Neonatologist at Home

Albert Pla-Planes, Natalia Mordvanyuk, Beatriz López,[1]
and **Abel López-Bermejo, Eva Bargalló, Cristina Armero**[2]

Abstract. Premature babies need special medical attention in the neonatal intensive care unit during a long time period. Recent studies show that time is shorter if spent in a familiar and loving environment. However, the vital signs of the baby should be closely monitored. To this end, mobile devices and artificial intelligence offer an invaluable service. NoaH is a mobile platform for helping parents, care givers and hospitals to remotely monitor pre-mature babies, allowing families returning home earlier.

NoaH uses wireless smart sensors to gather data regarding the babys status and combines a rule-based system and a case-based reasoner to provide support to both parents and care-givers.

Awards: this work has been awarded with the second prize in the Vall d'Hebron Research Institute (VHIR) Innovation Healthcare Contest (Barcelona 2015), and has been finalist in the eHealth award of the University eSante (Castres 2015).

1 DESCRIPTION

The World Health Organization estimates that preterm birth, defined as childbirth occurring at less than 37 completed weeks, range from 5% to 7% of live births in developed countries and substantially higher in developing countries, in addition, these figures appear to be rising. Premature infants, because of their immaturity, always need hospital care at a neonatal intensive care unit (NICU) for several weeks after birth. Prolonged hospitalization has been associated with poorer parentchild relationships, failure to thrive and parental grief and feelings of inadequacy. The noisy NICU environment , bright light and lack of day-night cycling can have adverse effects on infant growth and development. It also increases the newborns exposure to bacteria prevalent in NICU. Early discharge demonstrated that, once the premature infant reach a determined maturity degree, he can evolve faster and safeter at home than at the NICU. Nevertheless, at home, the baby requires a regular monitoring and to be assess by medical care givers in order to ensure an early detection of any abnormal or dangerous situation; requiring either a high number of visits from parents to the hospital, or the regular visits of nurses to the family home. This results in an increase of hospital resources that not always can be fullfilled.

NoaH (Neonatologist at Home) is an eHealth platform that aims to help in such scenario by providing mobile, intelligent and portable tools to monitor the status of the baby and to keep contact between the families and the physicians (see Figure 1). NoaH uses a smartphone app together with a Bluetooth LE pulse-oximeter to obtain the vital information of the premature baby. Every certain period, parents need to check the state of their baby, measuring his vital constants (heartbeat, weight, oxygen saturation in blood, etc.) and answering some questions regarding his behavior. The collected data is validated using a rule-based system that ensure that the measures have been taken in the propper conditions (e.g. the bayby was calmed, he was wearing the appropriate clothes, etc.). Following, the status of the baby is evaluated using the mobile reasoning engine of the NoaH app which informs parents regarding the status of the baby: OK (the baby is in a healthy situation), Warning (there is something abnormal, the hospital will contact you in short) or Alert (there might be a dangerous situation, contact the hospital immediately). The collected information is, at the same time, sended to the hospital facilities where it is analyzed using a Case-based reasoning engine that compare the current situation with past situations of the premature baby and with data from other similar patients; this reasoning step proposes an assesment for the babys status that needs to be confirmed by a physician.

NoaH uses artificial intelligence in two different steps. First, in the smartphone app. (see GUI on Figure 2), a rule-based system is in charge of two different tasks: on the one hand it models a set of validation rules to ensure the proper measuring of data. On the other hand, it models a medical knowledge in order to early detect possible illness symptoms (for instance, having a high breath frequency combined with a low hemoglobin level would trigger a respiratory distress warning message). To help adapting the rule-based system to the physicians needs, the rule-based system can be easily updated using a configuration file. In it, physicians can define complex rules using a formal grammar and can define the outputs to display in the app under each circumstance.

In the second step, the collected data is analyzed using a case-based reasoning tool. The CBR compares the collected data with information from the patients past health records but also using information from similar babies that had a similar context. In such step, first of all, the context of the baby is determined in order to select an appropriate knowledge-base for the CBR so the baby is compared only with patients that shared the same circumstances (similar environment, similar climate, similar type of family, etc.). The CBR provides physicians an assessment of the babies and also shows the most relevant cases that have contributed to determine such assessment. With such information the doctor can validate the diagnostic, which will be stored into the system, or can correct it. In addition, the doctor has the possibility to send a message to parents in order to request additional information or to require certain actions. In addition, in order to help physicians to understand the reasoning process held under the CBR system, the system incorporates a visualization system which illustrates one-by-one the CBR steps taken by NoaH that determine the status of the baby: context selection, retrieve and reuse (see Figure 3).

It is worth noticing that NoaH has been implemented following medical standards in order to maximize its usability and to favor its integration (SNOMED CT, ISO/IEEE 11073).

[1] University of Girona, beatriz.lopez@udg.edu
[2] Biomedical Research Institute of Girona, email: alopezbermejo@idibgi.org

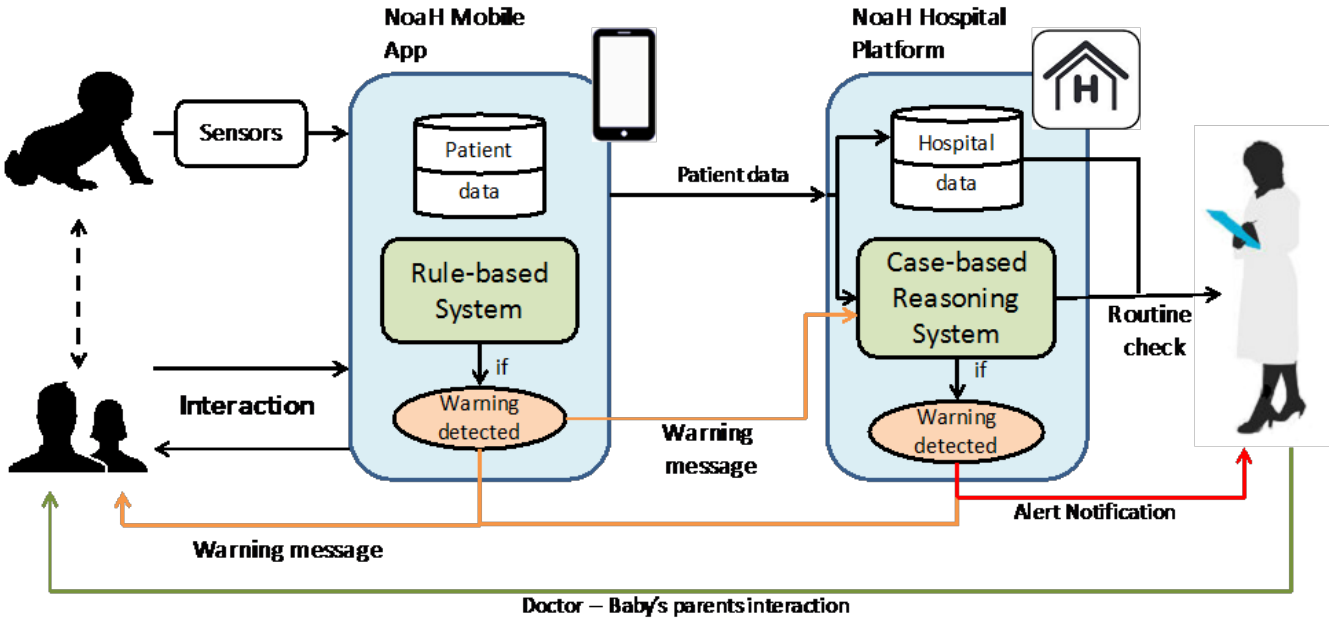

Figure 1. Platform overview.

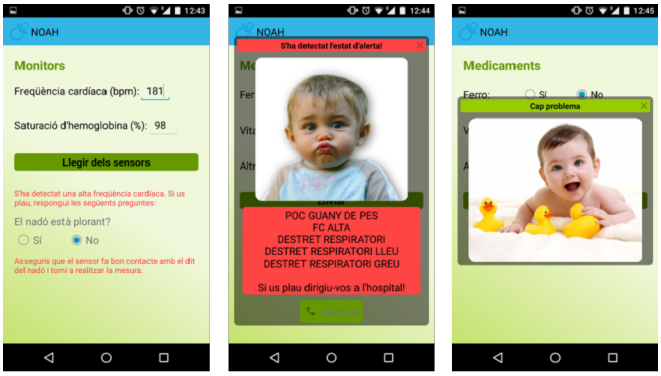

Figure 2. GUI for the parents.

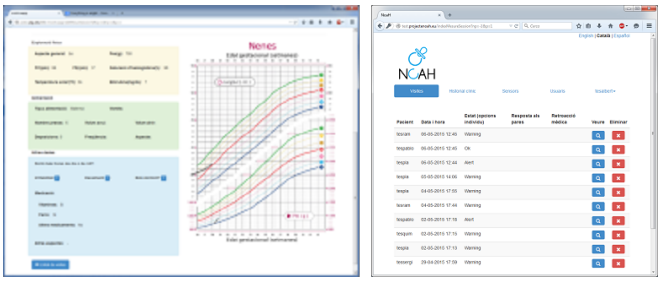

Figure 3. GUI for the clinical staff.