Introduction:

Unified Modelling Language (UML) and Business Process Modeling Notion (BPMN) models are exclusively used in the health care to deal the clinical workflows efficiently. UML class diagram serves as an important tool in defining the structure and relationships among the connected entities (Vasilakis et al.,2008). Analysis of the attributes depicted is possible with these UML diagrams. On the other hand, BPMN diagrams are used to represent control flow of a process with various activities. When concerned with healthcare, BPMN streamlines the clinical steps and workflows to aid in administration (Ramos-Merino et al., 2018). To suit the given clinical case(D), we have modelled a UML and two BPMN diagrams.

Model -1: UML Classes: Provider-Centered Relationships



Definitions:

* Code – This code refers to the terminology provider will be using to define a procedure or the diagnosis. For example, the physician might use ICD-10 but the radiologist might use SNOMED-CT. This code varies across different hospitals.

Notes:

* Here multiplicity note “0..1” is specified for gender as it is the personal preference of the patient to disclose, so we might encounter an empty field in some instances.
* The specialty of the provider holds importance as it is responsible for performing the procedures.
* Here the patient might experience multiple diagnosis and procedures performed by different providers.

Interoperability:

With the UML diagram, it is clearly evident that the provider can perform multiple procedures depending on the specialty. According to the use case, the physician orders for chest X-ray through EHR. This transfer of request to the radiologist is facilitated through standardized terminology. So, semantic interoperability holds significance in this scenario.

Examples of instances demonstrating semantic interoperability include, reporting the diagnosis of a patient across systems and exchanging the drug prescriptions across hospitals. Semantic interoperability is commonly seen during the Health Information Exchange across the connected systems to improve the patient outcomes.

Model -2: BPMN: Consultation and Diagnosis Decision Flow



Definitions:

* Patient – Refers to all the information and decisions taken by the patient.
* Medical Office – This includes any of the medical office staff.

Notes:

* The patient decides to attend the scheduled appointment or not.
* The physician comes to a provisional diagnosis of asthma after recording the history and physically examining the patient.
* Here the exit is out of the swim boxes as it is independent of both the entities.

Interoperability:

Here, in this diagram, the history of the patient is taken and saved in EHR following a standard terminology. Added to this, the physician made a provisional diagnosis of Asthma and stored the information in EHR according to any one terminology followed by the hospital (Ex: ICD-10). These activities draw to semantic interoperability as the data is stored and codified using a terminology. This facilitates ease of data exchange across various systems to discuss the clinical case efficiently.

Other examples of such interoperability are seen during reporting of any laboratory results and medication errors. Semantic interoperability is also seen during the billing procedures to facilitate ease of communication with insurance companies.

Model -3: BPMN: Radiology Referral and Diagnosis Flow



Definitions:

* Medical Office - This refers to any of the medical office staff.
* Radiology Clinic - Refers to the radiologist.
* Lab test – It refers to laboratory diagnosis. In this case, Chest X-Ray is used as additional supporting evidence to provisional diagnosis.

Notes:

* To support or oppose the provisional diagnosis, Chest X-Ray was requested by physician in the EHR to the radiologist.
* So, the flow is initiated from the medical office to the radiology clinic.
* The radiologist decides to perform the procedure or not and report back the diagnosis to EHR.
* The exit is drawn outside the swim lines as it is an independent event of both boxes.

Interoperability:

This diagram represents the request of information from one system to another and reporting back of the diagnosis to EHR. After the provisional diagnosis has been entered in the EHR, the physician ordered for Chest X-Ray. This information has to be transferred in a data format where syntactic interoperability comes into picture.

Requests for additional laboratory tests and referral requests pertaining to diagnosis are the situations that root to examples of syntactic interoperability. When finding solutions to research queries, syntactic interoperability plays an important role in exchanging data and finding meaningful inferences out of it.

Additionally, UML and BPMN models of this use case suggest organizational interoperability as the data is transferred between two systems. Human interoperability is also seen when there is manual diagnosis and interpretation of results made by the physician and radiologist respectively.

As a team, we believe that the clinical symptoms and results of physical examination are not represented in the modelling as well as not addressed by the physician after primary diagnosis. Patient follow-up and revisit is not shown in the BPMN diagram. The clinical workflow from the physician office requesting a Chest X-Ray through EHR as a worklist item at the radiology clinic can include detailed data elements. The interpretation of the Chest X-Ray by the radiologist has not been modelled in any of the diagrams.

References:

Ramos-Merino, M., Álvarez-Sabucedo, L. M., Santos-Gago, J. M., & Sanz-Valero, J. (2018). A BPMN based notation for the representation of workflows in hospital protocols. *Journal of Medical Systems*, *42*(10), 181. https://doi-org.proxy.ulib.uits.iu.edu/10.1007/s10916-018-1034-2

Vasilakis, C., Lecnzarowicz, D., & Lee, C. (2008). Application of Unified Modelling Language (UML) to the Modelling of Health Care Systems: An Introduction and Literature Survey. *International Journal of Healthcare Information Systems and Informatics (IJHISI), 3*(4), 39-52. http://doi.org/10.4018/jhisi.2008100103