Informatics for Health: Connected Citizen-Led Wellness and Population Health
R. Randell et al. (Eds.)

doi:10.3233/978-1-61499-753-5-511

Appraising Healthcare Delivery Provision: A Framework to Model Business Processes

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Abstract. Children are dependent on a reliable healthcare system, especially for the delivery of care which crosses the primary/secondary care boundary. A methodology based on UML has been developed to capture and single out meaningful parts of the child healthcare pathways in order to facilitate comparison among 30 EU countries within the MOCHA project. A first application of this methodology has been reported considering asthma management as an example.

Keywords. Business process modelling, UML, rich picture, building blocks, children, asthma

1. Introduction

The main objective of the MOCHA (Models of Child Health Appraised) project[2] is to compare and appraise existing models of primary care for children among 30 EU/EEA countries. The complexity and variation in care provision makes it a challenging task that needs a holistic and multidisciplinary approach for the analysis of health service patterns, and measurement of system performance, outcomes and costs. The identification of optimal models of primary child healthcare considers how health systems organise the interaction and integration of primary, secondary and social care to deal with the different healthcare needs, ranging from well-being related services, that monitor the psychophysical development of a healthy child and/or of children with special conditions or needs, to the treatment of acute and chronic conditions. Under this perspective the application of business process modelling contributes to the analysis of the current delivery models adopted in each EU country providing a synthetic and pictorial description of the different ways of organizing, coordinating and delivering children's care. For this reason, to produce a consistent and scientifically sound business process of child healthcare delivery a conceptual framework was developed to capture and single out meaningful parts of the child healthcare pathways so to facilitate the comparison between national health systems.

The paper is structured as follows: a methodology that captures the business process from a high-level to a low-level of granularity is presented in Section 2, providing the description of each model applied as well as its use in the MOCHA perspective. The third section reports the application of the methodology using asthma disease management as an example. Finally, discussion and conclusions are presented.

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2. Methods

The methodology proposed in this paper is described in Table 1, highlighting the main steps to be followed to identify homogeneous parts of the process of child care that can facilitate the comparison between national health systems.

Table 1. Main steps of the proposed methodology highlighting aim, method, input and result of each step.

Aim	*Method*	*Input*	*Result of the step*
Conceptual model			
Identify the main components that influence the child care from the MOCHA perspective	Rich picture	MOCHA objectives; Vision of child care	Determinants of care, set of macro-processes.
Identify the macro-processes and macro-activities that describe the child care	Map of building blocks	Rich picture	Identification, for each macro-process, of the generic workflow and of the linked building blocks.
UML model			
Identify the activities, the actors involved and their relationships to a disease	Use case diagrams	Macro-processes; Guidelines	Identification, for each macro-process, of all possible actors and roles involved.
Identify similarities and differences between countries in terms of: Activities performed; Actors involved; Where it is executed; Timeline	Activity diagrams	Use cases; Case studies; National norms and regulations	Identification, for each use case, of a set of activity diagrams grouping countries with similar process performance. They identify activities and messages exchanged, actors involved, their relationships and interactions.

The highest level of abstraction is described by a *rich picture* [1,2] that specifies the main components setting the boundaries of the healthcare service provision centred on child care pathways.

The second point of view, called *map of building blocks*, is a refinement of the rich picture that specifies the macro-processes describing their generic workflows and related macro-activities to be analysed in the provision of child care. Each map that represents one of the main healthcare pathways is composed by a sequence of building blocks executed in parallel or in series to accomplish a well-defined objective. Decision points are also included in the workflow to determine alternatives as well as parallel paths within a process flow. Additional linked building blocks are included in the map and represent macro-activities that can be executed in certain circumstances and anytime within the main process. Differently from the use of building blocks in software development [3], in our approach they are needed to single out homogeneous, comparable parts of the process that have to be taken into account when analysing the different national care provision.

This conceptual point of view is the starting point to apply and develop the UML models [4] that provide a standard way to visualize the process description relevant for our aims. In our methodology we select the use case and the activity diagrams as suitable means to describe the interaction between the different stakeholders as well as the activities performed in each identified scenario [5]. The *UML use case diagram* describes a single, previously identified building block focusing on a specific disease or type of intervention, generally based on available clinical guidelines. Considering that clinical guidelines are commonly agreed by the scientific community, they can be used as an ideal set of activities to be performed, thus providing a country-independent picture as an important point of reference to assess the quality of care provision.

Finally, once the actors and macro-activities of a specific building block have been identified, *UML activity diagrams* are used to capture the activities performed and the

messages exchanged by the different actors as well as triggering conditions taking also into account the location and timeline of each activity. The description of the activity diagrams is based on the results of Country Agents questionnaires developed by MOCHA partners around case studies, that capture real-life context [6] in child health service provision. On the basis of these descriptions, countries that have similar procedures, use similar services, and are based on similar caregivers for the provision of care are grouped and then compared.

3. Results: Application of the Methodology

This paragraph gives an example based on asthma treatment that illustrates how UML use case and activity diagrams (UML Model from Table 1) have been integrated in the proposed methodology. The rich picture shown in Figure 1a models at the centre of the system the child represented as a girl jumping from well-being to disease management and vice versa. Children are generally a healthy population whose psychophysical development is monitored especially, but not only, in the first years of their lives. When an illness occurs, this is treated following a disease management pathway whose results lead to the normal well-being monitoring, or with the management of chronic conditions. Strictly connected with these two pathways social support is included in the rich picture to identify services addressed to improve quality of life, such as social inclusion, ability to live independently, fundamental rights. Moreover, these pathways are surrounded by the family and the related living and working conditions, the community as well as health services and professional caregivers. Other determinants of health are identified in socio-economic and financial conditions as well as cultural and environmental settings.

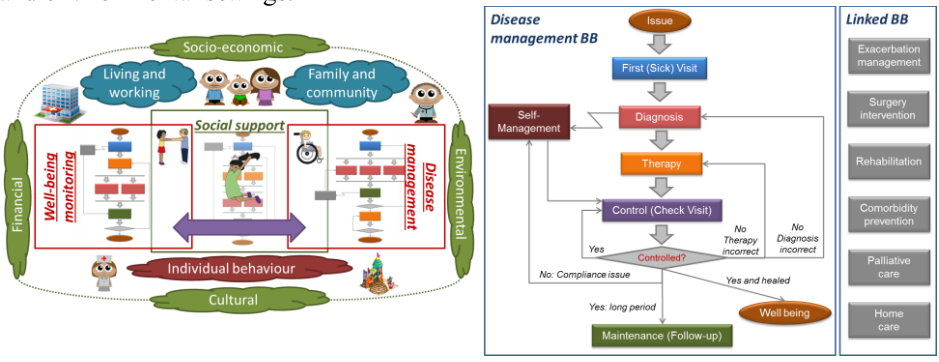

Figure 1. (a) Rich picture; (b) Disease management map of building blocks

Figure 1b shows a map of building block as a first refinement of the rich picture focusing on the disease management pathway. A high-level workflow comprises the macro-activities performed to make a diagnosis and prescribe the related initial therapy. A check visit is then scheduled to verify the appropriateness of the therapy, to control whether the issue is solved (return to well-being pathway) or follow-up activities should be foreseen (management of chronic patients). The disease management process comprises various linked building blocks that can represent the connection between primary and secondary care and/or the treatment of children with complex needs, such as exacerbation management, surgery intervention, rehabilitation. Figure 2 depicts a use case diagram that describes the "first sick visit" building block structured on the

GINA (Global Initiative for Asthma) [7] guidelines. Best practices described in guidelines do not specify who performs the activities given that it depends on the way the healthcare system is organized. In our perspective, this aspect is crucial to compare the different models of service provision in the 30 EU countries. Therefore, the use case diagram has the important function to identify actors and roles in the performance of the "first sick visit" macro-activities. This represents a synthetic, not country-specific, view useful to capture, for example, whether a diagnostic test is performed directly by a gatekeeper or a specialist and, in the first case, whether this is done by a GP or a Paediatrician depending on the national healthcare system (e.g. Italy is a primary care paediatrician-based system, whereas the UK is a generalist GP-based system).

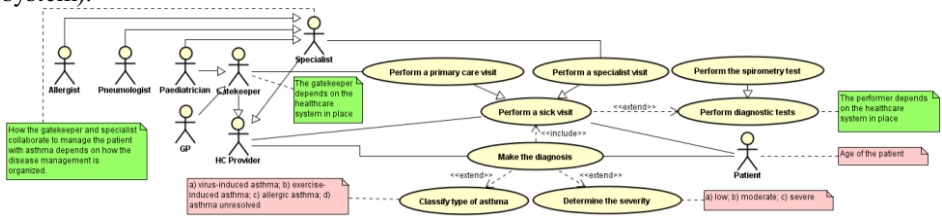

Figure 2. UML use case diagram describing a sick visit performed for the treatment of asthma

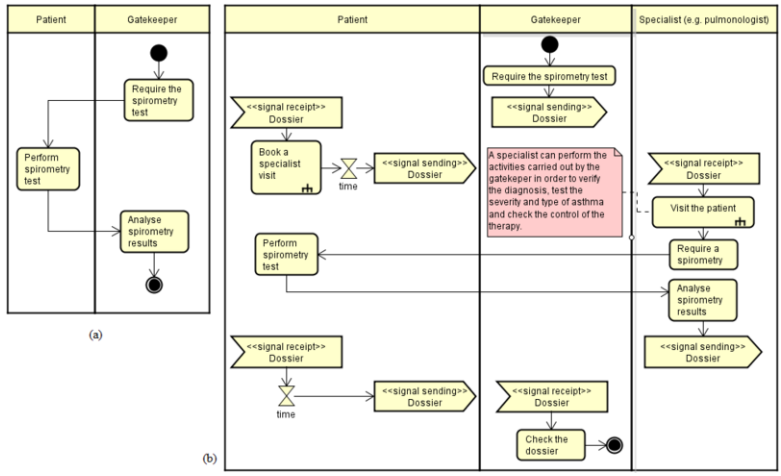

Figure 3. Activity diagram describing the spirometry test performed by a) gatekeeper; b) specialist

Figure 3 shows the activity diagram for the use case: "perform the spirometry test". The diagram is based on a case study where a ten-years-old child has occasionally experienced wheezy attacks and needs to perform this test during the sick visit to help the healthcare providers to make the diagnosis as well as determine the type and the severity of asthma. This test is an important part of the diagnosis process as it can be performed directly by the gatekeeper (GP or paediatrician) or by a specialist. Therefore, we can distinguish the countries in these two groups and compare the activities performed in each one. In particular, in Figure 3a the test is directly executed by the gatekeeper during the first sick visit. In this case the gatekeeper can analyse the results and consequently make the diagnosis. Differently, in Figure 3b the spirometry is performed by a specialist, for instance in countries where the gatekeeper is not equipped with spirometer or is not qualified to perform this task. Thus, in the diagram the introduction of this third actor is needed and visualized using the relevant swim

lane. In particular, the gatekeeper requires the family of the child to book a specialist visit during which the required test is performed. This implies the collaboration between the two healthcare professionals as well as the inclusion of administrative procedures related to the booking and eventually payment of the specialist visit. The two processes are compared not only on the basis of activities performed and actors involved but also on the time required to perform the diagnosis. This implies also to include waiting time for a child to access the primary as well as the secondary care visit, as shown by the hourglass reported in the diagram 3b.

4. Conclusions and Discussion

The paper describes a framework to facilitate the comparison between the different business processes performed in 30 EU/EEA countries in the delivery of child care within the MOCHA project. Given the difficulties in the a-priori identification of pre-defined models of care, the proposed methodology is based on a conceptual framework that allows the comparison between a set of homogeneous building blocks that are identified in the context of three main pathways: well-being monitoring, disease management and social support. The methodology also specifies how UML use case and activity diagrams are applied to achieve the comparison of business processes across countries. In particular, the use case diagram provides a snapshot of actors and activities related to a building block and relies on clinical guidelines that represent a benchmark to compare healthcare business processes. Activity diagrams highlight differences and similarities in activities performed, actors involved as well as timelines in real-life context. This methodology has the advantage of making comparison of child healthcare systems on the basis of homogenous, well-defined parts of the process of child care. Moreover, it is flexible enough to allow the analysis of parts of the process selected on the basis of the case studies identified by the MOCHA partners for the investigation and appraisal of health systems. Finally, this methodology is also suited to consider the interaction between primary and secondary care and/or complex care as well as the analysis of interfaces with social services within national healthcare systems.

Acknowledgment

This study is part of the Horizon 2020 MOCHA project. Grant agreement no. 634201.

References

[1] P. Checkland, J. Scholes, *Soft Systems Methodology in Action*, John Wiley and Sons, Chichester, 1990.
[2] H. Liyanage, D. Luzi, S. de Lusignan, F. Pecoraro, R. McNulty, O. Tamburis, P. Krause, M. Rigby, M. Blair, Accessible Modelling of Complexity in Health (AMoCH) and associated data flows: asthma as an exemplar, *Journal of Innovation in Health Informatics* **23** (2016), 476-484.
[3] J.K. Müller, Aspect design with the building block method, *Software Architecture* (1999), 585-601.
[4] J. Rumbaugh, I. Jacobson, G. Booch, *Unified Modeling Language User Guide,* Addison-Wesley, 2005.
[5] H. Eriksson, P. Magnus, *Business modeling with UML, Business Patterns at Work*, John Wiley & Sons, New York, USA, 2000.
[6] S. Crowe, K. Cresswell, A. Robertson, G. Huby, A. Avery, A. Sheikh, The case study approach, *BMC Medical Research Methodology*, 100 (2011), 1-9.
[7] GINA (Global Initiative for Asthma) guidelines. Available at www.ginasthma.org