Interacting Agents for the Risk Assessment of Allergies in Newborn Babies

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Abstract. Allergic diseases are increasing all over the world. Therefore, the risk assessment of allergy in newborns is a key issue for prevention purposes. The risk can be assessed at the birth by combining information about familiarity with results of blood examination. Then, the individual must be monitored, particularly in the fist months of life, in order to better define the type of allergy and the risk. The monitoring is carried on by different professionals (agents), therefore the communication and collaboration between these agents must be supported in order to obtain the best treatment strategy for the baby. This paper presents a new project which allows the cooperation between the agents involved in the risk assessment of allergy in newborn babies, and presents the main technologies which will be used to develop it.

1 Introduction

All over the world there is evidence that allergic diseases are increasing, and most of the allergies develop within the first decade of life. Among possible reasons for that, scientific debate in the literature reports air pollution, lifestyle, medication abuse, vaccinations, food additives, but weak evidence exist for definite answers. Diagnosis of allergy or of atopy (i.e. the tendency to develop immediate hypersensitivity to allergens) is a real challenge. Although familiarity is important, it is often extremely difficult to collect a detailed and focused family clinical history and to establish relationships between reported disturbances and allergies and interactions with other diseases. That's why more specific diagnostic tests must be performed. The two main types of diagnostic procedures are skin tests (in vivo) and blood tests (in vitro measure of immunoglobulin IgE), both measuring reaction of the patient's antibodies to a set of allergens. Even if skin testing has been for many years the most common screening method for allergy evaluation, blood tests are much more comfortable and quick, thus they are becoming more and more prescribed, mainly by non-allergists (pediatrician and general practitioners). The problem addressed in this paper is that allergens are hundreds, and the tendency of non-specialists is to test the biggest possible number of them. This trend caused a dramatic increase of allergy-related healthcare costs.

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Moreover, it does not necessarily increase the correctness of diagnosis, because of multiplication of false positive results. We propose a project for developing a network among neonatology departments, institutional healthcare agencies, pediatricians, General Practitioners (GPs), ambulatories and families, in order to suggest the best diagnostic and follow-up procedures.

2 Architecture of the System

The project described involves several actors (or agents) belonging to different organizations. The aim is to create a communication channel which permits the cooperation of the agents and the exchange of information and documents.

2.1 Serviceflow Management System

A Serviceflow Management System (SMS) is a system able to manage the overall care delivery process by establishing a tight link between different organizational units and professionals. The design of such a system is complex because there are several requirements to consider [2], and the agents involved in the care process must agree on the choice of IT support, on the communication protocols and on the timings and modalities of the service delivery. The advantage of the Serviceflow approach is twofold: from the patient's point of view, the coordination and synchronization of all the services are assured; from the organizations' point of view it permits to separate the definition of the activities provided from the method of providing them. The concept of Serviceflow relies on the concept of Service Point (SP): a SP is a "place" where the consumer and the provider of the service meet. Here, based on previous agreements, the consumer asks for a service and waits the producer to fulfil it. The SPs permit to coordinate the activities of the organizations ensuring their autonomy. SPs are characterized by pre- and post-conditions [3] that are respectively input and output parameters to be verified respectively to start the service and to determine the SP's success. These conditions enable the right service at the right time. By means of the SPs it is possible to coordinate the work activities, to monitor the work during its execution, to validate the executed activities and to manage dynamic process changes and exceptions.

A Serviceflow "is the successive interrelation of a number of Service Points" [2]. The execution of a Serviceflow, exploiting the agreements and the pre- and post-conditions, generates the correct flow of services for the patient.

2.2 Architecture

The architecture of the system is the result of our previous studies [5]. This architecture, shown in Fig. 1, is composed three different levels.

Each organization (Organizational Units level) manages its activities with private processes, (i.e. applications and/or workflow systems [4]). Fragments of these processes are published as Service Processes (SPRs) at the Service level,

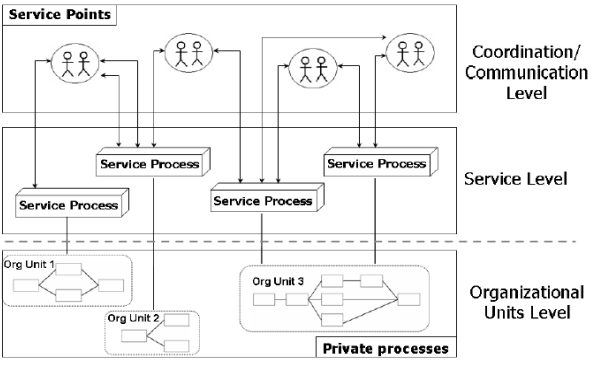

Fig. 1. Architecture of the system

acting as a public interface. A SPR is a public abstraction of an activity carried out by an organizational unit. A SPr definition contains also the conditions to be respected together with information about the provider. At the Coordination/Communication level [1], there are the SPs, which coordinate and synchronize any interaction exploiting the SPRs defined. As highlighted by the dotted line in Fig. 1, the model clearly separates the organization offer from its implementation in order to meet the privacy needs and the implementation choices of every organization unit.

On the basis of this general architecture, we designed a system which manages the network of agents involved in the assessment and treatment of allergic or atopy diseases of babies.

3 Application

The goal of this project is the creation of a collaborative network involving all the agents working on the diagnosis and the setup of the follow-up procedures for the babies considered at risk of breaking out allergies during the first ten years of life. This net is composed by: neonatology units, allergologic units, health-care institutional units, pediatricians, general practitioners and families of the babies. This application mainly focuses on the diagnostic procedures to assess the presence of allergies in the baby, or the possibility to break out allergies during the first years of life. The diagnostic strategy is carried out in three phases: (1) at the neonatology unit, a first evaluation is carried out by studying the familiarity and number of total IgE. If the risk is high, the baby is labeled as "positive", otherwise the label is "negative"; (2) if the label is "positive", the pediatrician carries out further investigations, monitoring the baby with appropriate tests until he/she turns 4; (3) when the baby turns 4, the diagnostic strategy implies the use of different tests and examinations, carried out by the GP when the baby turns 6.

Tests and examinations are carried out on a regular basis, according to predefined guidelines. During the phases presented above, The baby meets mainly

three different agents: a newborn specialist in the first, the pediatrician in the second and the GP in the third. This suggests to define every phase as a SPs of a Serviceflow at the *Coordination/Communication* level of the architecture shown in fig. 1. An additional SP permits the contacts between an agent at the neonatology unit and the provider of the data base containing all the baby's clinical information. These contacts allow the agents at the neonatology unit to receive results and outcomes of the tests and exams carried out and use these data to correct the initial labeling strategies in order to reduce the number of false positives and false negative cases. The interrelation of these SPs generates the Serviceflow shown in Fig. 2.

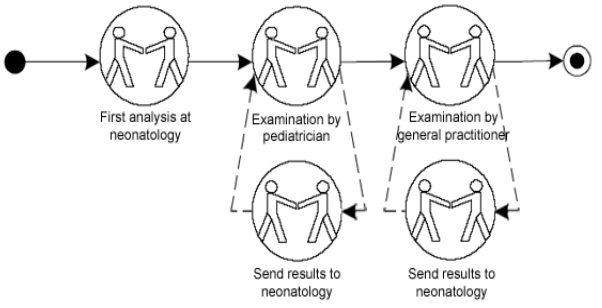

Fig. 2. Serviceflow for the risk assessment

Every phase described above is guided by a different guideline. Every guideline will be executed when the related SP is activated. Using this technique, we can offer the patient the proper services depending on his/her age and label, and execute the services with the proper guideline. The rest of this section describes one of the guidelines formalized with the tool *Guide* [6]. The implementation of these guidelines will compose the *Organizational Units* level of the architecture in fig. 1.

- *Guideline associated with the "examination by pediatrician" SP*

This guideline describes the management of newborns and babies under 4 years of age, carried out by the pediatrician, after the first analysis at the neonatology.

If the baby is symptomatic, the pediatrician checks her/his label: if it is negative or unknown, the test "Phadiatop level I" is carried out and his label may change; otherwise a "level II" test is performed.

If the baby is asymptomatic: (1) if the label is positive and one year has passed from the last test, a "Phadiatop level I" is carried out again. This allows performing the test every year on the babies labeled positive; (2) if the label is unknown and age is under 12 months, a label is assigned on the basis of the results of a a "Phadiatop level I"; (3) if the label is negative, or the age is over 12 months, the guideline stops.

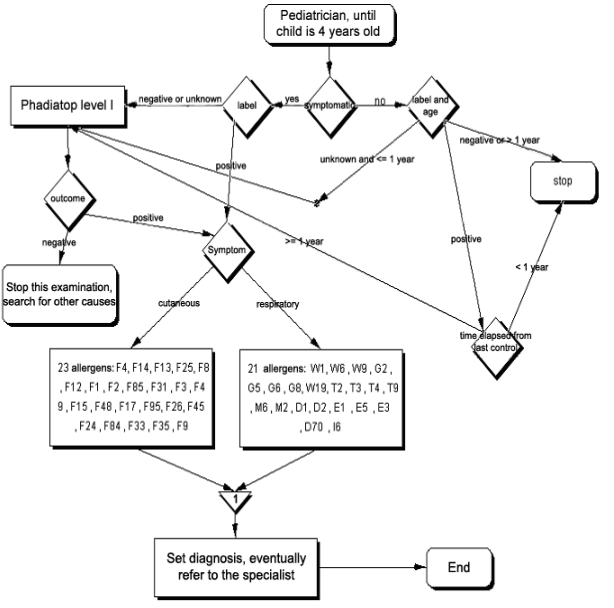

Fig. 3. Guideline 2: examination by pediatrician

The system proposed in this project manages the contacts between the baby and the agents involved in his/her care process, the exchange of information and documents between the agents and the coordination of the diagnostic activities in every phase. The contacts between the baby and the agents and the exchange of information are provided through the Serviceflow shown in Fig. 2, while the diagnostic activities are driven by guidelines like the one shown in Fig. 3. This system enforces the cooperation between the agents involved and the application of the protocols (guidelines) defined in order to offer a better diagnosis and treatment services without wasting resources in unuseful tests.

4 Conclusion

The challenge of the project we propose is to demonstrate that a Serviceflow Management System, associated to specific workflows based on clinical practice guidelines developed by expert allergologists, may be of great benefit for the national healthcare system, improving diagnostic procedures and follow-up and decreasing diagnostic tests expenditures. We are aware of the several issues that must be solved to develop such a system, first of all the integration with existing information systems that are currently used at the different levels (hospital units, healthcare agencies, regional level, etc), but also we are confident that the proposed architecture could harmonize those systems and foster collaboration.

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