a more detailed symptom associated with proper actions and services. Any other use of this data is deemed as misuse.
  - Misuse of this data: Any other uses of this piece of data other than specified in “correct use” are regarded as misuse. For instances, this data is NOT used for asking further questions in the chronic disease management life cycle. NOR could it be used for gathering detailed conditions of a patient (e.g. types of microbes that cause inflection)
- Value sets: In this scenario, the value sets need to be manually made up. The format of the value set is similar to what is shown in table 1-8-2. During the development phase, enough time (e.g.3 months) should be given for clinicians to enter those data.
- Identified issues: The issue for collecting data for this data element is obvious. Tremendous amount of work should be done by clinicians to enter data based on their professional knowledge. Medical guidelines and textbooks might need to be checked to ensure quality of data being entered.

Data element 4: Updated symptom:

- Definition: Unique identifier of a "physical or mental feature being regarded as indicating a condition of disease" that is decided by the answers to the questions.
- Why to choose this definition: This element is the updated symptom, which belongs to the question entity, after patients already come up with symptom(s) but is / are still not sufficient to give them advices and referred services. Therefore, in terms of this definition, components of "symptoms" have to be thought about, but it is one step further in the context of this system from original "symptoms" chosen by users, and it should be displayed as a SNOMED-CT symptom code to fit the model design.
- Collection of data: This data elements includes the codes of all the symptom sets of SNOMED-CT, plus other identified situations that SNOMED-CT does not include (e.g. negation of situations, such as asthma without an inhaler). So clinicians who are familiar with SNOMED-CT codes should help to fill the forms, and leave those codes they cannot find as blank and the system will be able to assign unique identifiers to those symptoms whose IDs cannot be found in SNOMED-CT.
- Use of data:
  - Correct use of this data: This data is only used in the context of this system, under the conditions that an original symptom or list of original symptoms are already entered by user, and more detailed symptoms are needed to make suggestions on advices and services. It is associated with the rule management of the system, and is only related to the original symptom(s) entered by users or detected through a series of questions.
  - Misuse of this data: Any other uses except the specified correct use are misuses. For example, this data is NOT used for pharmacy purposes to link symptoms to medications. It can NOT be used as the disease / disorder formally recorded in patients' EHR or EMR. NOR can it be used for administrative or billing purposes.
- Value sets: The value sets contains 2 parts, one is all the symptoms of the "code" column at URL: https://www.hl7.org/fhir/valueset-manifestation-or-symptom.html for the coding of the symptoms, the data is originally from SNOMED-CT. Another part is the set of symptoms combined with actions and service types entered by clinicians. (see table 1-8-1 and 1-8-2) And the set excludes those already in the original symptoms that users can choose from the image that loaded on the running of the application. The final symptom determined by questions is the one that induces advice and service types.
- Identified issues: This data element needs manual clinical checking to exclude those original symptoms that are not specific enough to give advices and service types.

Data element 5: Service type:

- Definition: Category of the Australian healthcare organizations that should be contacted for a person with symptoms and situations they have chosen through the portal from the system.
- Description: To define this data element, in the context of this application, I actually mean the category (level 'A', 'B', private, local GP, phone-base services, such as poison center, baby center and so on…) that a hospital belongs to. Therefore, the idea of the definition came from AIHW's document describing how different types of Australia work. METeOR has definitions about "support service type", but this definition cannot replace the word in my context. Plus, it might not be a good definition fitting my purposes, because it uses "type of services" to define

"service type". HL7 provides a service type value set, but it tends to be too detailed for the aim of my application (I do not need to know exactly whether it is an aged care organization, Maternal & Child Health or what, I just need to know level of services it can provide). So this also does not fit my purpose.

Service provider organisation—support service type, code N[N]

Identifying and definitional attributes

Metadata item type:	Data Element
Short name:	Support service type
METeOR identifier:	462314
Registration status:	Housing assistance, Standard 01/05/2013 Community Services (retired), Standard 19/09/2013
Definition:	The type of support services offered by a service provider organisation, as represented by a code.
Data Element Concept:	Service provider organisation—support service type

- Collection of data: Information of types of various hospitals as well as their categories should be collected for each state in Australia, this information is available on the website "Healthcare Identifiers Service for health professionals", and the collected data should be put in a quality assurance process.
- Use of data:
  - Correct use of this data: The data of register of healthcare organization Australia here is only used as an element of other information about a service type that are returned for users to look at, it is associated with the HPI-O of the healthcare organization. Also, once been collected, medical services and their types can be checked from this data element. Other uses of this data element are all treated as misuses.
  - Misuse of this data: Other purposes other than specified correct use of this data are all misuses. For example, this data should NOT be linked to trace patients' preferences of services. Also, it should NOT be used for administrative or billing purposes according to the levels provided.
- Value sets: Value sets of categories of healthcare organizations from: https://www.humanservices.gov.au/organisations/health-professionals/services/medicare/healthcare-identifiers-service-health-professionals should be collected and under quality assessed.
- Identified issues: This data element is subjective to change, as service types of different hospitals may change as the hospitals develop or shrink. So the system should be able to check update of this data element constantly.

References:

[1] "Person—body structure, code (ICF 2001) AN[NNNN]." [Online]. Available: http://meteor.aihw.gov.au/content/index.phtml/itemId/320147. [Accessed: 04-Sep-2018].

[2] "ICF Browser." [Online]. Available: http://apps.who.int/classifications/icfbrowser/. [Accessed: 05-Sep-2018].

[3] "symptom | Definition of symptom in English by Oxford Dictionaries." [Online]. Available: https://en.oxforddictionaries.com/definition/symptom. [Accessed: 12-Sep-2018].

[4] "67774-0." [Online]. Available: https://s.details.loinc.org/LOINC/67774-0.html?sections=Comprehensive. [Accessed: 05-Sep-2018].

[5] "Clinical Knowledge Manager." [Online]. Available: https://www.openehr.org/ckm/. [Accessed: 05-Sep-2018].

[6] “Question | Definition of Question by Merriam-Webster.” [Online]. Available: https://www.merriam-webster.com/dictionary/question. [Accessed: 12-Sep-2018].
[7] “ah16-2-1-how-does-australias-health-system-work.pdf.pdf.” .

Part III: (Haven’t finished yet, below are scripts)

One already know note: Work with Australian Medical Associations.
Need to think about user-friendly issues and easy-to-use issues, improve Ux