

Abstract

A Machine Learning algorithm to predict health clinical situations (fall, risk of denutrition, risk of depression and risk of heart failure) and improv decision-support tools in primary healthcare for older adults living at home.

Jacques-Henri Veyron M.S. ^{1*}, Théodore Rezel¹, Francois Lainée ^{2,3}, Stéphanie Malvoisin M.D.⁴, Charlotte Théry^{1,5,6} and Joël Belmin M.D., PhD^{5,6}

* corresponding author (jhveyron@presage.care)

Affiliation :

1 : PRESAGE, 112 rue de la Boétie – 75008 Paris

2 : Aleia, 47 Rue de Ponthieu, 75008 Paris

3 : Télécom Paris, 19 place Marguerite Perey, 91120 Palaiseau

4 : CHU La Réunion Sud, Unité Intersectorielle de GérontoPsychiatrie, BP 350, 97448 Avenue François Mitterrand, Saint-Pierre CEDEX, La Réunion

5 : laboratoire d'Informatique Médicale et d'Ingénierie des Connaissances en eSanté (LIMICS-Sorbonne Université, INSERM)

6 : AP-HP, Service de Gériatrie Charles-Foix APHP

Background: Unscheduled hospitalizations are frequent among older adults, especially as they are confronted with major geriatric syndromes: falls, denutrition, depression, incontinence, loss of autonomy, etc. Health digital systems could be useful by detecting worsening health conditions earlier. These systems represent an important resource for improving helathcare system's organization and therefore can have a medico-economic impact. We have implemented a prevention solution with a strong organizational impact on the health system. Indeed, we developed a machine learning algorithm to predict the risk of emergency department visits with a prediction window of 7 to 14 days with a good predictive performance Data recorded by home aides were send in real time to a secure server to be analyzed by our machine learning algorithm, which predicted risk level and displayed it on a secure web-based medical device.

Objectives

This study aims to implement and to evaluate the sensitivity and specificity's predictions of Presage system for four clinical situations with a high impact on unscheduled hospitalization of olders adults living at home: falls, risk of depression (is sadder), risk if (eat less well) and risk of heart failure (swollen leg).

Method

This is a retrospective observational multicenter study. To gain insight on both short-and middle-term predictions and how the risk factors evolve through different periods of observation, we developed a series of models which predict the risk of future clinical

symptoms. We constructed models with varying observation and prediction windows from 1 to 6 weeks. We developed 2 sets of models according to clinical symptoms were collected during the observation period (tautological events when events did not appear in the observation window) or not (non-tautologic events when events appear in the observation window). Depending of windows depth, 432 models have been developed.

Results: We analyzed data between April 2016 – June 2022 from 22 home care facilities using Présage medical device on a daily basis. 501 505 data from 18973 visits by home aides for 933 patients (Figure 1). All patients were older adults over 75 years, living at home and with a moderate dependency level.

For non-tautological events, the sensitivity and specificity predictions for fall, depression risk (is sadder), risk of denutrition (eat less well) and risk of heart failure (swollen leg) in the following weeks (between one and six) ranged from 65.6% to 85.6% and from 65.6% to 80.4% respectively. For tautological events, the sensitivity and specificity of predictions for fall, depression risk (is sadder), risk of denutrition (eat less well) and risk of heart failure (swollen leg) in the following weeks (between one and six) ranged from 73.2% to 94.1% and from 69.4% to 89.2% respectively. These results are detailed in table 1.

We illustrated our results with radar charts to help understanding factors' impact across very short (one week) short-term (four weeks) or middle-term (six-week). We grouped predictors into six predictors (patients' characteristics, patient autonomy, geriatrics risks, health risks, environment and quality of life, past 6 Months Hospitalization) to calculated weight of each category for each event prediction (figure 2).

	Tautologicals		No-tautologicals	
	Sensitivity % (95% CI)	Specificity% (95% CI)	Sensitivity % (95% CI)	Specificity% (95% CI)
Eat less well	94.1(71.3-99.8)	79.51(74.4-84)	72.7(59-83.9)	74.9(71.3-78.3)
Fall	73.2(57.1-85.8)	70.2(67.2-73.1)	65.6(46.8-81.4)	80.4(76.7-83.7)
Is Sadder	75.70(66.5-83.5)	69.4(66.2-72.4)	86.5(71.2-95.5)	65.6(58.7-72)
Swollen legs	91.71(86.9-95.2)	89.2(86.9-91.3)	72.7(54.5-86.7)	75.6(68.6-81.6)

Table 1 : Sensitivity and specificity of events'prediction for tautologicals events and no-tautologicals events.

Figure 1 : flow diagram

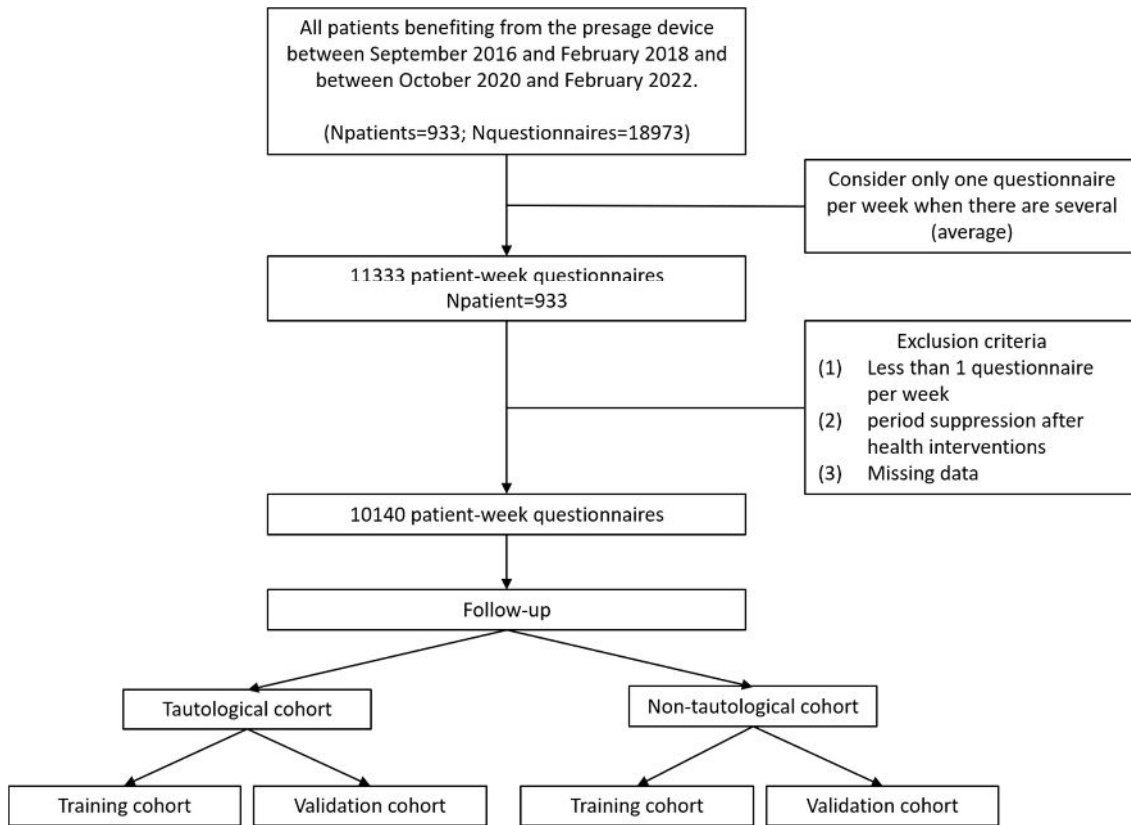


Figure 2 : weight contribution of predictors for three prediction windows for « fall ».

