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RISK STRATIFICATION TOOLS TO PREDICT FUTURE HOSPITAL ADMISSIONS IN ELDERLY PEOPLE. APPLICATION, DEVELOPMENT AND IMPLEMENTATION IN THE VALENCIAN HEALTHCARE SYSTEM

Programa de Doctorado en Ciencias Sociales,
del Trabajo y los Recursos Humanos (R.D. 1393/2007)

Presentada por:
Ascensión Doñate Martínez

Dirigida por:
Dr. Jorge Garcés Ferrer
Dr. Francisco J. Ródenas Rigla

VNIVERSITAT DE VALÈNCIA

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UNIVERSITAT DE VALÈNCIA

Facultat de Ciències Socials

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Tesis Doctoral:

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Kemst þó hægt fari

[You will reach your destination even though you travel slowly]

[Llegarás a tu destino aunque viajes despacio]

Icelandic proverb

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Thesis developed at Polibienestar Research Institute

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Cuando comencé esta tesis nunca pensé que sería un trayecto tan largo y tan lleno de obstáculos. Sin embargo, gracias a este ya proyecto de vida he podido crecer como profesional y como persona. Gracias a ella también he conocido a mucha gente que en algún momento a lo largo de estos años me ha ayudado y apoyado y de los que, a su vez, he aprendido mucho. A todos ellos tengo algo que agradecerles.

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Thanks to PhD Hein Raat for the opportunity he gave me to join his team during my stay in the Department of Public Health at the Erasmus Medical Centre in Rotterdam (Netherlands). Also, thanks to Carmen and my roommates to make my stay easier and comfortable.

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A todos, gracias, por haber hecho posible este proyecto y haberme ayudado durante el viaje.

List of abbreviations

AUC	Area Under the Curve
AVS	Agencia Valenciana de Salud
CARS	The Community Assessment Risk Screen
CD	Chronic diseases
COPD	Chronic obstructive pulmonary disease
ED	Emergency department
EHIS	Electronic health information systems
EIP-AHA	European Innovation Partnership on Active and Healthy Ageing
EU	European Union
FG	Focus group
FHA	Future hospital admissions
GP	General Practitioner
HRQOL	Health-related quality of life
ICT	Information communication technology
INE	Instituto Nacional de Estadística
LTC	Long-term care
MDS	Minimum Data Set
NGT	Nominal Group Technique

NPV	Negative predictive value
MS	Member States
OR	Odds ratio
PC	Primary care
PIS	Population Information System
PPP	Public-Private partnerships
PPV	Positive predictive value
Pra	Probability of Repeated Admission
OECD	Organization for Economic Co-operation and Development
ROC	Receiver operating characteristic
SSHM	Sustainable Social and Healthcare Model
UK	The United Kingdom
USA	United States of America
VAS	Visual analogue scale
VHS	Valencian Healthcare System
WHO	World Health Organization

General introduction and structure of the thesis

I, Ascensión Doñate Martínez, have carried out this thesis entitled *"Risk stratification tools to predict future hospital admissions in elderly people. Application, development and implementation in the Valencian Healthcare System"* in the framework of the Doctorate Programme in Ciencias Sociales, del Trabajo y de los Recursos Humanos (R.D. 1393/2007) from the Faculty of Social Sciences at the Universitat de València. The thesis has been performed under the Direction of Jorge Garcés Ferrer – Professor of Social Policies, PhD in Administration and Political Sciences, PhD in Psychology, Full Professor at the Universitat de València and Prince of Asturias Distinguished Visiting Professor at Georgetown University in the period 2014-2016 – and the Co-Direction of Francisco Ródenas Rigla – PhD in Sociology and Associate Professor at the Universitat de València – and within a research team from Polibienestar Research Institute (Polibienestar from now on). Polibienestar is a Public Research Institute belonging to the Universitat de València and led by Prof. Jorge Garcés. The final mission of the Institute is the improvement of the quality of life of society and it is specialized in research, innovation and social technology, technical advice and training in the field of public policies. Polibienestar is composed by an interdisciplinary team with 34 senior and 24 junior researchers with different backgrounds – such as Social Work, Psychology, Medicine, Economics, Law, Sociology or Telecommunication Engineering – from 9 national universities and 2 international ones: Universitat de València, Universitat Jaume I de Castelló, Universidad de Burgos, Universidad de Castilla-La Mancha, Universidad de Murcia, Universidad de Extremadura, Universidad Politécnica de Madrid, Universidad Politécnica de Valencia, Universidad del País Vasco, Universidad de Concepción (Chile) and Universidad Autónoma de Encarnación (Paraguay).

My collaboration with Polibienestar started in 2010 as a research assistant; in that moment I was doing another PhD project in another department of the Universitat de València, working in a laboratory with mice. After some months working at Polibienestar, Prof. Jorge Garcés and PhD Francisco Ródenas offered me the opportunity of doing a new PhD and to develop my career as a researcher with them. I decided to leave everything and to start a new way and a new project

of life in Polibienestar driven by the possibility of growing professionally and of contributing to the society.

I started to work in my thesis in 2012. During the period 2012-2016 I held a pre-doctoral fellowship FPU (Formación de Profesorado Universitario) from the Spanish Ministry of Education Culture and Sports [Ministerio de Educación, Cultura y Deporte] (AP2010-5354) addressed to develop the thesis topic I chose. My trajectory as pre-doctoral researcher has been reinforced and enriched through participating in parallel in other complementary activities out of my thesis. Since 2010 I have participated in 9 national and regional projects/ contracts and in 14 European ones. This has allowed me to collaborate with other research groups and with professional networks at international level – such as *Community of Regions for Assisted Living (CORAL) or European Innovation Partnership on Active and Healthy Ageing* –, and also to participate in more than 30 scientific conferences.

Moreover, in the frame of my thesis, I have carried out two stays at international research centres. The first one was in 2015 in the Department of Public Health at the Erasmus Medical Centre (Erasmus University Rotterdam, Netherlands) with Prof. Hein Raat team for 2 months. And, the second stay was in the Faculty of Social Work at the University of Iceland for 1 month (2016), collaborating with the team of PhD Sigurveig H. Sigurðardóttir. Thus, in the moment I applied for authorization to the thesis deposit I also applied for the 'Doctorate with International Mention' recognition.

The work carried out in this thesis is framed in the research line *Sustainability, ICTs and social innovation in long-term care systems,* which was launched by Prof. Jorge Garcés more than 20 years ago in Polibienestar. This research line arose due to a personal experience of Prof. Jorge Garcés that showed an emergent need of further investment and research in the field of LTC and integrated health and social care services. This research topic was a pioneer in that moment and right now it is completely aligned with the challenges and priorities highlighted by policy makers both by national and regional administrations as well as by the European Commission. One of the key outcomes of this line is the proposal of the Social Sustainability Theory (Garcés, 2000), which sets out the convergence between social and health care models addressed to people requiring LTC aimed at increasing their welfare, quality of life and dignified death. This theory was successfully implemented in the Valencia Region through a case-management

programme in a PC context. Polibienestar continues currently with this research field in which they have carried out 24 projects funded under regional, national and international programmes (such as the Spanish Ministry of Competitiveness, VII Framework or II and III Health Programmes of the European Commission) and more than 20 contracts with public administrations and the private sector.

In this line, this thesis means a continuation and a step forward of the previous work developed by Polibienestar. This thesis studies stratification tools for elderly population – specifically at the Valencian Healthcare System – with chronic conditions aimed to identify vulnerable patients in need of a more comprehensive and integrated care and close monitoring. This thesis is the result of the work carried out in the framework of two R&D contracts and three R&D projects performed by Polibienestar. Their main researchers are the Director and Co-Director of this thesis: Prof. Jorge Garcés and PhD Francisco Ródenas.

- 2010-2011. *Development of instruments to detect in advance patients with advanced chronic disease at the end of their lives [Desarrollo de instrumentos de detección precoz de paciente con enfermedad crónica avanzada en fase de final de la vida];* contract funded by the Agencia Valenciana de Salud (AVS) – Conselleria de Sanidad de la Generalitat Valenciana (ref. 743/2009). Coordinated by Prof. Jorge Garcés and PhD Francisco Ródenas.

- 2011-2012. *Functional adaptation, analysis of the implementation of instruments for early detection in patients with advanced chronic diseases in the Health information systems of the Agencia Valenciana de Salud and assessment of action plans [Adaptación funcional, análisis de implantación de instrumentos de detección precoz en paciente con enfermedad crónica avanzada en los sistemas de información de la Agencia Valenciana de Salud y evaluación de protocolos de actuación];* contract funded by the AVS – Conselleria de Sanidad de la Generalitat Valenciana (ref. 1345/2011). Coordinated by PhD Francisco Ródenas and Prof. Jorge Garcés.

- 2014-2015. *The efficient management in the healthcare system by the publci administration [La gestión eficiente por la administración pública en el sistema de salud];* project funded by the Instituto Nacional de Administración Pública (ref. GHE/nzs). Coordinated by Prof. Carmen Alemán at the Universidad Nacional de Educación a Distancia (UNED) and by Prof. Jorge Garcés at the Universitat de València.

– 2014-2017. *Technologies to improve the management of chronic patients at primary care [Tecnologías para la mejora de la gestión de pacientes crónicos desde atención primaria];* project funded under the Prometeo Programme addressed for Excellent Research Groups of the Generalitat Valenciana (ref. PROMETEOII/2014/074). Coordinated by Prof. Jorge Garcés.

– 2015-2017. *Development of tools to improve the management and stratification of chronic patients through ICTs. Detection of hospital admission risk [Desarrollo de herramientas para la mejora de la gestión y estratificación de pacientes crónicos usando las TIC. Detección del riesgo de hospitalización];* project funded by the Ministerio de Economía y Competitividad (ref. CSO2014-54490-R). Coordinated by Prof. Jorge Garcés and PhD Francisco Ródenas.

I have chosen to present my thesis as a compilation of publications in scientific journals. This format has allowed me, on the one hand, publishing the results of my thesis at the same time as I developed it, so my curriculum as researcher has been widened. On the other hand I had the opportunity and privilege to receive suggestions and improvement comments by the editors and referees from those journals, which have enriched the quality of my work.

I am the only author of one out of the three papers included in this compilation and the first author of the remaining two as I have carried out most of the work associated to them: establishment of the objectives and design; selection of the methodology; data collection, analysis and interpretation; as well as their writing. However, all this work would not have been possible without the participation and support of their co-authors (Prof. Jorge Garcés and PhD Francisco Ródenas).

According to the normative of the Universitat de València, a thesis presented as a compilation of publications must include a global summary of the topic, the main results and the conclusions. Moreover, it must include as an annex a complete copy of the published or accepted papers. Thus, this thesis is organized in the following sections:

– Theoretical framework (Chapter I).

– Papers – including introduction, methodology, results and discussion for each one (Chapters II, III and IV).

– Conclusions (Chapter V).

– Policy Recommendations (Chapter VI).

– Summary, both in English and Spanish.

– References.

– Anexes.

The papers included in this thesis are the following:

1. Doñate-Martínez, A., Garcés-Ferrer, J. & Ródenas-Rigla, F. (2014). Application of screening tools to detect risk of hospital readmission in elderly patients in Valencian Healthcare System (VHS) (Spain). *Archives of Gerontology and Geriatrics, 59*(2): 408-414. **Corresponding to the Chapter II.** This work is mainly framed in a contract that arose by the initiative of the AVS aimed at analyzing and proposing the use of available tools to detect elderly patients at risk of suffering future hospital admissions (FHA). After an exhaustive review of the available literature and the establishment of assessment criteria – together with technicians and professionals of the AVS – two tools developed and validated in the United States – Pra and CARS – were selected to be tested in a sample of patients of the Valencian Healthcare System (VHS). The results from the application of these tools were not sufficiently accurate and effective. This is likely owing to the limitations related to the use of instruments originally developed in the frame of a healthcare system and in a population with different characteristics than the Spanish context. In spite of these limitations, this study meant an important milestone as a starting point in the study of stratification tools of elderly people in the VHS.

2. Doñate-Martínez, A. (2017, accepted for publication). Risk stratification at primary care centres in Valencia (Spain) to activate integrated care pathways for elderly patients with chronic conditions. *International Journal of Integrated Care*. **Corresponding to the Chapter III.** This study arises from the results obtained in the previous one due to the limitations related to the use of tools originally developed for being implemented in non-Spanish contexts and the bias in the interpretation of their results. Therefore, it was decided to realize another study aimed to develop a stratification tool based on the characteristics of the VHS and of their elderly population. So, a multidisciplinary team of primary care (PC) professionals participated in the selection of variables to be included in this new tool and for its subsequent test. An algorithm to identify elderly patients at risk of FHA with moderate efficacy has been obtained.

3. Doñate-Martínez, A., Ródenas-Rigla, F. & Garcés-Ferrer, J. (2016). Impact of a primary-based telemonitoring programme in HRQOL, satisfaction and usefulness in a sample of older adults with chronic diseases in Valencia (Spain). *Archives of Gerontology and Geriatrics, 62*: 169-175. **Corresponding to the Chapter IV.** Finally, this study is an example of a practical implementation of a stratification tool in the VHS. The results of the first study – included in this thesis – were taken into consideration by the AVS to select a tool able to be adapted and introduced in the health information systems of the VHS. This instrument was CARS, which – together with the expert-professional opinion to compensate the limitations detected in the previous study – made possible the identification of potential users to be included in a telemonitoring programme (called Valcronic) aimed to improve the management of chronic patients. This paper presents the impact assessment of Valcronic in a user sample after one-year involvement.

Each paper has been presented in separated chapters including the following sections: introduction, methodology, results and discussion. As noted above, the complete papers have been attached as annexes, with the exception of the second paper as it has not been published yet; in which case a certificate stating the acceptation for publication by the journal has been included.

Chapter I

Theoretical framework

This first chapter is divided in five sections. The first one describes the main characteristics of the socio-demographic and epidemiologic context and situation that this thesis emerges from. In the second section a set of proposals are formulated – in accordance with the current literature – to approach the described challenges in the first one through a care model more oriented to the care of the elderly population. After, the topic of this thesis is presented and delimited as a formula to contribute in the put in action and implementation of the proposals indicated in the previous section: population stratification tools. The most relevant aspects of the context where the thesis is framed in are described in the fourth section. And, finally, the objectives and hypothesis that are object of study are set out by the scientific papers that define this thesis.

1. Socio-demographic and epidemiologic context

The starting point in which the thesis is characterized, basically, by two phenomena that western countries have continued to experience in the last twenty years: a) the demographic change and the consequent population ageing; and b) the chronic diseases (CD) increased prevalence and burden (European Commission 2015a; WHO, 2005). Both phenomena have (and it is expected they will continue in the future) a notable impact in the consumption of care resources by different population groups and in the (re-)organization of the healthcare and social systems among other Welfare State pillars.

1.1. Demographic change and population ageing

Life expectancy has increased notably almost at worldwide level and, of course, in the Member States (MS) of the European Union (EU). According to data from Eurostat (2016a), the average life expectancy of the EU-28 in 2014 was of 80.9 years; being specifically 83.6 years for women and 78.1 for men (see Table 1). In spite of these numbers have gradually increased in all MS, there are great differences between countries. So, for instance, in 2014 Spain was the country with the highest life expectancy (83.3 years) and Bulgaria and Latvia had the lowest (74.5 years) (see Table 1).

Table 1 | Life expectancy at birth for the period 1980-2014 in the EU

	1980			2000			2014		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
EU-28	:	:	:	:	:	:	80.9	78.1	83.6
Belgium	73.3	69.9	76.7	77.9	74.6	81.0	81.4	78.8	83.9
Bulgaria	71.1	68.4	73.9	71.6	68.4	75.0	74.5	71.1	78.0
Czech Republic	70.4	66.9	74.0	75.1	71.6	78.5	78.9	75.8	82.0
Denmark	74.2	71.2	77.3	76.9	74.5	79.2	80.7	78.7	82.8
Germany	:	:	:	78.3	75.1	81.2	81.2	78.7	83.6
Estonia	69.5	64.2	74.3	71.1	65.6	76.4	77.4	72.4	81.9
Ireland	:	:	:	76.6	74.0	79.2	81.4	79.3	83.5
Greece	75.3	73.0	77.5	78.6	75.9	81.3	81.5	78.9	84.1
Spain	75.5	72.3	78.5	79.3	75.8	82.8	83.3	80.4	86.2
France	:	:	:	79.2	75.3	83.0	82.8	79.5	86.0
Croatia	:	:	:	:	:	:	77.9	74.7	81.0
Italy	:	:	:	79.9	76.9	82.8	83.2	80.7	85.6
Cyprus	:	:	:	77.7	75.4	80.1	82.8	80.9	84.7
Latvia	:	:	:	:	:	:	74.5	69.1	79.4
Lithuania	70.5	65.4	75.4	72.1	66.7	77.4	74.7	69.2	80.1
Luxembourg	72.8	70.0	75.6	78.0	74.6	81.3	82.3	79.4	85.2
Hungary	69.1	65.5	72.8	71.9	67.5	76.2	76.0	72.3	79.4
Malta	70.4	68.0	72.8	78.4	76.2	80.3	82.1	79.8	84.2
Netherlands	:	:	:	78.2	75.6	80.7	81.8	80.0	83.5
Austria	72.7	69.0	76.1	78.3	75.2	81.2	81.6	79.1	84.0
Poland	:	:	:	73.8	69.6	78.0	77.8	73.7	81.7
Portugal	71.5	67.9	74.9	76.8	73.3	80.4	81.3	78.0	84.4
Romania	69.2	66.6	71.9	71.2	67.7	74.8	75.0	71.4	78.7
Slovenia	:	:	:	76.2	72.2	79.9	81.2	78.2	84.1
Slovakia	70.4	66.7	74.4	73.3	69.2	77.5	77.0	73.3	80.5
Finland	73.7	69.2	78.0	77.8	74.2	81.2	81.3	78.4	84.1
Sweden	75.8	72.8	79.0	79.8	77.4	82.0	82.3	80.4	84.2
United Kingdom	:	:	:	78.0	75.5	80.3	81.4	79.5	83.2

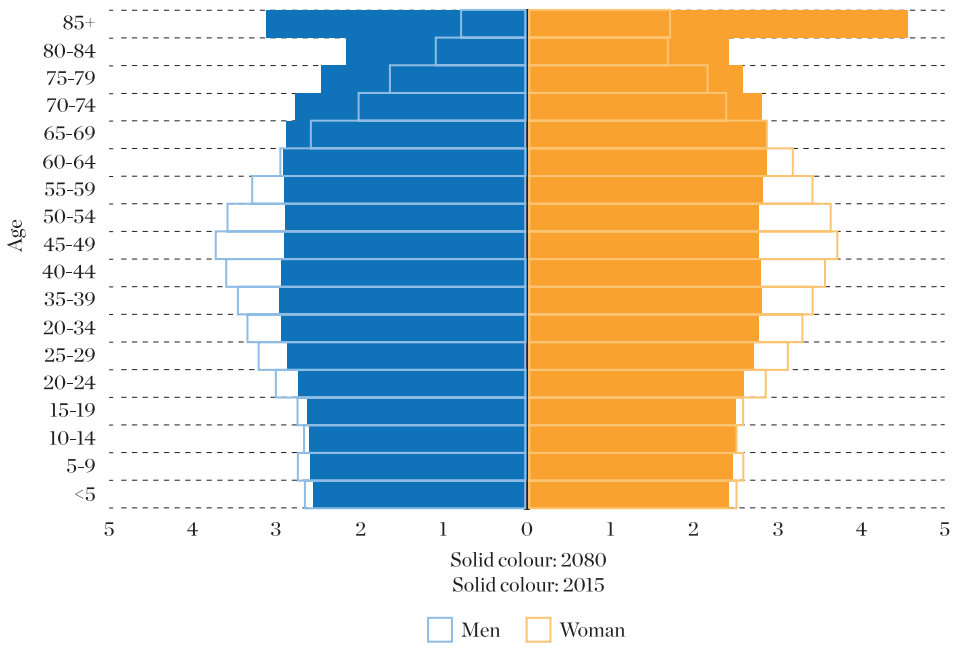
Source: Eurostat (2016a)

There is not generalized agreement among specialists regarding the trend and forecast of these numbers in the future as many factors must be taken into consideration; for instance, the natural biological limit to human lifespan, the impact of future medical and technological developments, the introduction of new public health actions, or the society behavior in the face of some risk factors. However, it is expected that in the EU the life expectancy for men increases around 5.9 years, from 78.1 years in 2014 to 84 in 2060. And, in the case of women, an increase of around 5.5 years, from 83.6 years in 2014 to 89.1 in 2060 (European Commission, 2015a).

According to the Ageing Report of the European Commission (2015a) – due to the variations in the fertility rates, the life expectancy and migratory movements – the age structure of the EU population is starting to change and its effects will be notably visible in the next decades. Thus, it is expected that in 2060 the population size is slightly larger but much more aged than it currently is. In 2013 the MS with larger populations were Germany (with 81 million people), France (66 million), the United Kingdom (64 million), Italy (60 million) and Spain (47 million). In accordance with Eurostat data, in 2060 the United Kingdom will be the most populated MS (with 80 million people), followed by France (76 million), Germany (71 million), Italy (66 million) and Spain (46 million).

In 2013 the average age for men and women in the EU was of 40 and 43 years respectively and it is expected that in 2060 these numbers increase until 45 and 47 years for each sex. Moreover, due to the fertility rates are under the replacement level during the last decades, it is expected that the base of the population pyramid is becoming even narrower; so its shape is progressively changing towards equal pillars for age groups (see Figure 1).

Figure 1 | Population pyramids in EU-28 for the years 2015 and 2080

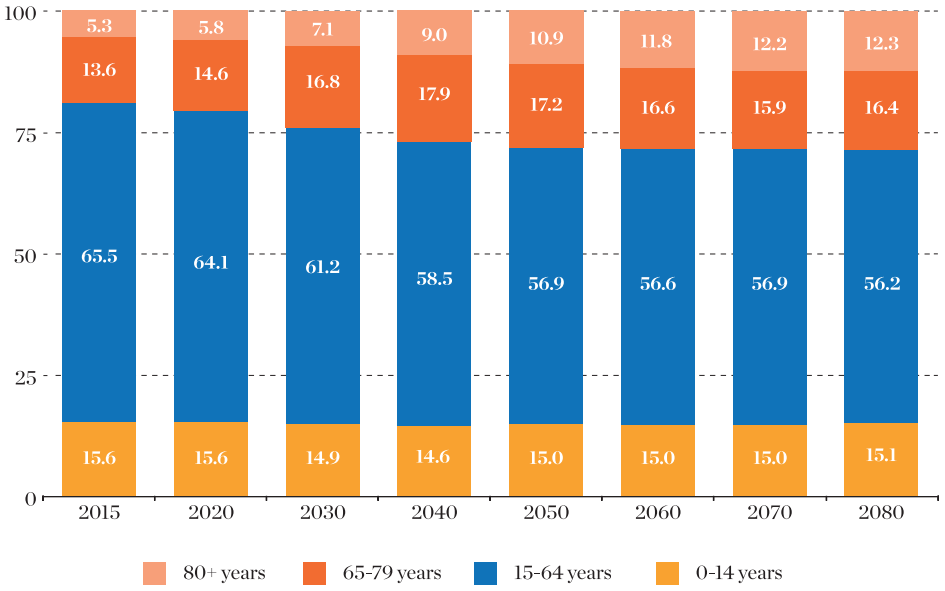


(1) 2015: provisional; estimate. 2080: projections (EUROPOP2013).
Source: Eurostat (online data codes: demo_pjangroup and proj_13npms)

Source: Eurostat (2016a)

Another aspect of population ageing is the progressive ageing of the elderly people itself. It is expected that the rate of people aged 80 years or above will be more than double between 2015 and 2080, from 5.3% to 12.3% (see Figure 2).

Figure 2 | Population structure by age groups



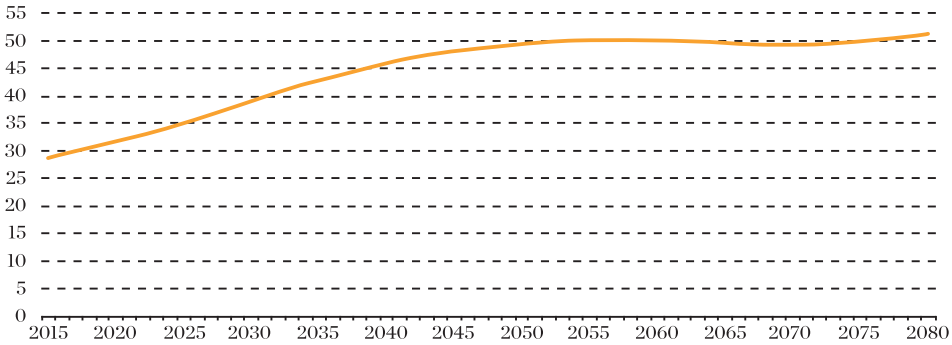
(1) 2015: provisional; estimate. 2020-80: projections (EUROPOP2013).
Source: Eurostat (online data codes: demo_pjangroup and proj_13npms)

Source: Eurostat (2016a)

As a result of the variation in the growth of the different age groups, the percentage of the working population is expected to decrease constantly in the next decades. Consequently, the old-age dependency ratio[1] is projected to increase from 28.8% in 2015 to 51% in 2080 in the EU (see Figure 3). In the case of Spain, the dependency ratio will raise from 52.95% in 2015 to 59.2% in 2029 and to 95.6% in 2064 (INE, 2014).

[1] Ratio between the number of persons aged 65 and over (age when they are generally economically inactive) and the number of persons aged between 15 and 64.

Figure 3 | Projected old-age dependency ratio in the EU for the period 2015-2080



([1]) 2015: provisional; estimate. 2016-80: projections (EUROPOP2013).
Source: Eurostat (online data codes: demo_pjangroup and proj_13npms)

Source: Eurostat (2016a)

1.2. Chronic diseases

According to the World Health Organization (WHO) <<*chronic diseases (or non-communicable diseases) are of long duration and generally of slow progression*>>. In accordance with Eurostat (2016b) data, CD, such as circulatory system diseases and cancer, were the main causes of death in the EU in 2012 (see Table 2). Circulatory diseases include those related to high blood pressure, cholesterol, diabetes and smoking; and the most common causes of death from diseases of the circulatory system are ischaemic heart diseases and cerebrovascular diseases. Cancer was a major cause of death in 2012 in the EU, being its most common forms malignant neoplasms of the trachea, bronchus and lung; colon, breast; pancreas; stomach and liver and bile ducts. After circulatory diseases and cancer, respiratory diseases are the third most common cause of death in the EU; within them, chronic lower respiratory diseases and pneumonia were the most common cause of mortality. Respiratory diseases are age-related as most of deaths from these diseases recorded among those aged 65 or more.

Table 2 | Main causes of death in the EU in 2013 (per 100,000 inhabitants)

	Circulatory disease	Heart disease	Cancer	Lung cancer	Colorectal cancer	Respiratory diseases	Diseases of nervous system	Transport accidents	Suicide	Breast cancer*
EU-28	383.4	131.9	265.1	55.2	31.3	82.5	38.1	5.9	11.7	33.2
Belgium	301.2	78.4	259.5	61.9	27.7	109.2	51.3	7.2	17.3	38.7
Bulgaria	1,085.8	199.5	245.9	47.6	35.5	53.8	14.7	8.3	9.8	30.6
Czech Republic	670.3	364.4	289.7	55.5	39.3	82.0	30.4	7.7	15.2	31.8
Denmark	267.7	86.8	301.6	72.0	36.6	127.5	42.0	4.1	11.3	38.5
Germany	433.1	155.0	256.2	51.1	29.6	76.8	29.9	4.7	11.8	36.3
Estonia	718.2	311.1	291.1	51.5	36.5	42.6	22.6	7.3	17.0	27.1
Ireland	343.9	166.5	286.2	60.0	34.4	131.3	48.6	4.0	11.1	40.3
Greece	404.7	97.9	250.2	61.5	21.8	95.7	15.6	9.5	4.8	32.1
Spain	253.1	72.1	238.9	49.5	34.5	91.7	45.7	4.4	8.1	25.3
France	212.9	51.8	245.0	49.1	26.8	56.5	52.8	5.1	15.5	32.9
Croatia	694.6	310.3	333.8	65.4	50.2	57.8	21.4	10.1	16.2	41.3
Italy	322.8	104.2	250.6	50.5	27.8	60.3	34.6	5.8	6.6	31.6
Cyprus	341.6	104.2	202.3	36.2	19.6	84.3	30.9	6.2	5.2	30.5
Latvia	914.6	462.2	300.6	49.3	34.5	43.1	15.9	9.8	19.1	34.8
Lithuania	894.1	589.3	272.6	45.4	32.4	52.0	20.9	11.0	36.1	31.3
Luxembourg	310.8	89.7	243.8	47.1	32.0	72.8	44.8	7.8	9.3	39.0
Hungary	778.2	396.6	352.1	89.0	56.4	81.3	19.7	7.7	21.2	39-1
Malta	405.8	214.2	230.4	40.3	30.2	113.7	23.5	5.1	5.1	40.5
Netherlands	282.8	66.5	284.4	67.6	33.9	90.1	54.5	4.2	11.3	37.6
Austria	443.8	191.7	249.7	45.9	27.2	50.5	36.9	5.9	15.4	33.5
Poland	635.3	140.1	292.4	68.4	36.1	79.8	18.7	10.7	16.4	30.4
Portugal	304.8	65.6	243.0	37.6	36.1	123.7	33.4	7.3	9.8	26.8
Romania	968.6	323.9	269.7	53.2	32.5	75.7	19.1	12.1	12.2	31.3

Slovenia	451.5	111.2	314.7	54.7	41.3	80.4	20.6	8.1	21.7	36.1
Slovakia	711.6	433.3	327.1	52.1	53.6	86.1	23.5	7.4	12.1	40.2
Finland	388.2	208.5	223.0	41.0	22.7	36.5	141.1	6.1	16.4	28.8
Sweden	354.1	139.2	236.8	38.8	29.5	64.2	42.1	3.3	13.0	28.9
U. Kingdom	276.4	126.1	279.6	61.6	28.1	144.2	44.2	2.7	7.4	35.2

Source: Eurostat (2016b)
** Data only for women*

1.3. Effects on care systems

In accordance with the numbers aforementioned at sections 1.1 and 1.2, the current scenario (and in the foreseeable future) is characterized by a population each time living longer and with a percentage of older people (or very old) being progressively higher. Thus, an increasing imbalance between the working population and those of retirement age is expected; a fact that may destabilize the current performance of the Welfare State and their different pillars. Moreover, the prevalence of CD means an important impact on healthcare systems, as they are the main cause of death in the EU and, in many cases, they are associated to dependency situations and long-term care (LTC).

In this sense, many studies and reports carried out by international organizations have demonstrated that both population ageing and CD have and/or will have in the future a significant impact on public healthcare systems and on national budgets (e.g. McDaniel & Zimmer, 2013; Beard & Bloom, 2015; Bloom et al., 2015). Below some of the effects related to the increase of care costs on healthcare systems and LTC are noted.

The demand of goods and services in the healthcare sector depends not only on the number of people requiring assistance, but also on the population health status. Both factors are related to the age and gender structure of the population and, notably, to the number of elderly people as a percentage of the total population (European Commission, 2015a). Healthcare cost generally grows when a person ages and notably from 55 years on for men and from 60 on for women. This is due to, among other reasons, multimorbidity[2] cases are more common from theses ages; so, some studies point out that two out of three elderly persons at retirement age suffer at least two CD (Kirchberger et

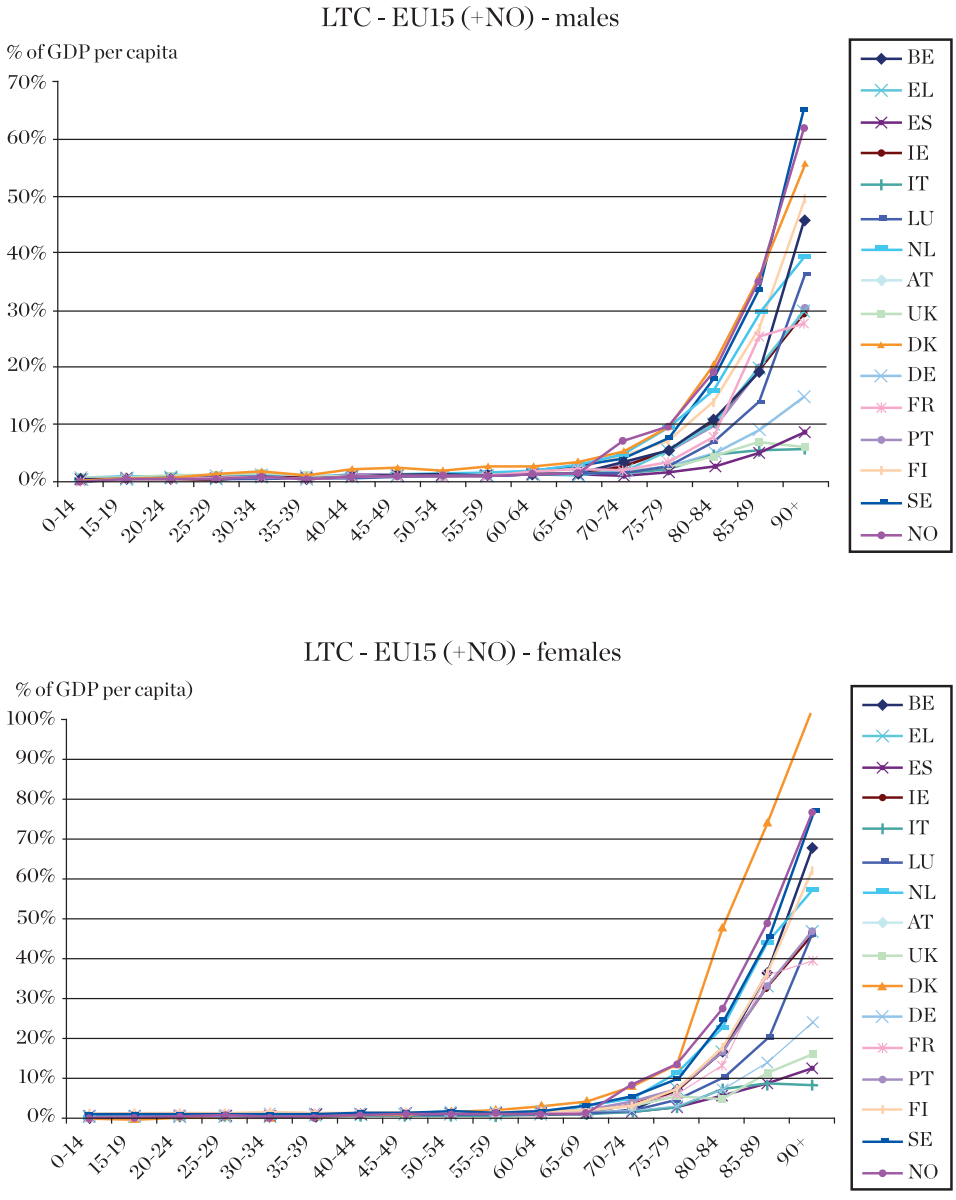
[2] Co-occurrence of two or more CD in the same person.

al., 2012). Multimorbidity may cause impairment in the quality of life, functional decline, high level of psychological stress and high use of healthcare resources such as visits at emergency services (Wallace et al., 2015).

LTC is defined – uniformly by Eurostat, the WHO and the Organization for Economic Co-operation and Development (OECD) – as the range of services for people with a reduced degree of functional capacity (physical or cognitive) which, consequently, are dependent on help with basic and instrumental activities of daily living over an extended period of time. The main purpose of LTC is promoting that dependent people maintain the best quality of life possible according to their individual preferences and with the highest level of autonomy, participation, personal fulfillment and human dignity (Carretero et al., 2013). MS fund in-kind LTC formal services and/or by financial aids to pay these services, in many occasions developed by informal caregivers (such as family relatives).

LTC needs are determined by the population health status which is closely related to the percentage of elderly people. In this sense, the risk of living with a physical or mental disability leading to a dependency situation tends to increase with age, especially from 80 years on (Lipszyc et al., 2012). At Figure 4 the relationship between the age of a person and his/her demand of LTC (noted as the cost as percentage of GDP) is shown. As observed, the expenditure increases substantially from the age of 65 both in men and women.

Figure 4 | LTC expenditure by age groups in EU-15 as percentage of GDP (2010)



Source: Lipszyc et al. (2012)

2. Health and social care model centred on elderly people

In Spain Social Services and the Healthcare System are not connected and, moreover, there is a territorial fragmentation as both social services and healthcare systems depend on autonomous governments. There is not any law or normative regulating jointly the resources, services and aid benefits that people in need of LTC require. This lack of connection between care systems entails different consequences (Garcés-Ferrer et al., 2003; Gröne & García-Barbero, 2004; Lloyd & Wait, 2006): a) lack of an effective and high quality supply and coverage of dependent elderly people's needs; b) higher inefficiency and higher costs for the administration by responding to citizens' problems with an uncoordinated approach.; or c) low satisfaction rate by the users of the services and resources offered and provided by the administration.

The Social Sustainability Theory – developed by Polibienestar – (Garcés-Ferrer et al., 2011; Garcés-Ferrer & Ródenas, 2012) proposes a joint reorganization of social services and the healthcare system as a holistic model offering a comprehensive answer to the needs of persons that require LTC over the entire disease process. In this way, this model aims to increase the welfare and quality of life of the patient as well as assuring a dignified death. This theory relies on three principles: a) social sustainability; b) quality of life and dignified death; and c) social co-responsibility. Based on the application of this theory, structural, cultural and practical changes in the care process are derived, such as the following (Garcés-Ferrer et al., 2011):

- Structure:
  - Reduction of the size and flow of the care protocols.
  - Increase of the investment in preventive and proactive actions by care systems.
  - The patient in the centre of the care relationship and process.
  - Design of efficient care pathways.

- Culture:
  - Establishment of common rules between social services and healthcare systems.
  - Interdisciplinary and multisectorial approach.
  - Humanization of the care process.

- Practice:
  - Management of patients through agreements between different professionals and joint interventions.
  - Cooperation protocols between systems and professionals.

Taking into consideration the elements characterizing the starting point of this thesis – described in the first section of this Chapter –, both current data as well as the future forecasts show the existence of a high demand of health and social services by elderly people and/or with CD. In the following subsections some of the characteristics that care systems should gather to approach more effectively the conditions associated to ageing and chronicity are described: a) placing the patient in the centre of the care relationship, so care services and their professionals have a more active role in the management of the population health; b) introduction of improvements in the disease management processes aimed to carry out more efficient actions; c) coordination of social services and healthcare resources taking into consideration a comprehensive view of the patient; and d) placing PC services as the central core to introduce these changes in the care culture.

2.1. More active care system

Healthcare systems have been originally designed to care for acute diseases, such as infectious ones, which use to have short course, are easily diagnosed and can be treated with a simple course of medications. This culture based on an acute care system entails the following aspects (Canadian Ministry of Health and Long-Term Care, 2007):

- Care staff use to act more passively and reactively, and the patient is the active agent of the relationship looking for treatment at healthcare resources to alleviate his/her evident symptoms.
  - Once within the care process, the patient is passive being a simple recipient of the treatments or interventions selected by professionals.
  - Visits to healthcare resources use to be centred in the treatment to alleviate the symptomatology instead of having a more holistic view and caring for the whole patient.

So, the current systems lack of a comprehensive view of the patient's health, are not centred on prevention and/or delay of disease onset and do not assure

a continuity of care between professionals. All these characteristics would be necessary to approach with high quality, efficacy and efficiency the effect of the population ageing and the high prevalence of CD in the population.

By placing the patient in the centre of the healthcare planning favours that the associated services are more complete and exhaustive and, of course, better coordinated (WHO, 2015). There are many descriptions of the concept patient-centred care from different points of view, but there is not a universal definition. According to the review carried out by Mead & Bower (2002), patient-centred care implies several aspects, among others the following: a) understanding the patient as a unique human being; b) being able to entre in the patient world and to see the disease through his/her own eyes; c) understanding the whole person; d) inclusion of preventive and health promotion actions; e) promotion and improvement of the relationship between the professional and the patient; or f) being realist regarding the personal resources and limitations.

According to the WHO (2015), the benefits of a patient-centred approach (or population-centred) would mean a higher efficiency in the services supply; decrease of costs; greater acceptation of services by users; more health and self-care literacy; increase of the satisfaction with care received; improvement of the relationship between the patients and care professionals; and greater capacity to respond to health problems or adverse events.

2.2. Disease management

In order to favor a care system becomes more proactive and patient-centred, it is necessary to know in advance the problems associated to the different clinical conditions. Also, it is essential to implement actions addressed to improve the disease management and being able to reduce the disease impact both in the patient and in the system. The definitions of the disease management concept are multiple too. In accordance with the perspective of this thesis, the following definition is preferred, which origin lies in the United States: specific programmes addressed to reduce costs and to improve the outcomes of patients with certain diseases (Rothman & Wagner, 2003).

According to the report carried out by the European Observatory on Health

Systems and Policies (Nolte et al., 2014), there is evidence of the benefits and efficiency of disease management oriented-programmes of different CD, such as heart ones, diabetes, chronic obstructive pulmonary disease (COPD) or depression. These programmes have facilitated the achievement of some benefits: better adherence of patients to treatments prescribed by health staff; reduction in the use of healthcare services – such as hospital admissions and re-admissions; significant improvement of symptomatology control; or higher patient satisfaction with the received care. In the literature, there is not consistency about the impact of disease management programmes on healthcare costs. A conclusion is drawn from de Bruin et al. (2011) review: the impact of this kind of programmes on healthcare costs is still unresolved; in spite of it is popularly considered that they imply savings for the sector.

Nolte et al. (2014) review considers that the main components of CD management programmes are:

Self-management support provided by healthcare professionals, such as general practitioners (GPs) or nurses. For instance, distribution of informative materials (as brochures), coaching services, counselling techniques, follow-up through in-person visits or phone calls, or training in healthy habits.

a. Delivery system design taking into consideration elements such as the clear definition of role, the development of care pathways or individualized treatments, or patients follow-up. Several strategies may be used for the delivery system design, such as case-finding or stratification of patients according to the risk of suffering an adverse event.
b. Decision support tools, for which implementation professionals require dedicated training.
c. Clinical information systems that favour the electronic and standardized use of clinical records through PC systems. This is the least developed element despite its relevance and strength.

In the last years the use of information and communication technologies (ICTs) has been gradually introduced to promote and drive CD management through different actions. For instance: providing education and training to improve disease self-management in patients; favouring the transmission and exchange of information between care professional and patients through telemonitoring systems; facilitating a more direct contact with professionals by phone support

services; or improving the electronic records of the information related to patients' diseases and health status (e.g. Hochhalter et al., 2010; Takahashi et al., 2010; Martín-Lesende et al., 2013; Segrelles et al., 2014; Salerno, 2015; Riegel et al., 2016). However, in spite of the potential of the ICTs on chronicity management, evidence from scientific literature regarding the efficacy, for instance, of telemedicine systems and mobile health care (mHealth) is generally contradictory and further research is needed (Hamine et al., 2015; Wootton, 2012).

2.3. Integrated care and continuity care

Both elderly patients and those with CD use to suffer the consequences of an uncoordinated and fragmented care system without the capacity of answering comprehensively to their needs. On the contrary, integrated care is characterized by a coordinated and coherent provision of services to each user individually through a wide range of agents and entities in charge of the healthcare and social services, with the involvement of different professional profiles (Leichsenring, 2004; Carretero et al., 2013). The benefits of integrated care programmes can be observed even after a short period of time working. For instance, Looman et al. (2014) observed that after 3 months implementing a programme of these characteristics, elderly users experienced positive effects in their quality of life. Nevertheless, a more long-term view is needed to observe significant effects on other variables, such as the improvement of health outcomes or the reduction of costs.

Another key aspect to approach the chronicity and pathologies associated to ageing is the continuity care. This concept can be defined, from a multidisciplinary analysis, as the union of independent elements in the care pathway – whether different episodes, intervention by different providers or changes in illness status – as well as the support of aspects that endure intrinsically over time, such as patients' values, sustained relationships with different professionals and management and coordination of care plans (Haggerty et al., 2003). Diverse studies have demonstrated the benefits of carrying out efficient continuity care actions in patients' health. Thus, a consistent association between higher levels of continuity care and lower rates of the use of health resources – such as hospital admissions or visits to the emergency department (ED) – was observed in a sample of users of the

Medicare programme diagnosed with different CD. Also, these patients showed lower complication rates related to their diagnoses and, therefore, less costs (Hussey et al., 2014).

Both aspects, the inclusion of integrated care and continuity care, are essential for an efficient and high quality care of multimorbidity and of elderly population. A multidisciplinary approach and relational coordination between different care professionals – GPs, specialists, nurses or social workers – are relevant to care for this kind of profiles in need of LTC. In order to implement these actions, clear proactive integrated care policies are needed at national, regional and local level; as well as economic incentives as is the case of countries like Finland, Sweden, Nederland or the United Kingdom (Mur-Veeman, 2008).

2.4. The role of primary care services

Chronicity and multimorbidity are mainly cared at PC services. This kind of patients represents a challenge in the healthcare systems and to their professionals. Moreover, literature states that multimorbid patients do not receive enough quality of care in accordance with their clinical needs that are more complex than those suffered by people with a unique CD (Sinnot et al., 2010). Some of the difficulties faced by PC professionals in the care of multimorbidity are the following (Wallace et al., 2015): a) lack of care organization and integration; b) unsuitable guidelines to care specific diseases; c) barriers when implementing shared decision making strategies; and e) perception of the professional isolation in the management of complex patients.

In spite of the challenges that PC models and their professionals are facing currently to tackle the chronicity and ageing population, there are studies pointing out the PC as the closer care level and one of the most suitable to decrease the rate of adverse events suffered by complex patients (Garcés & Ródenas, 2015). General population show lower hospital admissions rates for ambulatory care sensitive conditions (ACSCs) in areas with greater access to PC services (Rosano et al., 2012). Moreover, a greater continuity care of PC is associated with a lower rate of preventable hospitalization in population older than 65 years (Nyweide et al., 2013). In this way, PC services are a sound care level candidate to activate a new care model more proactive, comprehensive, continuous and efficient.

3. Stratification strategies

As presented in previous sections, currently healthcare systems and health administrations are facing a global challenge: the ageing population. The classic care approach – based on the care and treatment mainly of acute conditions – have become obsolete to address effectively, efficiently and standing the test of time chronic conditions and/or those associated to ageing.

PC services can play an indispensable role in the management, care and referral of this kind of patients with clinical and social needs. However, in order to not overload the daily functions of PC professionals it would be interesting and useful – besides the introduction of other improvements and policies – the implementation of support decision making systems related to the management of these patients. Thus, this thesis banks on the potential use of stratification systems in elderly population with CD at PC services.

Now, the current strategic role of stratification systems in Europe is presented as well as the relevance of one of the more frequently used dependent variables through these strategies – the risk of FHA. This variable has been taken as reference for the studies developed within this thesis.

3.1. Stratification systems in Europe

In the frame of the *European Innovation Partnership on Active and Healthy Ageing (EIP-AHA)* of the European Commission, integrated care is one of the key actions object of work; and within this, stratification tools are an essential aspect (EIP-AHA, 2012). These models/instruments are considered efficient methods to study populations and to select people at risk of suffering adverse events – such as FHA or functional decline – and, subsequently, to activate care pathways and/or to implement a more concrete management. The availability of stratification systems is also a facilitator factor for the transition from a reactive healthcare system to another more proactive and more suitable to care for a population growing older (as stated at section 2.1 in this Chapter). Within the EIP-AHA since 2013 Polibienestar has actively participated in different Action Groups – such as B3 focused on integrated care themes – and also it has been involved in the leadership of the D4 Group focused on innovation for age-friendly environments.

Risk or predictive stratification models or instruments are methods widely used to plan services and to detect potential patients for being recipients of general or more specific care programmes. Risk stratification can be used for health management of populations and to elaborate patients' profiles; while risk prediction can be used both in large populations and in individual patients. Most of the European healthcare systems have the capacity of employing aggregated clinical data to explore and analyze the health of their general population and of each particular patient. Some healthcare systems have already implemented stratification and prediction tools allowing that administrations, organizations and professionals in the health sector may adapt the planning, funding, management and healthcare provision (Martí & Contel, 2014).

During the period 2014-2016 Polibienestar participated in the project ASSEHS *(Activation of Stratification Strategies and Results of the interventions on frail patients of Healthcare Services)* – funded under the II Health Programme of the Health and Food Security Directorate-General of the European Commission (ref.: 529811). In its framework a wide study was carried out on the impact of risk stratification tools and predictive models in different spheres and elements of the healthcare system (Martí et al., 2016). The hospital was highlighted as the predominant care level in which this kind of strategies is implemented; and the main data source to stratify the population is the hospital (professionals or associated health information systems). Risk-adjusted resource allocation is the aspect of stratification models with higher impact at structural level. In this sense, stratification outcomes encourage administrations to innovate and improve care programmes and also to redistribute workloads among care. Moreover, the study showed the necessity of a more active role in continuity care and LTC by multidisciplinary professionals. Also, the introduction of stratification tasks has required, in some cases, the emergence of new health staff roles, such as case-managers. Finally, front line healthcare staff – especially in PC – is enough satisfied with the use of stratification systems for daily practice due to several reasons: their usefulness, clinical coherence, the identification of patients at risk and the positive impact both in the coordination and implementation of services. Nevertheless, differences in the results were observed between countries due to the characteristics of their care systems, as well as the different trajectories and know-how with the use of stratification models.

3.2. Detection of future hospital admission risk

In 2014 the elderly population represented more than half (54.9% concretely) of the total hospital stays in Spain; also, hospital morbidity rates increase with age when it is associated to worst health status and chronicity (Abellán & Pujol, 2016). Taking into consideration these data, it is important to activate actions addressed to potentially avoidable hospital admissions; among which many urgent admissions are included. In order to prevent this type of hospitalizations it is necessary to activate decision making processes both at the moment of admission and in the discharge. A first step may be the use of stratification tools – for the whole population or for more specific groups. As aforementioned, there is a wide range of these instruments, of which many establish the risk of suffering FHA as adverse healthcare outcome to stratify elderly people (O'Caoimh et al., 2015).

Patients identified as at risk and susceptible to receive a more specific care would require the implementation of interventions adapted to their characteristics and needs. Some evidence-based options in the literature showing positive impact in patients are (e.g. Purdy, 2010): interventions at PC; promotion of self-care skills in the patient; telemedicine; case-management; integrated care, etc. Nevertheless, a minimum period of time is necessary to observe and demonstrate a substantial impact of the policy, plan or programme activated in the quality of care, patient's health status or at management/ administration level. Most of the studies establish a period of 6-12 months after the launch of the programme to assess its impact (e.g. Glasgow et al., 1999; Farris et al., 2007; Honeycutt et al., 2015). In turn, most of the models aimed to predict FHA risk establish a prediction period of 12 months (O'Caoimh et al., 2015), although there are many tools addressed to predict repeated hospitalizations in a period of 30 days (e.g. Billings et al., 2012; Donzé et al., 2013; Shadmi et al., 2015).

4. Context of the thesis: the Valencian Healthcare System

This thesis has been developed in the context of the Valencia Region and, more concretely, in the VHS. In this section the main characteristics of the study context – at socio-demographic and functional and care levels, as well as the main approach for the care of ageing and chronicity – are briefly described.

4.1. Socio-demography of the Valencia Region

In 2016 the population of the Comunidad Valenciana (from now on Valencia Region) was of 4,934,032 people; which represented the 10.62% of the total Spanish population (INE, 2016).

Table 3 presents the evolution of some indicators of the population structure for the period 2010-2016, with national total numbers and specific ones from the Valencia Region.

Table 3 | Evolution of the population structure in Spain and the Valencia Region (2010-2016)

Indicator		2010	2011	2012	2013	2014	2015	2016
Average age	Spain	41	41.27	41.54	41.83	42.16	42.56	42.72
	Valencia Region	40.77	41.07	41.38	41.73	42.09	42.40	42.67
Rate of people aged 64 years and over	Spain	16.80	17.11	17.36	17.66	18.11	18.50	18.73
	Valencia Region	16.52	16.88	17.21	17.62	18.14	18.53	18.80
Ageing index[3]	Spain	106.12	107.35	108.34	109.53	112.24	114.72	116.36
	Valencia Region	103.03	104.75	106.46	108.53	111.61	114.05	115.84
Dependency rate[4]	Spain	48.44	49.35	50.12	51	52.11	52.95	53.44
	Valencia Region	48.26	49.23	50.09	51.18	52.42	53.30	53.87

Source: Own elaboration through data from INE

These indicators show how the Spanish population, and in parallel those from the Valencia Region, has been ageing constantly.

[3] *Ageing Index: represents the rate of the population older than 64 years over the population under the age of 16.*

[4] *Dependency rate: represents the rate between the potentially inactive population over the potentially active population.*

4.2. The Valencian Healthcare System

The Law 14/1986[5] organized the National Health System in a decentralized way; thus, the 12 Spanish Autonomous Communities have their own health competences. The decentralization process started in 1981 – according to the principle of territorial decentralization of the Spanish Constitution[6] – and concluded in 2002.

In accordance with Article 7 of the Law 10/2014[7], the VHS is composed of all centres and services of the Valencia Region, which are managed by the Generalitat Valenciana. The management and administration of the VHS is competency of the Regional Ministry of Universal Healthcare and Public Health – *Conselleria de Sanidad Universal y Salud Pública* (Regional Ministry of Health from now on) – which is in charge of the direction and execution of health policies and the execution competencies on healthcare, public health, pharmacy, evaluation, research, quality and patient assistance. According to the Decree 156/2015[8], the Regional Ministry of Health consists of the following executive bodies:

a. Autonomous Secretary of Public Health and of the Public Healthcare System.
b. Subsecretary.
c. General Administration of Human and Economic Resources.
d. General Administration of High Level Inspection.
e. General Administration of Health Care.
f. General Administration of Pharmacy and Health Products.
g. General Administration of Public Health.
h. General Administration of Research, Innovation, Technology and Quality.

The AVS is the axis of the organization of public health services aimed at coordinating all the administrative entities with responsibilities in the health field of the VHS. It is also in charge of the healthcare provision in the Valencia Region (according to the Law 3/2003[9]).

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[5] *Law 14/1986, of 25 April, General de Sanidad (29/04/1986).*

[6] *Spanish Constitution, of 6 December 1978 (27/12/1978).*

[7] *Law 10/2014, of 29 December, de la Generalitat, de Salud de la Comunitat Valenciana (31/12/2014).*

[8] *Decree 156/2015, of 18 September, del Consell, por el que se aprueba el Reglamento orgánico y funcional de la Conselleria de Sanidad Universal y salud Pública (22/09/2015)*

[9] *Law 3/2003, of 6 February, de la Generalitat, de Ordenación Sanitaria de la Comunidad Valenciana (14/02/2003).*

The management model of the VHS is arranged in 24 Health Departments (see Figure 5) that are the geographic areas in which the territory of the Valencia Region are divided. The health departments are managed with a great degree of autonomy regulated by four basic principles: a) capita funding of all the departments; b) integral management of the healthcare; c) invoicing of the healthcare between departments; and d) coordination by objectives.

Figure 5 | Health Departments in the Valencia Region

Each health department is divided in basic health areas, which is the basic action territorial scope for PC. Besides there is a Strategic Plan of the AVS, each department has their own plans, from where centres composing the department adjust their performance and, in turn, develop their own strategic plans.

Five out of these departments are managed through an administrative concession-operated by private entities: La Ribera (pioneering through the Modelo Alzira), Denia, Torrevieja, Manises and Elche. Thus, the administration exercises control and the financial risk is transferred to the enterprises that have the administrative concession of the health care.

In accordance with the Decree 74/2007[10], the AVS establishes the health services gathered at Table 4 within the VHS.

Table 4 | Health services of the VHS

Service	Type	Health centres or units
Ambulatory care	Primary care	Health centres or offices Support units Comprehensive Health centres Speciality centres
	Specialized care	
Hospital care		Conventional admission Hospitalization at home units Short stay units
Other services	Healthcare for elderly people and dependency care	In the most suitable centres or units according to the complexity of the patient
	Health emergency	--
	Hemotherapy activity	Transfusion centre of the Valencia Region
	Pharmaceutical supply	Pharmacy Office Pharmaceutical areas Pharmacy services at hospitals and Health and social care centres

[10] *Decree 74/2007, of 18 Mayo, del Consell, Reglamento sobre estructura, organización y funcionamiento de la atención sanitaria de la Comunidad Valenciana (23/05/2007).*

	Orthopaedic and prosthetic	--
	Dietetic products supply	--
	Patient transport services	--

Source: Decree 74/2007

The origin of VHS electronic health information systems (EHIS) lies in the Decree 126/1999[11], from which the Population Information System (PIS) of the Regional Ministry of Health is created. The PIS gathers, at least, identification and location data and credential modality of the right of health coverage for each of the registered people; and, when appropriate, the centre and GP assignment. So, the PIS has the following main objectives:

- The correct identification and register of all the patients and users of the VHS.
- Offering necessary information to assess the coverage and health care degrees of the population, as well as to develop actions in matters of public health.
- Facilitating the exchange of clinical and administrative data between the different corporative EHIS of the Regional Ministry of Health.

As every Autonomous Community in Spain, Valencia Region has experienced changes and adaptations in their EHIS. The VHS disposes EHIS with different objectives: care, logistic and business intelligence. The main EHIS at care level are listed and described:

- Electronic clinical history: It covers the complete and structured clinical history of each patient. It guarantees citizens and health professionals the access to the most relevant clinical information for healthcare from each patient. It contains available documents in electronic format from any part of the National Health System; assuring citizens that the consultation of their data is limited only to those professionals with authorization.

- SIA-Abucasis: System aimed at connecting PC and specialist centres and EHIS with administrative functions (citation, schedule management, etc.) in a comprehensive and integrated manner. It is specially aimed to manage the complete care process as it disposes and centralized all the administrative and clinical information of the patient from any point of the public care net

[11] *Decree 126/1999, of 16 August, del Gobierno Valenciano, por el que se crea el Sistema de Información Poblacional de la Conselleria de Sanidad (23/08/1999).*

(PC and specialist centres or hospitals) by the unique electronic clinical history of each patient.

- Orion Clinic / MDS (Minimum Data Set): Clinical and care application to support hospitals. It covers all specialized care areas, from external consultations, hospitalizations, ED, pharmacy, surgical actions, prevention and safety, social work, hospitalization at home, day hospital, etc.

- Electronic prescription: Automatized prescription and dispensation of medications. The treatment instructions are stored in a data repository accessed at the dispensation point for delivering to the patient.

- GAIA: Module of pharmaceutic prescription integrated in Abucasis and connected to PC and specialized centres, where electronic prescriptions done by authorized professionals are registered and centralized.

- Cordex: System for the coordination of ED and extra-hospital emergency.

In accordance with the report of the Spanish Ministry of Health, Social Services and Equality (MSSSI, 2014) throughout the year 2013 one of the areas within the VHS with a greater development was the improvement of the EHIS as a tool to support the clinical and economic management. Thus, systems aimed to improve the interconnection between PC and specialized information were developed, as well as the introduction of improvements in the electronic prescription systems with the incorporation of new clinical guidelines and decision making protocols for the management and prescription of the most prevalent conditions. However, EHIS are in a constant process to adapt, modernize and improve their functions. Thus, in accordance with the Law 10/2014[12], the modernization of EHIS is expected as a guarantee of a healthcare of high quality and an effective and transparent public health policy.

4.3. The care of chronicity and elderly people at the VHS

In 2007 the Comprehensive Plan for healthcare of elderly people and chronic patients for the period 2007-2011 (Plan integral de atención sanitaria a las personas mayores y a los enfermos crónicos para el periodo 2007-2011) was presented (Conselleria de Sanidad, 2007). The objective of this plan was,

in itself, innovative: personalization of healthcare, preventive, therapeutic and continuous care according to the needs of each person or social group in a specific moment. It should be noted three of the proposed strategic axis: a) integration of the portfolio services for their efficient management; b) coordination and integration of the healthcare system with Social Welfare services; and c) integration of EHIS.

Later, new and more specifically chronicity-centred strategies and action plans have been launched and implemented (AVS, 2012; Conselleria de Sanidad, 2014). The most recent is the Strategy for chronic patients care in the Valencia Region (Estrategia para la atención a pacientes crónicos en la Comunidad Valenciana) (Conselleria de Sanidad, 2014). This strategy establishes the lines aimed to healthcare for chronic patients becomes effective, sustainable and high quality. Table 5 shows the five proposed strategic lines, as well as some of the projects planned for their fulfillment.

Table 5 | Strategic lines and actions of the Strategy for chronic patients care in the Valencia Region

Strategic lines	Examples of specific actions
1. Orientation of the healthcare towards to chronicity	– Developing and implementing population stratification and risk identification tools. – Reorganizing of healthcare at department level towards chronicity through the definition of care processes and the design of departmental and supra-departmental care pathways.
2. Activation of a patient-centred (and their environment) care model	– Developing interventions to strengthen the autonomy and self-care in the patients, the figure of the expert patient and other group interventions. – Implementing patient safety through the development of programmes for an effective prescription and use of medications in the chronic patient.
3. Encouragement of policies addressed to Health promotion and chronicity prevention	– Implementing the Active Ageing Strategy. – Implementing programmes for the health promotion disease prevention by intervening on the most important risk factors related to the chronicity situation.
4. Strengthen the management of the knowledge about chronicity	– Preparing a training plan for the care of chronicity integrating current actions. – Implementing effective and safe clinical practice and cost/effective recommendations about CD.

5. Development of systems and ICTs for chronicity	– Integrating the information of chronic patients in the electronic clinical history and to strengthen them as a facilitator for a comprehensive approach. – Developing ICTs for remote care at home and as communication tool between professionals.

Source: Consellería de Sanidad (2014)

The Active Ageing Strategy of the Valencia Region (Estrategia de Envejecimiento Activo de la Comunidad Valenciana) is mentioned in objective three at Table 5 (Consellería de Sanidad, 2013). This strategy aims to establish a frame of reference addressed to citizens and to health and social care professionals, both from public and the private sector, to favour citizens from the Valencia Region to age as healthy as possible. Also, this strategy expects to reduce the dependency and disability burden suffered by elderly people. At Table 6 the strategic areas and specific objectives of this strategy are detailed.

Table 6 | Strategic areas and objectives of the Active Ageing Strategy of the Valencia Region

Strategic lines	Examples of specific actions
Institutional coordination, governance and social participation	Coordination of actions of the institutions and entities related to the Active Ageing Strategy
	Encouragement of social participation
Training and research	Improvement of active ageing knowledge among Health and social care professionals
	Making possible the access of elderly people to information and training about active ageing
	Incorporation of knowledge, skills and attitudes about active ageing in elderly people, relatives and volunteers
	Supporting research on active ageing and health problems of elderly people from the Valencia Region

[12] *Law 10/2014, of 29 December, de Salud de la Comunidad Valenciana (10/02/2015).*

Promotion, protection and prevention	Improvement of the social image of elderly people
	Promotion of lifestyles for an active and healthy ageing
	Promotion of actions in the psychosocial field for elderly people
	Preparation of working population for active ageing
	Prevention of traffic accidents among elderly people
	Encouragement of the rational use of medications
	Prevention of gerontological health problems
	Assuring suitable vaccine coverage against communicable diseases among elderly people and caregivers
Comprehensive care to health problems	Identification and avoidance of prevalent chronic health problems
	Identification of vulnerable elderly people or in a dependency situation
	Promotion of the complementary care models
	Adaptation of the health organization to health needs of elderly people in a dependency situation
	Supply of suitable health actions according to the needs of elderly people in a dependency situation caregivers

Source: Conselleria de Sanidad (2013)

In accordance with the numbers presented at section 4.1, Valencia Region – as well as the rest of Spain and Europe – is characterized by an increasing ageing population. In this regard, the Regional Ministry of Health more than a decade ago started to take strategic measures to tackle this challenge both at institutional and clinical practice levels; and, also, through citizenship training and raising awareness.

Therefore – and for other factors and actions not mentioned in this thesis – in 2013 and 2016 the Valencia Region presented its candidature for being considered as an innovative model on active and healthy ageing by the network European Innovation Partnership on Active and Healthy Ageing (EIP-AHA) of the European Commission. In both occasions, the Valencia Region got a three star qualification – out of the four possible. Thus, the Reference Site award recognizes the Valencia Region as an inspiring ecosystem within the EU. Polibienestar is part of this Reference Site together with the Regional Ministry

of Health, the Regional Ministry of Social Affairs, the Council of Valencia, INCLIVA (Instituto de Investigación Sanitaria), Hospital La Fe, FISABIO (Fundación para el Fomento de la Investigación Sanitaria y Biomédica de la Comunidad Valenciana), the research group ITACA (Instituto Universitario de Tecnologías de la Información y Comunicaciones) from the Universidad Politécnica de Valencia, InnDea among others.

5. Set out of objectives and hypothesis

This thesis sets out the following **general objective**:

> Application, development and implementation of stratification tools at primary care services of the Valencian Healthcare System aimed to identify elderly patients at risk of suffering hospital admissions in the following 12 months.

Nevertheless, in order to operationalize this general objective in a simpler way, the following **specific objectives** have been defined and, in most of the cases, **specific hypothesis** related to them have been also set out.

Objective 1. To know the available tools in the scientific literature aimed at identifying elderly patients at risk of FHA and to identify among them potential ones to be applied in the VHS.

- Hypothesis 1. *There are tools with probed validity and efficacy including variables which data can be easily collected through different databases from the VHS.*
  It is expected to identify tools that include variables able to be collected by the access to the EHIS of the VHS; and, also, these tools do not require data from periods of time larger than 12 months previous at the assessment moment.

Objective 2. To apply the tools identified by the literature review in a sample of elderly patients of the Valencia Region and to know their performance stratifying it in risk groups.

- Hypothesis 2: *The application of the selected tools is viable and the variables that compose them are easily accessible by accessing to the EHIS.*

- Hypothesis 3: *The efficacy and diagnostic accuracy of the selected tools is moderate.*
  So, foreseeably, these tools may be developed and validated in contexts different to the Spanish one, it is expected that the outcomes derived of their application are not excellent.

Objetive 3. To identify potential variables to be included in a new tool for detecting elderly chronic patients at risk of FHA.

Objective 4. To develop a mathematical model able to identify elderly patients at risk of suffering hospital admissions in the following 12 months after their evaluation.

- Hypothesis 4: *There is a set of socio-demographic, clinical, social and related to the use of healthcare resources variables with statistical significance able to identify elderly patients at risk of FHA.*

- Hypothesis 5: *The variables included in the model are easily accessible in the EHIS.*

- Hypothesis 6: *The algorithm associated to the mathematical model can estimate the risk of FHA through a risk score and a threshold.*

- Hypothesis 7: *The efficacy and diagnostic accuracy of the model are good.*

This model is purposely developed for our target population and our healthcare system, it is expected that the outcomes derived of its application are good.

Objective 5. To study the profile of the elderly people identified as high and low risk of FHA.

- Hypothesis 8: *High risk elderly people have a higher prevalence of CD than low risk people.*

- Hypothesis 9: *People identified as high risk are older than low risk ones.*

- Hypothesis 10: *There are significant differences in the rate of men and women between within the high and low risk groups identified by the model.*

- Hypothesis 11: *High risk elderly people use more healthcare resources than the low risk ones.*

Objective 6. To put in action and to study the practical utility of the stratification tools in the VHS.

- Hypothesis 12: *It is possible the introduction of the algorithms associated to stratification tools within the EHIS.*

- Hypothesis 13: *It is possible the connection of the stratification tools outputs with intervention programmes and/or individualized care pathways.*

Objective 7. To study the impact of a telemonitoring programme – aimed at improving the management of chronic patients at the VHS – on elderly patients identified at risk of FHA.

- Hypothesis 14: *The users improve their quality of life after one-year in the programme.*

- Hypothesis 15: *The users reduce the consumption of healthcare resources after one-year in the programme.*

Chapter II

Application of screening tools to detect risk of hospital readmission in elderly patients in Valencian Healthcare System (VHS) (Spain)

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1. Introduction

Western countries have seen a significant increase in life expectancy and in the number of elderly people (León, 2011). Life expectancy at birth has increased significantly in most developed countries worldwide; in Spain, following the European trend, it has risen from an average of 75.4 years of age in 1980 to 82.5 in 2011 (Eurostat, 2012). Moreover, the age structure of the European population is projected to change dramatically, with an expectation that elderly people aged 65 and over will become a higher share of the population; rising from 87.5 million in 2010 to 152.6 million in 2060, that means a variation of share from 17% to 30% of the population (European Commission, 2011).

Although there is no consensus between experts on the long-term consequences of the aging population, it is clear its impact over fiscal sustainability both due to the decrease of working population, as well as the increase of pressure on public health care expenditure (Esteve et al., 2013; European Commission, 2009). Elderly people often suffer comorbidity and chronic diseases that entail a decrease in their quality of life and an increase of the probability to become inactive and dysfunctional (Anderson, 2003; Landi et al., 2004). These risks imply in the end high medical needs and costs; as, for example, if poorly managed, chronic diseases can account for as much as 70% of health expenditure, partly because of the significant costs involved in hiring a workforce to care for sick elderly people (Economist Intelligence Unit, 2011). To control the increase of public health expenditure and, especially, related to LTC, it will be necessary to invest resources in improving health services, in linking health and social care and a preventive approach of CD (Commission Communication, 2006; Garcés & Ródenas, 2013; Garcés et al., 2013).

In Spain, population of 85 years old and over represented in 2009 7.7% of the total of hospital discharges, a 0.4% increase from the previous year. The greater relative participation of this age group in total of admissions has been increasing gradually in recent years, from 5.2% in 2000 (National Institute of Statistics, 2010). In Valencia, according to the AVS, in 2011 41% of all hospital discharges were as well of people over 65 years old. Currently, healthcare systems as well as research professionals try to respond to the rising burden of CD and its economic, social and health consequences through new models, approaches and strategies to provide comprehensive care delivery achieving a better coordination between different kinds of services and across the continuum of care and, also, reducing the percentage of medical expenditure (Nolte et al., 2008).

This paper is framed within a holistic model of health care for people with LTC needs; the Sustainable Social and Healthcare Model (SSHM). This model is based on the concept of 'social sustainability' (Garcés, 2000) and it was developed and validated using case management methodology to link the network of health and social resources with the support of multidisciplinary teams (Ródenas et al., 2008; Garcés et al., 2011). The application of SSHM implemented new care pathways in PC systems, contributed to decreasing the use and cost of health services and to improve the integration and efficiency of social and health care for elderly people with LTC needs in a Mediterranean Welfare State scenario. In the SSHM primary health care professionals – as they represent the first and most frequent contact with users – have an important role screening patients with specific needs and problems associated with chronic diseases. In this way, according to this model as well as to others (e.g. Brand et al., 2004) one of the first strategies to improve the management of patients with comorbidity is the segmentation of population in risk groups through standardized tools. Presently we can find many studies with the purpose of identifying risk factors of FHA and readmissions of elderly people (e.g. Holloway et al., 1988; Marcantonio et al., 1999; Mudge et al., 2011; Nägga et al., 2012). A review shows a variety of variables of poor-health or frailty that are potential risk factors: comorbidities, increasing severity class, increasing age, general poor health, high previous utilization of the healthcare system, difficulty in getting caregivers or lack of social support (Vest et al., 2010). Thanks to the identification of these kind of factors, a wide range of risk assessment tools are available for detecting elderly patients at high risk for hospitalizations or emergency department (ED) encounters (e.g. Shepperd et al., 2009; Oeseburg et al., 2009). In Spain, unlike other countries as the United States (USA) or United Kingdom, the use of this kind of standardized tools to screen patients at risk it is not very widespread. In spite of most of the models and consequent results obtained from research and studies undertaken might not be generalized to foreign contexts – due to, for example, the differences in the healthcare systems or in social and cultural factors – the application of standardized and validated instruments in other countries and study of their accuracy could be an useful starting point for the development of one's own screening models.

So, the objective of the present study was to determine the viability of the implementation of the screening tools Probability of Repeated Admission – Pra – and The Community Assessment Risk Screen – CARS to detect patients at risk of hospital readmission – selected from the literature – in a sample of older population from the VHS (Spain).

2. Methodology

2.1. Study design

This was a retrospective study to examine the predictive ability of Pra and CARS instruments with the aim of identifying patients at risk of hospital readmission during the subsequent 12 months in a sample of elderly people from the Valencian Region (Spain). The data collection of predictive variables was from 2008, and the readmission variables were collected within the following year (2009) as reference date.

2.2. Target population and sample

The target population of this study were patients of 65 years and over attended by the VHS in three Health Departments connected with the following three hospitals: Arnau de Vilanova, Doctor Peset and Ribera. These hospitals are characterized to have available 539, 302 and 301 beds (MSPS, 2010) and to have 23,500, 13,416 and 20,831 hospital discharges, respectively (Instituto de Información Sanitaria, 2012). The elderly population in these areas in 2008 was 153,895 people (Conselleria de Sanitat, 2009). The criteria to include these Departments for our study were mainly three: (1) a similar total population; (2) a special interest and implication to improve the provision of care and management of chronic diseases; and (3) a different kind of administrative model at hospitals – public in the case of Doctor Peset and Arnau de Vilanova hospitals, and private in the case of the Ribera's.

Patients were screened and recruited from 30 general practitioners (GPs) from six health centers. Our sample was selected randomly between the patients attended by the participating doctors from the 1st until 31st December 2008. Exclusion criteria for participation were absence of patient data in databases, aged under 65 and exitus.

In total, our sample was composed of 500 patients, with a sampling error of ±4.37% yielding a 95% confidence level. However, we dropped 68 cases for analyses related to Pra tool due to data loss from patients; meaning, a sample dropout rate of 13.6%. The mean age of the entire sample was 74.76 years (±6.54)

and 58% were women. 15% of the patients in the study were hospitalized one or more times in the following year after risk evaluation. The mean number of readmissions of this group was 1.41 (±0.77) and the mean length in days of hospital stay was 6.58 (±7.68).

2.3. Instruments

The selection of two instruments to screen the risk of hospital readmission was carried out through a systematic bibliographic search. Six screening tools were selected to be widely assessed by interjudge agreement through the application of several criteria. At Table 1 it is mentioned the main characteristics of these tools although this paper is not aimed to deeply evaluate or summarize them.

Table 1 | Screening tools characteristics

Tool	Country of development	Target population	Predictor	Data source	Cut-off point
Community Assessment Risk Screen – CARS	USA	≥ 65 years	Hospital admissions or visits to ED in the following 12 months	Telephone interview	4 ≥ High risk 3 ≤ Low risk
Emergency Admission Risk Likelihood Index – EARLI	UK	≥ 75 years	Urgent hospital admissions in the following 12 months	By post or interview	1-10 Low risk 11-15 Moderate risk 16-20 High risk 21-19 Very high risk
Method to identify elderly people at risk for high hospital utilization	USA	≥ 65 years	High use of hospital services in the following 3 years	Interview + Laboratory tests	7 > High risk 3 < Low risk
Patients At Risk for Rehospitalization – PARR	UK	≥ 65 years	Hospital admissions in the following 12 months	Database	everal options 50; 10; 80 ≥ High risk
Probability of Repeated Admissions – Pra	USA	≥ 65 years	Hospital admissions in the following 4 years [a]	By post or telephone interview	≥ 0.50 High risk 0.36-0.49 Moderate risk ≤ 0.35 Low risk
Triage Risk Screening Tool – TRST	USA	≥ 64 years	Use ED, hospitalization or health care in the following 30-120 days	Interview	≥ 2 High risk < 2 Low risk

[a] A subsequent study found that the accuracy in predicting one or more hospital admissions during a 1-year follow-up period is comparable to the original time frame of 4 years (Studenski et al., 2003)

In accordance with the quality assessment carried out, the instruments selected were *The Community Assessment Risk Screen – CARS –* and *Probability of Repeated Admission – Pra.* Their common features were that both were developed and tested in the USA, had less than 10 items, required previous data of patients from a considerable period of time (6-12 months prior to the evaluation) and showed similar accuracy in the prediction of future readmissions. And, in accordance with the methodological approach of the current study, their main limitation was that both Pra and CARS were designed to be fulfilled by post or telephone interview.

Pra is a tool used in research and clinical practice to predict re-hospitalization more than once within four years in elderly people (Boult et al., 1993). This instrument includes 8 factors found to be the strongest indicators of future hospitalization: age, gender, global self-reported health, history of diabetes or coronary heart disease, physician visits or previous hospitalizations in the previous year, and caregiver availability (Boult et al., 1993, 1995). This tool uses a regression equation – developed by the John Hopkins University – that weighs responses to each survey question to provide an overall score between 0.07 and 0.80. This score rates the individual probability that the patient will be a re-hospitalized with a multiple of more than once in the four years after the administration of the survey. In this way, a Pra score of 0.5 is interpreted as a 50% chance the patient will be hospitalized in the future. So, patients with a Pra score of 0.5 or higher are regarded as being at high risk, those with a score between 0.36 and 0.49 as moderate risk and those with a score lower than 0.35 are regarded as a low risk of being readmitted.

The CARS includes 3 factors to predict FHA: preexisting CD (heart disease, diabetes, myocardial infarction, stroke, chronic obstructive pulmonary disease – COPD – or cancer), the number of prescribed medications and hospitalizations or ED use in the preceding 6-12 months (Shelton et al., 2000). In the first item, if the patient has two or more comorbidities the score is 2 points, in the second factor if he/she has 5 or more prescribed medications it is scored with 3 points and in the last item if the person has used healthcare services previously the score is 4 points. A total score is obtained by adding the points of each question, with a possible range of 0-9. So, patients with a total score of 4 or higher are classified in the high risk group, and those with a smaller score than 4 are classified in the low risk group.

2.4. Data collection

Data related to the variables that compose both Pra and CARS were collected with a reference date of December 2008 from several health information systems of the VHS: (1) 'Abucasis' – with data related to clinical history, diagnostic tests, appointments, medical alerts, etc. – and 'GAIA' – that registers the prescribed medications to patients through electronic prescription – at PC centers; and (2) at hospitals 'MDS' (*Minimum Data Set*) that registers the patients' discharges among other data: main and secondary diagnostics, clinical and/or surgical procedures, demographic variables (birthdates and gender), and hospital stays. To get access to this information, our project was evaluated and approved by the Scientific and Ethical Committee from the Valencian Ministry of Health and Research Committees from the participating hospitals in accordance to bioethics and data protection rules.

Data collection was performed jointly with health staff (doctors and nurses) at the PC centers and hospitals. To fill out two items from the Pra questionnaire (global self-reported health and caregiver availability) it was necessary to contact by phone with every patient to obtain information related to 2008. Once the information was collected, we removed any kind of identifying information; preserving only the SIP number (*Population Information System*) as a reference number to access medical and admission histories of patients.

Finally, we carried out a search of hospital admissions of each patient during the year 2009 through MDS from the regional network of hospitals. We collected if patients were readmitted or not, the number of admissions and the length of stay in days of every readmission. After that, the SIP number was associated with a random number to identify patients, and removed to preserve privacy.

2.5. Statistical analysis

500 and 432 subjects with complete CARS and Pra data, respectively, were used for statistical analysis. Statistical analysis was performed using SPSS 17 software with the whole sample and not differentiating between hospitals or healthcare centres. Analyses were conducted in four main phases in accordance with scientific literature and similar studies (e.g. Gómez de la Cámara, 1998; Hanley and McNeil, 1982; Wagner et al., 2006).

Firstly, descriptive analyses were made to characterize the sample according to the variables of Pra and CARS tools.

Subsequently, to test for differences between the several risks groups we compared the readmission variables (number of readmissions and hospital length of stay in days) using Student's t-test of difference between independent sample means or one-way ANOVA test, and also through non-parametric analysis (Kruskall-Wallis and Mann-Whitney U tests). In the case of Pra, results were completed through post hoc analysis with Tukey's HSD and Mann-Whitney *U* tests.

In the third stage, we tested operating characteristics of each tool: sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy. In the case of Pra tool, we carried out these analysis subdividing patients into High risk group and Low/Moderate risk group.

Finally, the predictive ability was analyzed through receiver operating characteristic (ROC) curves to show sensitivity and specificity of future readmissions in the following year after the assessment. The performance of the model was assessed using area under the curve (AUC) analysis.

3. Results

The distribution of the sample according to Pra risk groups was 15.28%, 36.11% and 48.61% in High, Moderate and Low risk respectively; and in the case of CARS 40.6% and 59.4% in High and Low groups. The overall mean Pra score was 0.36 (±0.12) and the overall mean CARS score was 3.92 (±2.68).

Taking into consideration the total sample, the average number of admissions in 2009 was statistically significantly different across all Pra risk groups and between the two CARS risk groups, showing in both cases the 'High' risk group more admissions than 'Moderate' and 'Low' risk groups (see Table 2). In the same way, the mean hospital length of stay was statistically significantly different across Pra risk groups and between the two CARS risk groups, showing in both tools greater length of stay of the 'High' risk group in comparison with 'Moderate' and 'Low' risk patients (see Table 2). In the case of Pra, through post hoc analysis, multiple comparisons showed that both number of hospital readmissions and length of stay were significantly higher in patients at 'High' risk than those at 'Moderate' or 'Low' level. Also, there were no significant differences in both variables between 'Moderate' and 'Low' groups of patients. Results obtained through non-parametric tests followed the same line with statistical significance in all cases.

Table 2 | Differences between the different risk groups

		Pra					CARS			
		High	Moderate	Low	F	*p*-value	High	Low	t	*p*-value
Number of admissions in 2009	Mean	0.47	0.25	0.12	6.79	< 0.001	0.36	0.11	4.75	< 0.001
	SD	0.86	0.61	0.45			0.76	0.40		
Length of stay in 2009	Mean	2.97	0.98	0.43	8.10	< 0.001	1.76	0.44	3.91	< 0.001
	SD	7.72	3	2.08			5.28	2.01		

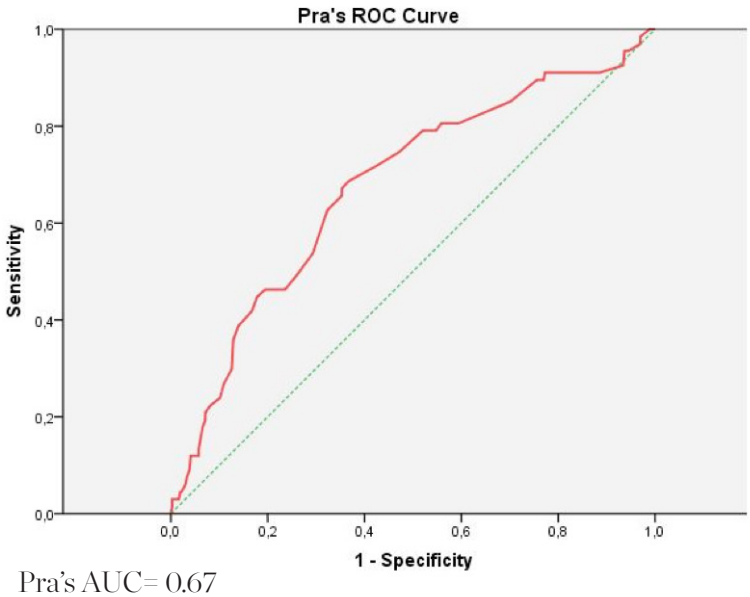
Table 3 shows the values of the operating characteristics of Pra and CARS. It is worth noting the high negative predictive value in both instruments.

Table 3 | Operating characteristics

	Pra [a] (n= 432)	CARS (n= 500)
Sensitivity	54%	64%
Specificity	81%	64%
Positive predicted value	30%	24%
Negative predicted value	92%	91%
Diagnostic accuracy	77%	67%

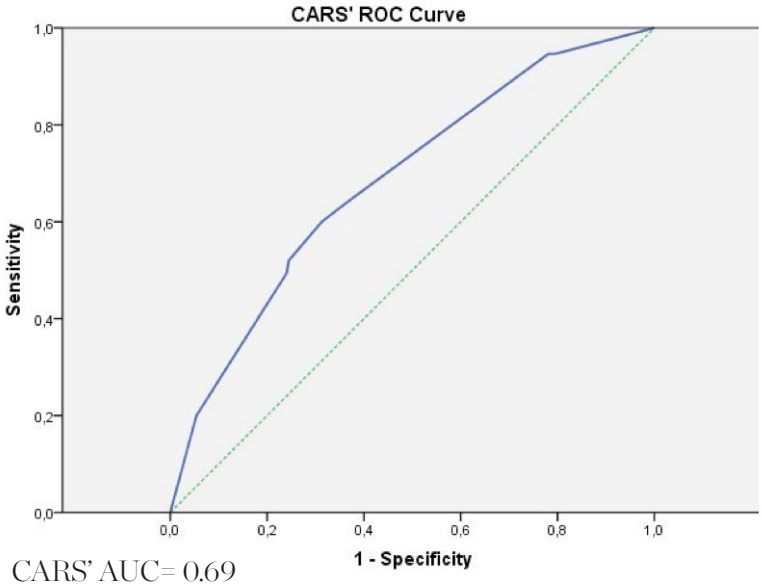
ROC curve analysis for prediction of the presence or absence of hospital readmissions for Pra and CARS models resulted in AUCs of 0.67 and 0.69 respectively (see Figure 1).

Figure 1 | ROC Curves for presence or absence of hospital readmission in 2009 according total Pra and CARS scores



Pra's AUC= 0.67

[a] To carry out this analysis for Pra tool authors did a dichotomous assessment subdividing patients into high risk group and low/intermediate risk group.



CARS' AUC= 0.69

4. Discussion

Given the need to deal with the current challenges of our healthcare systems to achieve an efficient and sustainable management of the consequences of demographic aging, the European Commission has proposed different European Innovation Public-Private Partnerships (PPP) in the Europe 2020 Strategy. Among these PPP, we can find the European Innovation Partnership on Active and Healthy Aging (EIP on AHA), which is focused on three main pillars related to care processes; (a) prevention, screening and early diagnosis; (b) care and cure; and (c) active aging and independent life. Moreover, the SSHM offers an alternative to the current model of care in Spain to encourage a more effective management system based on the definition of risk groups of patients to offer more specific and tailored action plans.

This paper offers a practical implementation of both EIP on AHA and SSHM, as it presents the application of two screening tools aimed to identify patients at risk of hospital readmission in a sample of elderly patients at regional level (Valencia, Spain). The first instrument selected through literature review was Pra, mainly, due to its wide use in the North American Health System and has been applied and validated in several European countries (Wagner et al., 2006). And, the second one selected was CARS, as it entails an easier-to-use application and correction, as well as all its variables can be obtained in the Valencian health information systems.

This study is the first application of the Pra and CARS tools in the Spanish Healthcare system. The most important results indicate that both instruments predict with high efficacy the proportion of patients not to be readmitted with an NPV between 91% and 92%. The tools performed with a moderate efficiency: the Pra was less sensitive (54 %) and more specific (81 %) than CARS (with a sensitivity and specificity of 64 %). The accuracy detecting patients at risk of readmission by Pra in our sample is similar to other studies (e.g. Jensen et al., 2001). Our results also indicate that both tools have an acceptable level of accuracy in the prediction of hospital admissions during the following year in our sample; with reported AUCs of 0.67 in Pra and 0.69 in CARS. These scores are similar to those found in other studies using the Pra tool (Boult et al., 1993, 1995; Bowles & Cater, 2003; Wagner et al., 2006) and CARS (Shelton et al., 2000). Moreover, the risk levels obtained by both Pra and CARS are significantly associated with later admissions suffered by our patients ($p<0.001$) and there

are significant differences ($p<0.001$ in all cases) between the several risk groups in the variables 'number of future admissions' and 'length of stay of the future admissions'. Other authors (Sidorov & Shull, 2002) obtained similar results related to significant differences across all three Pra risk groups in the mean number of readmissions and in the mean length of stay.

This study has practical implications for a subsequent application, test and/or validation of these tools – or different ones – into Valencian or Spanish context. Although Pra is usually administered by mail or telephone, and CARS is normally filled in by medical staff through an interview directly with the patient or by telephone, in the present study we have collected the necessary data to fulfill all CARS and most of the Pra variables through three databases from the VHS. Using this administrative method for data collection, and without dropping any item as in other studies (Coleman et al., 1998; Vojta et al., 2001), our sample's dropout rate for Pra analysis has been only 13.6%. So, as other tools (Crane et al., 2010), Pra and CARS have demonstrated that readily accessible data available in medical databases could be used to identify elderly patients at high risk of re-hospitalization.

The main limitations of this study are the following. First, the poor values of AUC, sensitivity and specificity as well as PPV imply that both Pra and CARS do not identify efficiently elderly population at risk of future hospital admissions. Another limitation is the method of data collection employed within the study based on medical databases in comparison with the originally designed methodology based on the use of primary data collected in real time. Therefore, this difference could imply constraints in the comparison of their efficiency from other studies in the literature. However, as we have aforementioned, our results are consistent with those obtained in other studies, which means a strength of this paper. Another weakness of the study is that the instruments selected were validated in North American samples which possibly impacts on our results and, as well, in the comparisons with those obtained by other authors in other countries. The main differences reside in the utility of both instruments to detect patients at risk in every context. In this sense, both Pra and CARS were designed to answer the specific needs of a population attended by the North American healthcare system, characterized by a mix of public and private funding and provision. For its part, the Spanish system provides universal coverage and is almost fully funded from taxes and predominantly within the public sector. These issues, among others, may entail differences in aspects as the number

of prescribed medications consumed by elders, the process to refer patients to hospital services or the number of visits to PC centres by patients. In spite of this, it is important to take into consideration that the objective in the current paper was to study the viability of the implementation of Pra and CARS tools in a sample of elders from a Spanish region with a different Welfare State, not to validate them in our national context. Consequently, all these issues may affect the clinical application of these specific tools in the Spanish healthcare system.

CD represent a major challenge to PC providers as they demand more services and monitoring due to the increase of patients' vulnerability, consumption of inpatient and outpatient care, relapses and hospital admissions (Condelius et al., 2008). So, CD usually imply a burden on health care systems that require specialized support and initiatives to achieve a cost-efficient management and changes in the governance models (Garcés et al., 2011; Morgan et al., 2007). In Spain there is a lack of integration of services and care based on patients' needs and health status after their discharge from hospital to home. There is wide scientific evidence that agrees with the argument that PC services facilitates a better management and monitoring of chronic patients in the transition from hospital to home (Rosenthal, 2008). In this sense, the PC staff/clinicians can play a crucial role to monitor patients' health status and recovery with medical care at home. Moreover, according to the SSHM, as the PC professionals are the first interacting with patients, they can benefit using standardized tools as Pra and CARS to screen and act following the most appropriate health care resources and pathways (Ródenas, et al. 2008).

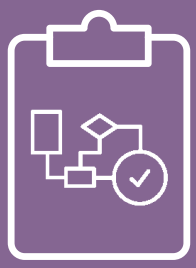
So, identifying patients with high risk of FHA can be useful in the design of programmes and in the management of specialized resources to elderly patients with specific needs and difficulties related to CD (e.g. Freund et al., 2010). Presently, we can find in the literature several comprehensive PC models with a great potential to improve quality of care and quality of life of older patients with complex health care needs; as the Geriatric Resources for Assessment and Care of Elders – GRACE – model (Counsell et al., 2006) or the Programme of All-inclusive Care for the Elderly – PACE (Kodner, 2006). These two models are based on care by teams of professionals – based in PC settings – and, among other aspects, both develop and implement a comprehensive care plan over time and imply a proactive monitoring of patients' clinical status and adherence to the care plan. In the Valencian Region there is a comprehensive programme called Valcronic with similar characteristics (AVS, 2012) aimed

mainly to improve the management of chronic patients involving closely PC staff (clinicians and nurses). In this programme, patients receive specialized and personalized care pathways based on different kinds of interventions according to their health status and risk of future hospital admission: home-based care, education/counselling and support through ICTs. One of the screening tools employed computationally is CARS, which has efficiently facilitated the identification and target patients to the most appropriate intervention. So, in our context, the standardized use of tools to detect patients at high risk of re-hospitalization makes sense through its computerized application within EHIS of the VHS. In other countries with a more tradition using this kind of screening tools, researchers have refined and improved the accuracy of predictive risk models to detect early hospital readmissions; as the PARR-30 aimed to identify inpatients at high risk of readmission to a National Health Service hospital in England within 30 days (Billings et al., 2012) or a model developed and tested in the United States to detect acute care hospitalization within 60 days of admission to home health care (Rosati et al., 2007). Moreover, the segmentation and screening of population provided by this kind of instruments is planned to be implemented in a more comprehensive simulation tool. Grimaldo et al. (2014) proposes a computer-based simulator for integrated LTC systems for elderly people that allow to repeatedly simulating successive interactions of the target population within the healthcare system. The proposed tool can provide useful predictions to policy makers about the consequences of the application of different policies on several scenarios and taken into consideration different agents prior to finally determining the real policy to be adopted.

Conclusions

In summary, this research provides a first attempt to test validated screening tools in the VHS. For healthcare administrations the application of this kind of instruments can be a good strategy to improve the management of elderly patients at risk with comorbidities and to guide clinical decision. Consequently, the use of the available social and health care services could be optimized and, finally, could be sustainable (Garcés et al., 2011; Garcés & Monsonís, 2013). So, results from this study suggest that the application of tools as Pra and CARS are of interest to the Valencian Health Administration. However, further research is needed to define and design optimal methods to identify different risk groups of patients with specific LTC needs and to establish specialized social and health

care pathways. So, the next step will be the development and implementation of one's own tool validated in a Spanish sample and based on our specific health and social features.



Chapter III

Risk stratification at primary care centres in Valencia (Spain) to activate integrated care pathways for elderly patients with chronic conditions

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1. Introduction

The care and management of CDs – those with a long duration and generally with slow progression – is one of the big challenges that public healthcare systems are currently facing within developed countries. In Spain, chronic diseases represent around 70% of the total costs in healthcare (García-Goñi et al., 2012) and are associated with a high use of several healthcare services and resources, such as visits to GPs, hospital admissions, pharmacological treatments or LTC.

The approaches to these types of diseases are complicated by the fact that most of these patients do not suffer a unique chronic condition, but they present several of them at the same time; which is known as multimorbidity. Moreover, cases of multimorbidity are strongly associated with age (e.g. Salisbury et al., 2011). For instance, a study carried out in a sample of Spanish adults shows that the group of persons aged 65 and over presented the highest prevalence of multimorbidity; concretely, 67.3% of women and 52.9% of men (Garin et al., 2014).

In this regard, elderly people do have a high number of visits to GPs at PC centres as they suffer more chronic conditions than other groups of population (Salisbury et al., 2011). However, according to a systematic review carried out by Sinnot et al. (2013), the current model of PC is fragmented and lacks a patient-oriented approach, which does not facilitate an efficient management or an appropriate care of chronic patients. It is necessary that the model addresses an individualized perspective with special focus in continuity care (Garcés et al., 2011). Nonetheless, the identification of the most vulnerable patients in need of a more specific and comprehensive care is not always simple, so tools or strategies are required that facilitate this task to GPs in their daily work.

The systematic use of stratification tools and prediction models can be useful and support GPs in the decision-making processes, especially regarding elderly people with multimorbidity (Orueta et al., 2013). These types of initiatives would enable early implementation of intervention or prevention programmes to avoid adverse situations that would foster: (a) the support to GPs in the management of patients with more efficiency according to their clinical profile; and (b) savings for the system related to the use of health resources that these patients imply, such as hospital admissions.

In the current literature there is a wide number of population stratification tools aimed to identify patients at risk in accordance with different output variables; for instance, risk of frailty (Sternberg et al., 2011), individual risk of high healthcare cost (Coderch et al., 2014) or risk of suffering FHA (Kansagara et al., 2011). Avoiding emergency hospital admissions in elderly population is a major interest for public administrations. Thus, early identification of profiles of patients at risk may facilitate the implementation of interventions to save potential costs related to healthcare utilization (Lehnert et al., 2011) and to avoid and/or decrease the functional decline and impairment of quality of life and physical and cognitive status in elderly people (Boltz et al., 2012; Merino & Cruz-Jentoft, 2012).

In previous studies, the authors have implemented stratification tools – originally developed and validated in the United States – in a Spanish sample of elderly patients using eHIS as main source of data. Results showed a moderate efficiency in the identification of elderly patients at risk of suffering FHA (Doñate-Martínez et al., 2014). In spite of that study, it meant a starting point for the application of these types of strategies in the author's context (Ródenas et al., 2014), it is important to take into consideration the limitations associated to the use and extrapolation of tools in contexts that are different to the original one. The features of each healthcare system impact on numbers related to clinical variables (e.g. visits to PC centres or ED) and, therefore, to the results derived from stratification.

Thus, the objective of this study was the development of a new predictive model of elderly patients at PC services from the VHS (Spain) according to their risk level of suffering hospital admissions in the subsequent year.

2. Methodology

2.1. Overall study design

Design

The stratification model was developed between May 2014 and November 2015 in three main phases. In a first step, it was organized several sessions of focus groups (FG) with the participation of PC professionals aimed to design the first set of variables for the model. In the second phase the preliminary version of the model was piloted through a retrospective cohort study in order to analyse its performance in a small sample from our study setting. Finally, based on the results of the previous step, a refined set of variables was implemented in a larger sample following a retrospective cohort design.

Setting

The study was carried out in the Comprehensive Healthcare Centre of Burjassot in Valencia (Spain), which combines primary and specialized care. In this municipality the population that was 65 years old and over were 6,905 people in 2013. The activity related to PC in this municipality in 2012 is summarized in 90,312 visits to general medicine, 11,569 to nursing and 1,366 in social work services (AVS, 2013a). The hospital of reference of this centre is the Hospital Universitario Arnau de la Ribera, which received a total of 14,338 admissions in 2013; 67.31% out of them were urgent (AVS, 2014).

Ethical issues

The project was approved by the Ethical Committee of the Hospital Arnau de Vilanova. During all phases of the study the data collection was undertaken by PC professionals involved and the subsequent handling and statistical analysis was carried out after removing any type of personal data. In the second and third phases informed consents were not requested to patients as data was collected following a retrospective revision of clinical and administrative records of clinical histories.

2.2. Stage 1 – Focus Groups: selection of variables

Participants

Six PC experts from different fields (general medicine, nursing and social work) – with strong experience dealing with older people, chronicity and LTC – participated in different sessions of FG.

Organization of the sessions

Five sessions of FG took place aimed to agree and design a list of potential items to be included in the stratification model of patients. Every session lasted around 90 minutes and took place in the Comprehensive Healthcare Centre of Burjassot (Valencia). Sessions were coordinated and conducted by a researcher with previous experience in stratification models. Discussions were recorded on a digital recorder – after previous agreement of experts. A second facilitator also took notes on observations, summaries and reflections derived from the discussions.

Discussions were structured, so for every session organizers prepared in advance materials and defined a goal to be achieved. After each meeting organizers analysed the content recorded and in the following session they shared main results and consensus obtained to promote experts' commitment and motivation. Table 1 specifies the protocol followed along the FG and the main goals obtained in every session. In some sessions the Nominal Group Technique (NGT) was used to achieve consensus on key points for the scheduled discussions.

Table 1 | FG protocol (6 experts)

Session	Task	Objective
1	Introduction of the project, organizers and experts.	To present the objectives and tasks of the study. To establish the first contact of the working group and rapport.
2 & 3	Study of 10 clinical cases (selected by experts) with a profile characterized by: a) 65 years and over; b) multiple chronic diagnoses; c) with and without previous hospital admissions.	To draw enabling and protective variables of suffering FHA.
4	Presentation by the organizers of variables selected from the analysis of sessions 2 and 3. Assessment and prioritization by every expert of variables according to: a) their rate in the prediction of future hospital admissions; and b) relationships between variables. Share assessments and discussion.	To reach an agreement and to select the most relevant variables for the identification of patients at risk of suffering FHA.
5	Presentation by the organizers of agreed variables at session 4. Discussion to define every variable and to establish how to measure them.	To operationalize the selected variables. To detect the information sources for data collection.

2.3. Stage 2 – Pilot cohort

In the second stage a retrospective study was carried out to identify the variables – those previously detected and designed in the first stage – with a higher contribution in the prediction of hospital admissions in the subsequent 12 months.

Target population and sample

Target population of this study were patients aged 65 years and over attended by PC services at the Comprehensive Healthcare Centre of Burjassot.

The sample was screened and recruited through consecutive sampling from the quota of assigned patients of the six healthcare experts participating in the FG. Patients were selected from the available population which fulfilled the selection criteria on the established reference date (February 2013). Exclusion criteria for inclusion were: a) aged under 65; b) absence of data at the EHIS; c) no permanent residence in Burjassot; d) exitus; e) being institutionalized; and f) hospital admissions in the subsequent 12 months not associated to long-term diagnosis (e.g. cataract) and/or programmed admissions.

Finally, the pilot sample was composed of 107 patients, with a sampling error of 2.3% yielding a 95% confidence level.

Data collection

Data related to independent variables were collected with reference date February 2013 using several sources:

a. Most of the information was collected through different EHIS of the VHS available for PC professionals:
   - Abucasis, with information related to clinical history, diagnostic tests, medical alerts, appointments, demographic variables, etc.;
   - GAIA, which registers the prescribed medications to patients through electronic prescription; and
   - MDS (Minimum Data Set), which registers patients' discharges and associated information (main and secondary diagnosis, clinical and/or surgical procedures, etc.).

b. Some information was gathered through consultation of the professional of reference (GP, nurse or social worker).

Finally, a search was carried out of hospital admissions of each patient during the subsequent 12 months at MDS. In this regard, the author knew if patients were admitted or not, the number of admissions and the length of stay in days of every admission.

Once all the data had been collected, any type of personal or identifying information was removed and was assigned a random number to each patient to preserve privacy.

Statistical analysis

The processing and statistical analysis of data collected during the whole study was done using PASW Statistics 22 software (SPSS). Firstly, descriptive analyses were made to characterize the sample according to the variables agreed through the FG. Subsequently, logistic regression analysis was conducted with the independent variables obtained in the FG to identify the most significant variables associated to FHA.

2.4. Stage 3 – Development cohort

This third stage is also characterized by a retrospective study. In this case, on the basis of the findings of the previous phase, the objective was to develop the prediction model through an appropriate and accurate combination of the set of variables analysed in the previous stages.

Target population and sample

Target population and the exclusion criteria were the same than used in the pilot cohort (see Stage 2, at section 2.3). The development sample was composed by 343 patients with a sampling error of 2.2% yielding a 95% confidence level. In this case, the sample was screened and recruited through quota sampling in order to distribute a representative number of patients with FHA for the subsequent logistic regression analyses.

Data collection

The set of variables included in this study was based on the results obtained in the previous stage: number of visits to ED at hospital, visits to ED at PC centres, emergency visits at home and emergency phone calls to the PC centre in the previous 12 months. Moreover, other variables that could be easily accessible from EHIS were included: sex, age and active diagnosis.

The procedure for data collection of independent and dependent variables was the same as in the previous study. However, in this case the sources employed were only EHIS (Abucasis, GAIA and MDS).

Statistical analysis

Descriptive analyses were made to characterize the sample according to the variables studied.

Logistic regression analyses were performed to identify those variables with a higher contribution for the prediction of FHA; creating a risk score from 0 to 1 to describe the estimated probability of admission in the subsequent 12 months.

From results achieved by logistic regression, a predictive risk model was developed based on adjusted odds ratios (OR). For this purpose, the author randomly divided the sample in two groups. The first one included the 80% of the sample and was used to estimate the model with a 95% of confidence; the remaining 20% of the sample was used to validate the model.

The goodness of fit of the model was evaluated by Nagelkerke R-squared and Hosmer-Lemeshow tests, which determine the proportion of variance of the dependent variable explained by the model.

The predictive accuracy of the model was assessed through sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and the area under the receiving operating characteristic (ROC) curve (AUC).

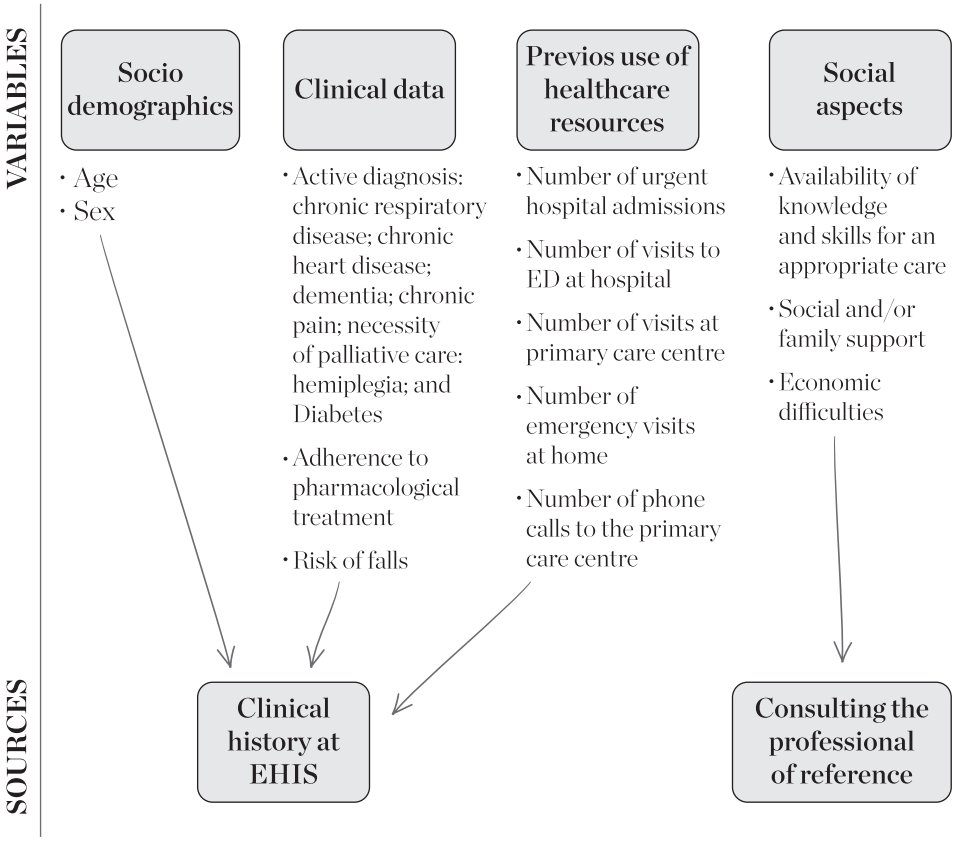
Finally, the sample was divided into two groups (low and high risk) according to scores' of the predictive model. Comparisons between both groups were made using the t-test for normally distributed continuous variables or Mann–Whitney U test for non-normally distributed continuous variables; and Chi-square tests for categorical variables.

3. Results

3.1. Stage 1 – Focus Groups: selection of variables

Six health and social care professionals from a PC centre participated in five FG sessions. The output derived from these meetings was a list of potential variables to be tested for the development of the predictive model. Figure 1 presents these variables and the source where to find the related data.

Figure 1 | Selected variables from FG for the development of the predictive model



3.2. Stage 2 – Pilot cohort

Table 2 shows dataset of the sample (n= 107) in which the first proposal of variables was tested. Average age was 77.05 ± 6 years, and most of the sample was women (67.29%). The most prevalent diagnoses were diabetes (39.25%) and chronic heart conditions (31.78%).

Out of 107 patients, 9 (8.41%) suffered hospital admissions in the subsequent 12 months. The mean number of hospital admissions was 0.12 ± 0.49 and the length of stay was 7.08 ± 6.22 days. Most of the causes of 12-months admissions (44.44% patients) were diagnosis derived from diabetes, as hypoglycaemia or diabetic foot.

Table 2 | Characteristics of the pilot sample

Variables	n = 107
Active diagnosis, n (%)	
- Chronic respiratory disease	20 (18.70)
- Chronic heart disease	34 (31.78)
- Dementia	11 (10.28)
- Chronic pain	17 (15.89)
- Palliative care	4 (3.74)
- Hemiplegia	0
- Diabetes	42 (39.25)
Availability of knowledge and skills for an appropriate care, n (%)	102 (95.33)
Adherence to pharmacological treatment, n (%)	102 (95.33)
Risk of falls, n (%)	47 (43.93)
Number of previous urgent hospital admissions, (SD)	0.20 (0.52)
Number of previous ED visits at hospital, $\bar{x}$ (SD)	0.77 (1.37)
Number of previous visits at PC centre, $\bar{x}$ (SD)	1.54 (2.81)
Number of previous emergency visits at home, $\bar{x}$ (SD)	2.21 (9.81)
Number of previous phone calls to the PC centre, $\bar{x}$ (SD)	0.17 (0.57)
Social and/or family support, n (%)	89 (83.18)
Economic difficulties, n (%)	14 (13.08)
Age, $\bar{x}$ (SD)	77.05 (6)
Sex, n (%)	
Men	35 (32.71)
Women	72 (67.29)

3.3. Stage 3 – Development cohort

In this last stage of the study, several logistic regression analyses were conducted including those variables that showed significance in the previous phase ('number of previous visits to ED at hospital' and 'number of previous emergency visits at home'). Other variables related to the use of PC resources detected in the first stage were also taken into consideration but, in this case, only if they were urgent cases ('number of previous visits to ED at PC centre' and 'number of previous emergency phone calls to the primary care centre'). Additionally, variables of 'active diagnosis', 'age' and 'sex' were included as researchers and experts from FG considered and agreed as relevant for clinical assessments and socio-demographic clusters.

Socio-demographic, clinical and use of resources data of the development sample (n=343) are presented in Table 3. Mean age was 75.20 ± 6.89 years and 61.81% of the sample was women. Diabetes (36.44%) and chronic heart conditions (29.74%) were the most prevalent conditions.

Out of 343 patients, 99 (28.9%) suffered hospital admissions in the subsequent 12 months. The mean number of hospital admissions was 0.39 ± 0.76 and the length of stay was 3.76 ± 14.35 days.

Table 3 | Characteristics of the development sample (n= 343) and by risk categories

Variables	n= 343	Low risk group (0 – 0.49) (n= 291)	High risk group (0.5 – 1) (n= 52)	*p*
Active diagnosis, n (%)				
- Chronic respiratory disease	72 (21)	53 (18.21)	19 (36.54)	0.003
- Chronic heart disease	102 (29.74)	67 (23.02)	35 (67.31)	< 0.001
- Dementia	43 (12.54)	32 (11)	11 (21.15)	0.042
- Chronic pain	22 (6.41)	18 (6.19)	4 (7.69)	0.68
- Palliative care	15 (4.37)	0	15 (28.85)	< 0.001
- Hemiplegia	6 (1.75)	3 (1.03)	3 (5.77)	0.016
- Diabetes	125 (36.44)	100 (34.36)	25 (48.08)	0.058
Number of previous urgent hospital admissions, $\overline{x}$ (SD)	0.70 (1.12)	0.36 (0.60)	2.60 (1.45)	< 0.001
Number of previous ED visits at PC centre, $\overline{x}$ (SD)	0.75 (1.25)	0.68 (1.13)	1.10 (1.73)	0.001
Number of previous emergency visits at home, $\overline{x}$ (SD)	0.15 (0.52)	0.09 (0.40)	0.47 (0.90)	< 0.001
Number of previous emergency phone calls to the PC centre, $\overline{x}$ (SD)	0.09 (0.42)	0.04 (0.24)	0.40 (0.87)	< 0.001
Age, $\overline{x}$ (SD)	75.20 (6.89)	74.58 (6.72)	78.65 (6.87)	0.589
Sex, n (%)				
Men	131 (18.19)	111 (38.14)	20 (38.46)	0.97
Women	212 (61.81)	180 (61.86)	32 (61.54)	
Cases with 12-months hospital admissions, n (%)	99 (28.9)	57 (19.59)	42 (80.77)	< 0.001
Number of 12-months hospital admissions, $\overline{x}$ (SD)	0.36 (0.76)	0.23 (0.54)	1.23 (1.13)	< 0.001
Length of stay in days, $\overline{x}$ (SD)	3.76 (14.35)	1.81 (6.37)	14.69 (31.74)	< 0.001

Table 4 shows the main details of the variables being part of the predictive model. Logistic regression analysis determined that the variables presence of 'chronic respiratory disease', 'chronic heart disease' and 'palliative care', and the 'number of previous visits to ED at hospital' were statistically significant as predictors. The diagnosis of 'palliative care' was the most significant predictor with an OR of 22.53 (95% CI, 2.70 – 188.60); and the 'number of previous visits to ED at hospital' was the weakest one with an OR of 1.82 (95% CI, 1.39 – 2.37). 'Age', diagnosis of 'dementia', 'chronic pain' and 'hemiplegia', or the number of previous contacts with the PC centre ('visits to the ED', 'emergency visits at home' or 'emergency phone calls') were not of any significant result on the regression analysis.

Table 4 | Summary of variables included in the predictive model

Variables	OR	95% CI	*p*
Chronic respiratory disease	2.32	1.18 – 4.59	0.015
Chronic heart disease	2.10	1.13 – 3.91	0.019
Palliative care	22.53	2.70 – 188.60	0.004
Diabetes	1.94	1.06 – 3.54	0.032
Number of previous visits to ED at hospital	1.82	1.39 – 2.37	< 0.001

The percentage of variance explained by the final model was 31% (Nagelkerke's $R^2 = 0.31$). Moreover, the estimated risk showed very good agreement with the observed incidence (Hosmer-Lemeshow $x^2 = 1.24$, $p = 0.975$).

The model determined a risk score from 0 to 1 for each patient, classifying patients as high risk of future hospital admission at a risk score threshold of 0.5 or higher. The model had a sensitivity of 42% and specificity of 96%, and the PPV was 81% and the NPV 80%. The Figure 2 shows the ROC curve illustrating the trade-off between sensitivity and 1-specificity for the model. The AUC was 0.76.

Figure 2 | ROC curve for presence or absence of future hospital admission based on risk scores derived from the predictive model

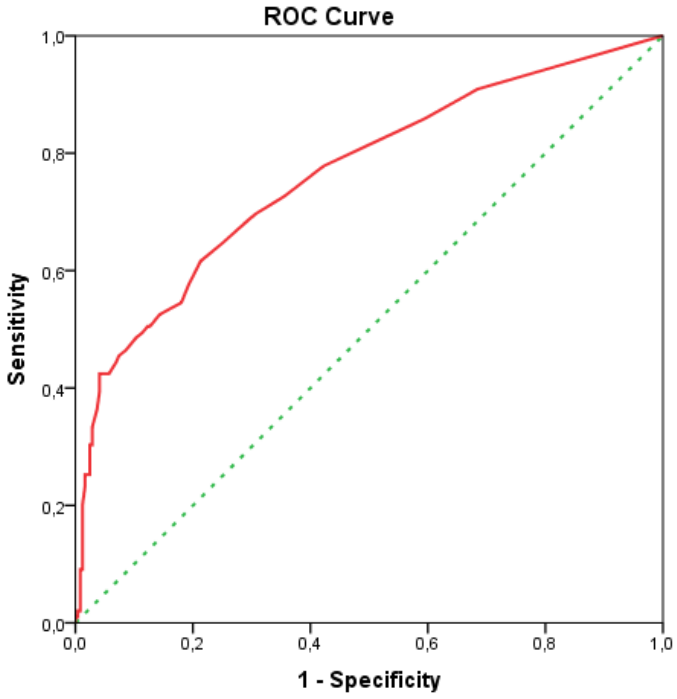


Table 3 shows baseline data on socio-demographics, health conditions and health service utilization measures, as well as data related to FHA for low- (risk scores 0-0.49) and high-risk groups (scores 0.5-1). The high-risk group (15.16% of the sample) had significantly higher prevalence of CD (with the exception of 'chronic pain') and reported higher prior emergency visits' or contacts' (both to hospital, PC centre, at home or emergency phone calls) rates. Low- and high-risk groups did not differ in the mean age or sex rates. Table 3 also presents data from the sample on the subsequent 12 months. In this regard, the high-risk group showed a significantly higher rate and mean of FHA, as well as more days of length of sta.

4. Discussion

This paper presents the development of a new prediction model to identify elderly patients at risk of hospital admission in the subsequent 12 months using routine data from EHIS from the VHS. For this purpose, the author followed a combined methodological approach using both qualitative and quantitative techniques. Thus, on the basis of different sessions of FG with a panel of PC experts the set of variables were selected that subsequently were tested and analysed in two retrospective studies aimed to assess their predictive ability on FHA.

The model incorporates five predictor variables which are associated with an increased risk of hospital admission: diagnosis of chronic heart diseases, chronic respiratory diseases, diabetes, presence of palliative care and number of previous visits to ED at hospital. These findings are close to those variables found in other studies on the general population and on elderly people. For instance, "Probability of Repeated Admission" (Pra) and "The Community Assessment Risk Screen" (CARS) tools (Boult et al., 1993; Shelton et al., 2000) include as relevant variables diagnosis of different chronic conditions (such as diabetes or heart diseases), as well as previous use of hospital resources (admissions or ED visits).

The performance of the model was good, with acceptable ability to identify patients at high risk of hospital admission which really were admitted (sensitivity of 42%) and excellent ability to identify patients at low risk which really did not suffer any admission (specificity of 96%). The accuracy detecting patients was similar to other comparable studies (e.g. Hippisley -Cox & Coupland, 2013) or even higher (Billings et al., 2006; Lyon et al., 2007; Chandra et al., 2015) with reported AUC of 0.764.

In our model, the presence of palliative care had a strong effect on the prediction of FHAs, with an OR of 22.53 (p= 0.04). In the current literature we did not find similar prediction models or tools considering this variable as relevant. However, palliative care has shown a strong association with the risk of death in hospital or soon after discharge (Cardona-Morrell & Hillman, 2014; Cowen et al., 2014), since people receiving palliative care suffers a notable irreversible deterioration of health outcomes as well as in their quality of life.

The regression model derived a risk scoring system ranking each patient from 0 to 1, with a cut-off point of 0.5. The development sample was stratified following this threshold, so it was divided into two risk-groups. High-risk group (84.84%) differed significantly from the low-risk (15.16%) in almost all diagnosis and previous emergency visits' or contacts' measures. Moreover, high-risk patients suffered significantly more FHAs and they spent more days at hospital than low-risk individuals. These numbers support the main goal and utility that authors expected with the development of this predictive model and stratification system: to help PC professionals in decision-making processes through early detection of vulnerable patients with a higher trend to use healthcare resources and, therefore, which mean higher costs for the administration.

The final predictive model is composed by variables that can be collected automatically from EHIS. In this way, as other stratification and predictive systems available in the literature (e.g. Billings et al., 2012), the associated algorithm could be easily introduced into the health administration system of the Valencia Region. Nevertheless, experts interviewed in the FG – carried out in the framework of this study – highlighted other kind of variables that usually are not registered within EHIS of special relevance to identify vulnerable elders. These variables are: 'availability of knowledge and skills for appropriate care', 'social and/or family support' and 'economic difficulties'. Firstly, due to the long duration and irreversible nature of chronic conditions it is vital that patients are empowered and confident in the self-management of their diseases with appropriate knowledge and skills adapted to their own needs. There is evidence suggesting that self-management education improves health outcomes and can reduce hospitalizations for some kind of CD (Bodenheimer et al., 2002). Secondly, social isolation and lack of social support may have negative impact on the health and wellbeing of elderly people (Hawton et al., 2011). Moreover, according to an exploratory study (Jakobsson et al., 2011), elders with low utilization of inpatient and outpatient care were characterized by having a larger social network or feeling less loneliness than those with higher consumption of these resources. So, it is very important that elders have some kind of social support by their circle of support (family and/or friends) or by social services from the public administration or private companies. And finally, Spain is currently facing a financial crisis which has entailed budget cuts in health; and pensioners suffer these effects through pharmaceutical and assistance co-payments (Aguilera et al., 2013). Moreover, older adults and elders have become the main source of economic support for the family due to the return of adult children to the parental home as a consequence of the lack of work opportunities

and extremely high unemployment rates (Foessa & Cáritas, 2013). These issues mean that many elders do not spend part of their pension or acquisitive power to acquire prescribed pharmacological and therapeutic treatments not covered by social security (as blood glucose test trips in the case of patients with diabetes), which may affect the stability of chronic conditions' symptomatology and higher rates of hospital admissions (Fernández-Ruiz et al., 2015).

Variables discussed in the above paragraph may have a relevant potential to identify vulnerable elderly patients, especially in the current context of financial crisis in Spain. For this reason, it would be interesting to propose a 2-phase stratification system, as other methods we find in the literature (Reuben et al., 2002). The first phase would entail the calculation of the developed algorithm through the use of EHIS; and the second one, the assessment of social variables by consulting the professional of reference.

From this comprehensive evaluation and screening, professionals may implement individualized care plans, which can potentially improve quality of care and reduce costs in comparison to usual population-based guidelines (Eddy et al., 2011). In order to guarantee these care pathways respond patients' clinical and social needs the decision-making should be shared by multidisciplinary case-management teams composed by different PC professionals, as GPs, nurses and social workers (Garcés et al., 2013; Garcés & Ródenas, 2015). According to the conclusions derived from a European Conference on Multimorbidity Policies (European Commission, 2015b), these interventions should increase patient-centeredness and empowerment through a higher involvement of patients' and families in the care of their CD. Educative and training approaches should be introduced, as they are effective increasing patients' knowledge and skills, self-management of symptoms or self-efficacy (Barlow et al., 2002). Moreover, new ICTs play a crucial role. In this line, a recent study focused on a telemonitoring programme addressed to chronic patients show that, after one-year of use, users became more aware of the importance of controlling their diseases and symptoms and improved their self-perceived health-related quality of life as well (Doñate-Martínez et al., 2016). Last but not least, continuity of care should be a common point in all care plans addressed to chronic patients – especially elders – as it is essential to guarantee quality of care over time. In this regard, higher continuity of ambulatory care has been associated with lower rates of preventable hospitalization in elderly Medicare beneficiaries (Bayliss et al., 2015).

Our study has several limitations that deserve mention. First, in spite of our study includes a large number of elders from a specific setting of Valencia (Burjassot), it is not representative of the whole elderly population in the Valencia Region. Secondly, pilot and development studies followed a retrospective design; however the use of unified EHIS enhances and guarantees the accuracy of the collected data, both independent variables and those to be predicted. Thirdly, there is an increasing interest of developing risk prediction tools aimed to detect adverse effects in a short period of time; within 30 days from a previous discharge (e.g. Fabbian et al., 2015). However, the authors' goal was to identify patients at risk allowing primary care professionals have enough time to implement the most appropriate care pathways to prevent FHAs in the following 12 months. Moreover, during this period of time it is favoured that the benefits of the established interventions are visible; recommendations to change lifestyles, introduction of new pharmacological treatments or modifications in previous ones, establishment of additional social services increasing patient quality of life, etc. And, finally, the model considered and included a limited number of predictors. It is possible that other variables could be useful as predictive factors, nevertheless we followed the opinion and consensus achieved by our panel of primary care experts, which are in line with those obtained by other authors.

Conclusions

In conclusion, our results suggest that our predictive model composed by a reduced number of variables agreed by PCexperts and collected from EHIS (automatically or manually by PC professionals) identifies with a moderate level of efficiency elderly patients at risk of suffering FHAs. The algorithm associated to this model is intended to be introduced computationally in EHIS in order that healthcare professionals can carry out regular analysis of datasets containing specific quota to identify and alert high risk patients for further assessment of social variables and subsequent management. So, the screening of high risk patients is just the first step of a comprehensive and patient-centred strategy to improve both the quality of life of this profile of patients and also the quality of their management at PC centres.

Future studies are needed to validate these results with a larger sample from the Valencia Region and other regions in Spain; as well as to explore their applicability in other health and social care settings, as hospitals or nursing homes.

Chapter IV

Impact of a primary-based telemonitoring programme in HRQOL, satisfaction and usefulness in a sample of older adults with chronic diseases in Valencia (Spain)

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1. Introduction

Spain has been following the international trend of growth in the number of chronic patients in recent decades; over 15 million people suffer from CD in Spain and their care accounts for 70% of healthcare expenditure (García-Goñi et al., 2012). Chronic patients are frequent users of different healthcare services, especially primary and specialized care, and they also represent a vulnerable group at high risk of being hospitalized (Martín et al., 2011). These patients have LTC needs related to both health and social issues, and they experience notable impairments in their quality of life. Also, the interaction between different chronic conditions causes a greater impairment in health related to quality of life (HRQOL) caused by the exacerbation of specific disease combinations (Hunger et al., 2011).

According to the traditional and current physician-centred model of care, patients with chronic conditions usually receive fragmented, incomplete, inefficient or ineffective care; this may lead to avoidable and unnecessary use of health services (Fortin et al., 2004; Vogeli et al., 2007). In recent years, integrated care through programmes providing interdisciplinary intervention and monitoring addressed to chronic patients are an ongoing priority and necessity in public health administrations (EIP-AHA, 2012; Busse et al., 2010). These programmes are usually based on a model of care centred on the patient, encouraging different kinds of interventions throughout the cycle of the disease: early detection, prevention of deterioration, health promotion, treatment of exacerbations, management and self-management, LTC, rehabilitation or palliative care (Nuño et al., 2012). The integration of care services entails a wide range of benefits related to a higher quality of care, a cost-efficiency approach, individualization of care or higher levels of satisfaction both in patients and professionals (e.g. Garcés et al., 2015; Rosen et al., 2008; Singh, 2008).

Within the Spanish context, the Valcronic programme manages chronic care patients through different levels of telemonitoring and telecare (AVS, 2012). This initiative was implemented as a pilot in 2012 – and is currently active – in the Valencia Region in a population of around 12,000 chronic care patients. The programme is centred on the patient and services are adapted to the specific needs of each user. Mainly, it offers prevention of decline, patient empowerment in the self-management of their diseases as well as the incorporation of new technologies for the care and communication between health professionals and

patients. In this regard, Valcronic means innovations at the technological level by the use of ICTs in the management of patients and the stratification tools of population within health information systems (Ródenas et al., 2014).

There are no specific studies about the pilot implementation of the Valcronic programme in the context of the Valencia Region providing evidence regarding its impact on users' health outcomes that would be useful for decision-making processes. Therefore, the objective of this study was to examine the impact on self-perceived HRQOL in a one-year period and perceptions of satisfaction and usefulness of a pilot-implemented primary-based telemonitoring programme in a sample of older adults with CD in the Valencia Region (Spain).

2. Methodology

2.1. Design

The paper presents both a longitudinal – with a one-year follow-up – and transversal study in which we used an exploratory and descriptive design. The study was carried out in 2 PC centres in a Health Department located in the Valencia Region (Spain): Sagunto and Puerto de Sagunto II. These centres comprised a population of 108,342 and in 2012 these centres received 181,884 visits to GPs and 120,225 to nursing services (AVS, 2013b).

2.2. Sample

The target population of this study were older adults with chronic conditions participating in the Valcronic programme and they were at high or moderate risk of hospital admissions (around 4,800 patients). A random sample of 100 older adults was drawn from those users of the participating PC centres.

2.3. Intervention

The intervention was performed through the Valcronic programme (AVS, 2012), a telemonitoring programme to manage patients with chronic conditions – specifically diabetes mellitus, COPD, heart failure and hypertension – and their combination in comorbid and multimorbid patients. This was funded and implemented by the Regional Ministry of Health of Valencia (Spain). The programme offered telemonitoring of biologic variables – blood pressure, heart and respiratory rates, pulse oximetry oxygen saturation, level of glucose and weight – through biomedical devices according to the patients' pathologies. Data was sent to the health centres via different devices (tablets, smartphones or computers). The implementation of different kinds of telemonitoring and telecare was in accordance with the stratification of patients on low, moderate and high risk of FHA. Patient screening was based on an adaptation of the The Community Assessment Risk Screen – CARS (Shelton et al., 2000) tool within computerized information databases in the PCsystem of the VHS (Ródenas et al., 2014), which was later confirmed by primary GPs.

2.4. Procedure

Prior approval to conduct this study was obtained from the coordinators of the PC centres involved. In addition, informed consents from participants had previously been obtained at the beginning of the Valcronic programme.

Staff from the involved PHCCs randomly selected potential participants for this study from a list of Valcronic users stratified as having a moderate or high risk of hospital admissions. Nurses and administrative staff contacted potential participants via telephone, and once users gave verbal consent, their telephone numbers were provided to the researchers. Interviews (both from the basal analysis and from the one-year follow-up) were structured and conducted by two researchers using the same procedure and schedule.

For data processing and statistical analysis the sample was stratified in groups considering different variables:

- Risk level of hospital admission: high risk (HR) and moderate risk (MR).
- Age: younger than 65, 65-75 and older than 75.
- Gender: women and men.
- Chronic conditions: diabetes mellitus, COPD, heart failure and hypertension. Nevertheless, the combination of disease was not taken into consideration for the statistical analysis due to the low number of individuals in each subgroup.
- Living alone or with another person at home (a relative in most cases).

2.5. Tools and outcome measures

2.5.1. Sample characteristics

Socio-demographic and clinical characteristics of the sample were self-reported by patients through telephone interviews (diagnosis of chronic conditions and availability of caregiver) or collected through electronic databases (age, gender and risk).

2.5.2. Assessment of HRQOL

HRQOL was assessed at two points in time through telephone interviews carried out by researchers with every patient: 1) baseline (before the beginning of the programme); and 2) after one year of involvement in the Valcronic programme. The tool employed was the EQ-5D questionnaire that consists of a self-reported health state description and a visual analogue scale (VAS) (Brooks et al., 2005; The EuroQol Group, 1990). It describes the health status in five dimensions – mobility, self-care, usual activities, pain/discomfort and anxiety/depression – with three possible response levels (no problems, some problems or extreme problems). These response levels generate a total of 243 different health states which can be transformed into a single utility value (EQ-5D index) using a scoring algorithm which is based on valuations of representative general population samples. In this study, adaptation and validation to the Spanish language was used, which is based on Spanish general population time trade-off values (Badía et al., 1999). In our study, we included the assessment of the EQ-5D index but not the VAS, as this item is cognitively more complex than the descriptive system via a telephone interview; especially to the oldest subjects of our sample.

2.5.3. Assessment of perceptions of satisfaction and usefulness

Authors developed a questionnaire with 11 items in Spanish to quickly and easily measure participants' perceptions of satisfaction and usefulness of the Valcronic programme one year after their inclusion by telephone. Nine of the items were closed-ended questions with three possible answers requiring only one choice. These items assessed the following variables: information, usability, performance, failures, security, visits to GPs, communication, health awareness and health habits. Another item included in the questionnaire was a numeric scale to assess the global satisfaction of users with the programme. Patients

had to rate their satisfaction choosing a value from 0 to 10; 10 was the highest score. Finally, the questionnaire included an open-ended and optional question to collect users' suggestions to improve the programme. The tool was tested for adequacy in a sample of 5 patients and it was reviewed by a panel of experts, but it was not validated or checked for reliability.

2.6. Data analysis

The processing and statistical analysis of data collected during the study was done using PASW Statistics 19 software (SPSS). Previously, any kind of personal data had been removed. Statistical significance was considered at p equal or less than 0.05. Analyses were carried out in three main phases. First, socio-demographic and clinical data of patients were analysed through descriptive methods: mean and standard deviation (SD) for the quantitative variables, and frequency and percentage for the qualitative variables. Secondly, we calculated the percentage of the whole sample reporting moderate and severe problems in the five dimensions of the EQ-5D taking into consideration the different classification categories. Moreover, we calculated the frequencies for the different subgroups in which the sample was classified. In a third phase, non-parametric tests – such as Mann Whitney and Kruskall-Wallis – were performed to know the relationship between the EQ-5D indexes (both basal and one year after) and the different stratification groups (risk level, age, gender, chronic conditions and living with another person at home). Comparisons between the baseline and one-year follow-up indexes were carried out for the whole sample and within every group. And, finally, descriptive analyses were carried out with data from the questionnaire employed to assess the samples' perception of satisfaction and usefulness. In the case of the last item of the questionnaire, non-parametric tests were also performed to know if there were significant differences between the scores on 'Global satisfaction' within the categories in which the sample was classified. Also, qualitative analysis was conducted on the answers obtained in the optional open-ended question developing categories that include the themes that emerged in the review of responses; and, thus, assigning each response to a category.

3. Results

In June 2012, 100 patients completed the basal analysis of the EQ-5D index. One year later it was performed with a dropout in the sample of 26 non-responders in the case of the EQ-5D tool and 27 for the satisfaction and usefulness perception's questionnaire. Mean reasons were: death (5 people); premature withdrawal from the programme due to issues associated with technology, such as poor internet coverage (9); moving to another city (1); impossibility to contact them or refusal to participate (10); and due to hospitalization (1). Thus, the statistical analyses were carried out with a sample of 74 and 73 patients respectively.

3.1. Sample characteristics

Socio-demographic and clinical data of the entire sample are presented in Table 1. Mean age was 67.95 ± 11.14 and more than half of the sample was men. From the 74 patients evaluated, 54 belonged to the HR; diabetes and hypertension were the most prevalent conditions; moreover, 63.51% patients had other chronic conditions – such as asthma, chronic bronchitis, arthrosis or cholesterol. Some patients had the co-occurrence of several chronic pathologies: 19 with diabetes + hypertension; 14 with diabetes + heart failire; 4 with diabetes + COPD; 2 with COPD + hypertension; 2 with diabetes + heart failire + COPD; and 1 with diabetes + hypertension + COPD. Finally, 87.84% of the participants lived with a relative at home.

3.2. Assessment of HRQOL

Table 1 describes the results obtained in the pre- and post- indexes according to the different stratifications of the sample. The most frequent health state (combination of the answers to the five dimensions) in both moments of assessment was 11111 (full health); comprising 17.57 % of all participants in the pre-analysis and increasing to 25.98 % after one year.

Table 1 | Description of the sample and EQ-5D index Pre (basal) and Post (1-year follow-up) values

		EQ-5D index		
	n (%)	Pre Mean (SD)	Post Mean (SD)	*p-values*[1]
TOTAL	74 (100)	0.63 (0.27)	0.67 (0.27)	0.18
Age group				
< 65	25 (33.78)	0.66 (0.22)	0.72 (0.27)	0.34
65-75	31 (41.89)	0.60 (0.30)	0.67 (0.26)	0.07
>75	18 (24.32)	0.63 (0.32)	0.61 (0.30)	0.68
Gender				
Men	49 (66.22)	0.72 (0.24)	0.74 (0.23)	0.52
Women	25 (33.78)	0.45 (0.27)	0.53 (0.30)	0.25
Chronic conditions				
Diabetes	46 (62.16)	0.63 (0.30)	0.71 (0.28)	0.04
No diabetes	28 (37.84)	0.62 (0.25)	0.61 (0.26)	0.79
Hypertension	61 (82.43)	0.59 (0.27)	0.64 (0.28)	0.09
No hypertension	13 (17.57)	0.82 (0.24)	0.79 (0.21)	0.95
Hearrt failure	29 (39.19)	0.58 (0.30)	0.64 (0.27)	0.30
No Heart failure	45 (60.81)	0.66 (0.26)	0.69 (0.28)	0.36
COPD	12 (16.22)	0.67 (0.35)	0.62 (0.29)	0.86
No COPD	62 (83.78)	0.62 (0.27)	0.68 (0.27	0.08
Risk group				
High risk (HR)	54 (72.97)	0.65 (0.29)	0.67 (0.27)	0.58
Moderate risk (MR)	20 (27.03)	0.58 (0.26)	0.68 (0.28)	0.15
Living with another person				
Yes	65 (87.84)	0.64 (0.28)	0.68 (0.27)	0.87
No	9 (12.16)	0.59 (0.26)	0.58 (0.29)	0.16

[1] *Non-parametric tests: Mann Whitney and Kruskall-Wallis.*

3.2.1. Dimensions of health status

There was a decrease in the percentage of patients of the entire sample that reported at least a problem (moderate or severe) in at least one dimension (basal analysis 82.43% vs. 74.32% one-year follow-up analysis). In comparison to the basal data in the one-year follow-up analysis, the percentage of patients reporting problems decreased in all dimensions – except in 'Usual activities'; the highest decrease was observed in 'Anxiety/depression' with 17.57% fewer cases (see Table 2). In general, figures of the whole sample as well as of the different groups showed this trend towards an increase of patients without problems.

Table 2 | Frequencies (and percentage for the whole sample) of patients reporting moderate or severe problems pre and post (n= 74)

	Mobility		Self-care		Usual activities		Pain/discomfort		Anxiety/depression	
	pre	*post*	*pre*	*post*	*pre*	*post*	*pre*	*post*	*pre*	*post*
TOTAL SAMPLE (n)	35 (47.29%)	31 (41.89%)	15 (20.27%)	12 (16.21%)	31 (41.89%)	36 (48.65%)	48 (64.86%)	45 (60.81%)	39 (52.70%)	26 (35.13%)
Age group										
< 65	8	5	4	1	12	11	16	13	17	9
65-75	18	15	6	4	10	14	20	21	15	9
>75	9	11	5	7	9	11	12	11	7	8
Gender										
Men	19	15	6	5	14	18	26	27	20	13
Women	16	16	9	7	17	18	22	18	19	13
Chronic conditions										
Diabetes	21	18	6	6	18	21	26	22	24	12
Hypertension	32	27	15	10	31	31	42	41	37	25
Heart failure	17	15	8	6	16	17	18	21	17	13
COPD	5	6	3	3	5	8	7	7	4	5
Risk group										
High risk (HR)	26	26	12	10	22	28	33	33	26	20
Moderate risk (MR)	9	5	3	2	9	8	15	12	13	6
Living with another person										
Yes	31	25	14	10	27	32	43	39	32	22
No	4	6	1	2	4	4	5	6	7	4

3.2.2. Basal EQ-5D index analysis

According to the results obtained through non-parametric inferential tests, we found statistically significant differences in the basal EQ-5D index between women and men, and between patients with and without a diagnosis of hypertension ($p<0.001$). Thus, women and patients with hypertension showed lower EQ-5D indexes in comparison with men (♀ 0.45 ± 0.27 < ♂ 0.72 ± 0.24) and in comparison with patients without a hypertension diagnosis (0.59 ± 0.27 < 0.82 ± 0.24) respectively. Moreover, we did not find significant differences between the different categories of the variables 'age', 'diagnosis' (diabetes, heart failure or COPD), 'risk' or 'living with another person at home'.

3.2.3. One-year follow-up EQ-5D index analysis

In the one-year follow-up analysis of the EQ-5D index we found statistically significant differences between women and men ($p<0.005$); thus, women showed a lower index than men (♀ 0.53 ± 0.30 < ♂ 0.74 ± 0.23). There were no significant differences between the categories of the other variables: 'age', 'diagnosis of CD', 'risk' or 'living with another person at home'.

3.2.4. Comparison of basal and one-year follow-up EQ-5D indexes

Although numbers indicated that the whole sample experienced an increase of the mean EQ-5D index after one year, the differences between pre- and post-indexes were not significant (see Table 1). Likewise, most of the groups employed to classify the sample showed a higher post- EQ-5D index in comparison to basal data, except these groups of patients (with no significance): 'over 75', 'no diabetes', 'COPD', 'no hypertension' and 'living alone at home'. However, the only group that showed a statistically significant increase in the post EQ-5D index in comparison to basal data were 'patients with diabetes' ($p<0.05$). The groups '65-75 years old', 'no COPD' and 'hypertension' showed a significant trend with p-values close to 0.10.

3.3. Assessment of perceptions of satisfaction and usefulness

A detailed analysis of the questionnaire items regarding satisfaction and usefulness perceptions is described below taking into consideration the whole sample (n=73):

- *Information*. 87.67% of the interviewers reported that the information provided before the beginning of the programme was adequate and useful in knowing how to use the devices and services of the programme. Just 12.33% found the information moderately useful or inadequate.

- *Usability*. Most of the sample indicated that the devices were easy to use (80.82%); 16.44% found some problems and 2.74% could not use the devices by themselves.

- *Performance*. The devices worked correctly in 67.12% of the cases and with some problems in 32.88% of them.

- *Failures*. 100% of the patients that required technical support when devices or services did not operate reported that the call centre resolved the problems quickly.

- *Security*. Most of the sample (76.71%) felt safe and comfortable with this kind of telemonitoring at home; and 12.33% felt moderately safe. Just 10.96% preferred direct monitoring of their symptoms by the PC centre medical staff.

- *Visits to GPs*. 51.39% of the sample expressed a notable reduction in the number of visits to PC centres during their participation in the Valcronic programme; and 37.5% indicated they visited the PC centres just for indispensable issues (with the same frequency as before their involvement in the Valcronic programme). Only 11.11% reduced visits moderately.

- *Communication*. 40.27% of the sample expressed that their communication with the health staff had improved notably or moderately since their inclusion in the Valcronic programme. 59.72% indicated that their relationship with GPs was already good before their inclusion in the programme.

- *Health awareness.* 50.68% of the participants expressed they were notably more aware of the importance to control their diseases and symptoms after their participation in the programme. 21.92% were moderately more aware, and 23.29% indicated that they already controlled their health status before they were involved in the Valcronic programme. Three patients did not answer this question.

- *Health habits.* 38.36% reported they had been following new and healthier habits since their inclusion in the Valcronic programme; 24.62% of the sample moderately; and 32.88% did not change their habits. Three patients did not answer this question.

- *Global satisfaction.* The mean score of global satisfaction of the entire sample was 8.63 ± 1.35 in a scale from 1 to 10 points. Patients with diabetes showed a significantly higher score in this variable than those without this diagnosis (8.93 ± 1.21 vs. 8.14 ± 1.43 respectively). There were no significant differences between the categories in which the sample was stratified.

Out of the 73 people assessed, just 9.59 % of them – i.e. 7 users – answered the open-ended question. The responses indicated that the programme could be improved following different lines: 4 patients stated it was necessary to receive more feedback from clinical staff; 3 people requested easier access to personal data within the devices (e.g. clinical or login data); 2 patients demanded higher personalization features in fulfilling questionnaires or taking clinical data; and finally, 1 person requested the availability of other useful information (e.g. specific diets). These are some examples of answers collected:

> *"I would like to receive more calls by practitioners in the centre. Sometimes, when I send my data, I do not know if I am well or not because nobody tells me anything."*

> *"I just check my sugar once per week and I do not feel safe. I would like to control it more frequently."*

> *"I am very happy with the devices, but the programme could be improved. I would like useful information for everyday life to be available; for example, recipes or physical activity guidelines for diabetics like me."*

4. Discussion

This study uses an exploratory and descriptive design to measure and examine the impact of a pilot implementation of the Valcronic programme through the assessment of self-perceived HRQOL of a sample of its users before and one year after their inclusion, and their perceptions of satisfaction and usefulness. It shows results associated to the practical implementation of a stratification system of population in risk groups of hospital admission through the computerized algorithm of the CARS tool in VHS EHIS.

This study found that the percentage of patients with at least one problem in the dimensions assessed by the EQ-5D instrument decreased one year after their inclusion in the programme (pre 82.43% vs. post 74.32%). The percentage of users from the whole sample experiencing problems in aspects related to 'Mobility', 'Self-care', 'Pain/discomfort' and 'Anxiety/depression' decreased as well; nevertheless, the percentage increased slightly in the case of 'Usual activities'. The dimension 'Anxiety/depression' experienced a remarkable decrease in the number of patients from the total sample with problems as well as in the different stratification groups – except in the group 'over 75'.

With respect to the assessment of the EQ-5D index, we found that the whole sample experienced an improvement, although not significant, of its self-perceived HRQOL after one year in the programme; only the patients diagnosed with diabetes showed a significant increase in the value of the EQ-5D index. These results follow the trend shown by de Bruin et al. (2012) in a complete review of comprehensive care programs for patients with multiple chronic conditions. In this review, seventeen studies – from a total of thirty-three – reported effectiveness in a follow-up assessment of HRQOL. In agreement with the results of other studies (e.g. Jansson et al., 2009; Guallar-Castillón et al., 2005; Casado et al., 2001), our sample of women showed a lower HRQOL than men both in the basal analysis and one year later. Patients 'over 75', with 'no diabetes', 'no hypertension', 'COPD' and 'living alone at home' showed impairment in their HRQOL.

Our results indicate that patients' perceptions of satisfaction and usefulness were highly positive; like in other studies (Mira-Solves et al., 2014) and other telemedicine programmes for diabetic patients (Bakken et al., 2006). We observed that the global satisfaction of the sample was very high, rating the

programme with an average of 8.63 over 10. We can highlight the fact that patients with diabetes showed significantly higher satisfaction than those without this condition. Most of the patients found the devices user-friendly, felt safe with the monitoring at home and communication with the GPs and nurses improved after one year in the programme. It is worth noting that patients experienced changes in their daily life after using the Valcronic programme, as they reported that the number of visits at PC centres decreased notably and they became more aware of the importance of controlling their diseases and symptoms.

This is the first study with evidence on health outcomes regarding the implementation of the Valcronic programme since its start-up in 2012. We can tentatively consider that patients diagnosed with diabetes particularly benefit from their involvement in the programme, as they were the only group of users with a significant improvement in their HRQOL after one year involved in the programme and their levels of satisfaction were significantly higher than patients without diabetes. However, from the results obtained, we found some gaps in the programme that could be improved. As patients over 75, with COPD and living alone did not experience an improvement in their HRQOL one year after their inclusion in the programme, further assessment may be required to identify their specific needs which should be taken into consideration to adapt the initiative. In this sense, it may be interesting to join the population stratification process employed and the telemonitoring programme itself with other social and health resources available in the context of the study (Garcés et al., 2006). Thus, those patients in need of more comprehensive care could benefit, for example, from the case-management methodology implemented at the PC level, which could facilitate treatment adherence among other benefits (Garcés et al., 2013: Ródenas et al., 2008). Moreover, it may be useful to involve other suppliers of services – such as NGOs or municipalities – that could provide social support through home visitation programmes, especially to the older patients living alone and/or with a weak social network of support (e.g. Stijnen et al., 2013). In this way, the behavioural risk factors derived from living alone may be reduced (Linardakis et al., 2013). To address the poor data obtained in the EQ-5D dimension 'Usual activities' the programme may be connected with Home Help Service, from which patients and their caregivers – without high dependency demands – could benefit through assistance in activities of daily living (Garcés et al., 2011; Carretero et al., 2007). Another point that could be improved is the introduction of guidelines and practical tips within the ICTs – e.g. specific diets for diabetics or exercise activities – which could encourage the acquisition of

healthier habits. Finally, although patients showed they were in general satisfied with the quality of communication with health staff, some indicated the need to gain more confidence in the functioning of the remote monitoring system so that more PC centre feedback could take place.

The present study and the Valcronic programme are based on a stratification of population according to the results from previous studies of authors identifying risk groups with different health needs and taking into consideration comorbidities and multimorbidities (Doñate-Martínez, et al., 2014). Also, the programme involves different stakeholders – patients, GPs and nurses – who, in the case of primary end-users, entail a positively-assessed patient empowerment and self-management through the use of ICTs. These are strong points based on criteria and challenges identified by the EIP-AHA of the European Commission (European Innovation Partnership on Active and Health Ageing), which is aimed to assess integrated care activities or initiatives developed and undertaken at regional or local levels (EIP-AHA, 2012).

Some limitations of the present study should be noted. First, those related to the sample size which was notably reduced as many users were dropped from the research during the follow-up phase. Second, this study had no control group; however, in accordance with the review by Paré et al. (2007) more than half of the home telemonitoring studies focused on several chronic conditions did not have a control group. In our case, the exploratory and descriptive purpose of the study outlined did not require a control group to compare results with. And, finally, although it was not the aim of this study, we may need to do further research to draw conclusions about the impact of the Valcronic programme by taking into consideration caregivers' and clinicians' input.

Conclusions

On the basis of our findings in this paper, by way of conclusions we propose the following points. Firstly, as a continuation of previous results of the authors, this research demonstrates the applicability and strength of the use of computerized models within EHIS to identify high-risk patients with CD. So, thanks to the introduction of screening algorithms it is possible to guide clinical decisions for target interventions or pathways according to patients' needs in the VHS. Secondly, given the outcomes, Valcronic appears to be an

appropriate telemonitoring programme for the management of older adults with comorbidities or multimorbidities as it decreases patients' visits to PC centres, improves health awareness and perceived quality of life, as well as its positive impact on their perception of satisfaction and usefulness. However, significant improvement is needed to address a comprehensive response to the needs of the global population of reference in the Valencia Region; and including an assessment on the impact of the caregivers' and professionals' burden as well. Moreover, it remains necessary to do further research through larger longitudinal studies to determine which groups or profiles of patients may benefit most from this telemonitoring and which characteristics of the programme contribute most to positive effects in health status.

So, this initiative is an initial point to join resources from healthcare – through primary care – and social welfare systems in the design of more complete care pathways aimed to respond to the global LTC needs of the population with CD, especially in older adults or older people.

Chapter V

Conclusions

The main objective of this thesis has been the application, development and implementation of stratification tools aimed to identify elderly patients at risk of suffering hospital admissions in the subsequent 12 months. In order to achieve the specific objectives proposed and to verify the hypothesis formulated in the Chapter I, three studies were designed and carried out with the following characteristics:

a. In the first paper (within the Chapter II) two tools selected from the literature – Pra and CARS – were applied in a sample of 65 year old and over people and over (n= 500) from six PC centres from the Valencia Region. The results of this study are related to the Objectives 1 and 2.
b. In the second paper (detailed in the Chapter III) a study was carried out to select the most accurate variables to predict FHA. Also. A new predictive model was developed through the data collection from two 65 year old and over samples (100 and 343 persons in each one) from a comprehensive care centre (that combines primary and specialized care) for the Valencia Region. This study has allowed achieving the Objectives 3, 4 and 5.
c. And in the last paper (presented in the Chapter IV) it was assessed the impact of a telemonitoring programme in a sample of 74 older adults with CD from two PC centres from the Valencia Region. The Objectives 6 and 7 have been analyzed by this study.

The most relevant results, based on the established objectives and hypothesis, are summarized as follows.

Objective 1. To know the available tools in the scientific literature aimed at identifying elderly patients at risk of FHA and to identify among them potential ones to be applied in the VHS.

The first specific objective considered carrying out a literature review about tools to stratify and detect elderly people at risk of suffering FHA. So, in the first study of this thesis a literature review was carried out. 108 full-text articles of potentially relevant references were retrieved independently and blindly assessed by two reviewers. Finally, six screening tools were selected to be widely assessed by interjudge agreement through the application of seven screening criteria defined jointly by Polibienestar researchers and professionals from the VHS. The method established a total score range between 1 and 14 points of each tool by adding up points of each criteria; being considered as optimum

and of interest for further study those tools scored with 12 or more points. The criteria and the results obtained by their application are at the Table 1.

Table 1 | Application of criteria

Criteria / Tool	Application	Scientific publications	Nº items	Previous data	Correction	Presence variable in databases	Psychometric values	Total score
The Community Assessment Risk Screen – CARS	USA *1 point*	Shelton et al. (2000) *1 point*	3 *2 points*	6 months *2 points*	Adding scores from each item *2 points*	3/3 items *2 points*	AUC= 0.67 *2 points*	12
Emergency Admission Risk Likelihood Index – EARLI	UK *1 point*	Lyon et al. (2007) *1 point*	6 *2 points*	12 months *2 points*	Adding/ subtracting scores from each item *2 points*	4/6 items *1 point*	AUC= 0.669 Sensitivity: 14-45 % Specificity: 80-97 % PPV= 41-55 % NPV > 79% *2 points*	11
Method to identify elderly people at risk for high hospital utilization	USA *1 point*	Reuben et al. (2002, 2003) *1 point*	12 *2 points*	24 months *1 point*	Adding scores from each item *2 points*	4/10 items 2/2 laboratory tests (not always) *1 point*	AUC= 0.694 Sensitivity: 46.7 *2 points*	10
Patients At Risk for Rehospitalization – PARR	UK *1 point*	Billings et al. (2006, 2007); Ham (2009) *2 points*	22 *1 point*	36 months *1 point*	Algorithms *1 point*	2/3 factors *1 point*	AUC= 0.685 Sensitivity: 8.1-54.3 % Specificity: 72.2-98.6 % PPV= 65.3-84.3 % *2 points*	9

Footnotes

Has been the tool applied in several different countries?
- *At least 3 countries: 2 points*
- *One or two countries: 1 point*

How many scientific publications are related to the tool in prestigious journals according to the Information Sciences Institute (ISI)?
- *Three or more publications: 2 points*
- *Less than three publications: 1 point*

How many items compose the tool?
- *Nine or less items: 2 points*
- *Ten or more items: 1 point*

What period of time does the tool refer when requiring previous data from patients to calculate the total risk score?
- *Data from the 6-12 months prior to the moment of evaluation: 2 points*
- *Data from less than 6 months / more than 12 months prior to the moment of evaluation: 1 point*

What is the method of calculating the tool's total score?
- *Through a direct addition of the scores obtained in each item: 2 points*
- *Through other methods (as regression equations or algorithms): 1 point.*

Are the variables of the tool present at health information systems in primary care and hospitalization databases from Valencian Healthcare System (Abucasis, GAIA and MDS)?
- *All the variables are available: 2 points*
- *Not all the variables are: 1 point*

Has the tool moderate/high psychometric criteria (sensitivity, specificity, AUCs, etc.) in general?
- *Yes: 2 points*
- *No: 1 point*

– Hypothesis 1. *There are tools with probed validity and efficacy including variables which data can be easily collected through different databases from the VHS.*

The ***hypothesis 1 is confirmed.*** By the literature review it was found stratification tools to identify elderly people at risk of FHA developed and/or validated in different countries with statistical validity and efficacy. The period of time required by these tools to calculate the total risk score was not so extensive and their variables can be easily collected through the different health information systems of the VHS.

In accordance with the results of this review, the instruments with the highest scores were selected: Pra and CARS, with 12 points each one. Both tools were developed and validated in the United States, had less than 10 items, required data of patients from 6 to 12 months prior the moment of the evaluation – mostly available in the health information systems of the VHS – and showed good diagnostic accuracy (similar between them) in the prediction of FHA.

Objective 2. To apply the tools identified by the literature review in a sample of elderly patients of the Valencia Region and to know their performance stratifying it in risk groups.

As it is derived from the Objective 1, Pra and CARS were identified in the literature as stratification tools to be applied and to study their viability in the context of the Valencia Region through a retrospective study.

– Hypothesis 2: *The application of the selected tools is viable and the variables that compose them are easily accessible by accessing to the EHIS.*

The ***hypothesis 2 is partially confirmed*** as the application of both tools was viable; most of their variables could be easily collected through health information systems of the VHS.

Specifically, CARS is composed by 3 items (diagnosis of CD – heart disease, diabetes, myocardial infarction, stroke, COPD or cancer –, number of prescribed drugs and previous hospital admissions or visits to hospital emergency department in the previous 6-12 months), which information could

be collected through three EHIS: Abucasis (ambulatory information), MDS (hospital information) and GAIA (information on prescribed medications). Pra is composed of 8 items, 6 out of them were collected from Abucasis and MDS (age, gender, diagnosis of diabetes, diagnosis of heart disease, visits to the GP in the previous 12 months and hospital admissions in the previous 12 months). For the remaining 2 items (global self-reported health and caregiver availability) it was necessary to contact – by phone or through a face.to-face visit – to complete that information.

– Hypothesis 3: *The efficacy and diagnostic accuracy of the selected tools is moderate.*

Pra and CARS were respectively applied in a sample of 500 and 432 people aged 65 years or over from the Valencia Region. In the case of Pra it was a sample dropout of 13.6% due to the lack of information from two of its items (self-reported health and caregiver availability) which made impossible calculating the risk score.

CARS showed a sensitivity and specificity of 64%, a diagnostic efficacy of 67% and a AUC value of 0.69 (interpreted as the probability that in two people, one with high risk and the other with low risk, the test could be classified correctly). Whereas Pra obtained a lower sensitivity (54%) but a much higher specificity (81%), a diagnostic accuracy also higher (77%) and a similar AUC value than CARS (0.67).

Thus, taking into consideration these results, ***the hypothesis 3 is confirmed***. In spite of Pra and CARS were developed and validated in very different contexts than the Spanish one, the results derived from their application in a sample of the Valencia Region are quite good.

Objetive 3. To identify potential variables to be included in a new tool for detecting elderly chronic patients at risk of FHA.

This objective was outlined in the framework of the second study of this thesis with the collaboration of a multidisciplinary group of professionals (general medicine, nursing and social work) from a comprehensive care centre from the Valencia Region. This group of experts participated in several sessions of

focus groups aimed to analyze potential variables to be included in the new stratification tool and to select a first set of variables to be subsequently tested in a sample of the Valencia Region.

After these sessions with the professionals, the following variables were identified:

a. Socio-demographic:
   - Age.
   - Sex.

b. Clinical data:
   - Active diagnosis: chronic respiratory disease, chronic heart disease, dementia, chronic pain, necessity of palliative care, hemiplegia and diabetes.
   - Adherence to pharmacological treatment.
   - Risk of falls.

c. Use of healthcare resources in the precious 12 months:
   - Number of urgent hospital admissions.
   - Number of visits to the ED at hospital.
   - Number of visits to ED at PC centre.
   - Number of emergency visits at home.
   - Number of emergency phone calls to the PC centre.

d. Social aspects:
   - Availability of knowledge and skills for an appropriate care.
   - Social and/or family support.
   - Economic difficulties.

Objective 4. To develop a mathematical model able to identify elderly patients at risk of suffering hospital admissions in the following 12 months after their evaluation.

This objective is framed in the second study of this thesis and also is a continuation from the results of the first one in which already existing stratification tools were applied in a pilot sample of the Valencia Region. So, in this second study a new instrument was developed – through a mathematical model – able to identify

elderly chronic patients at risk of suffering hospital admissions in the following 12 months based on the own features of the VHS and its target population.

– Hypothesis 4: *There is a set of socio-demographic, clinical, social and related to the use of healthcare resources variables with statistical significance able to identify elderly patients at risk of FHA.*

First, a set of potential variables was identified with the PC experts' panel – through FG. Secondly, two retrospective studies were carried out to pilot these variables: the first one with a sample of 100 elders and the second with 343. Logistic binary regression analyses were done to identify the predictive variables with the highest explanatory capacity of our dependent variable (FHA). According to the obtained results, the variables with statistical significance were: necessity of palliative care (OR= 22.53; p= 0.004), diagnosis of chronic respiratory disease (OR= 2.32; p= 0.015), diagnosis of chronic heart disease (OR= 2.10; p= 0.019), diagnosis of diabetes (OR= 1.94; p= 0.032) and the visits to the hospital ED in the previous 12 months (OR= 1.82; p< 0.001).

So, we can say that ***the hypothesis 4 is partially confirmed*** as the mathematical model obtained is composed of 4 clinical variables and 1 related to the use of healthcare resources, but not any social or socio-demographic ones.

– Hypothesis 5: *The variables included in the model are easily accessible in the EHIS.*

The information related to the 5 variables included in the model can be easily obtained from the EHIS of the VHS; specifically Abucasis (in the case of the 4 clinical variables) and MDS (for the variable related to the use of hospital resources). Thus, ***the hypothesis 5 is validated***.

– Hypothesis 6: *The algorithm associated to the mathematical model can estimate the risk of FHA through a risk score and a threshold.*

The hypothesis 6 is verified. On the basis of the logistic regression analysis and ROC curves it was established a risk score (from 0 to 1) describing the estimated probability of hospital admission in the following 12 months. A threshold was also defined – as a determined value of the model establishing the limit between the presence and absence of FHA risk – after determining the optimal balance

between sensitivity and specificity values; in other words, the ability to identify true positives and false positives.

From this threshold each patient was classified as high or low risk of FHA. Those patients with a score of 0.5 or higher were considered as high risk while lower scores to that probability mean a low risk of hospital admission.

– Hypothesis 7: *The efficacy and diagnostic accuracy of the model are good.*

According to the different statistical analysis realized to assess the efficacy, quality and diagnostic accuracy of the model we can say that ***the hypothesis 7 is partially confirmed.***

On the one hand, the model shows a true positive rate (sensitivity) relatively low; with a value of 42%. However, the rate of people that actually suffered a FHA identified as high risk (positive predictive value) is high (81%). On the other hand, the true negative rate (specificity) showed by the model is high with a value of 96%. Moreover, the rate of people that actually did not suffer a FHA identified as low risk (negative predictive value) is high too with a value of 80%.

The diagnostic accuracy of the model is good and suitable accordingly to the AUC value (0.76). It is important to take into consideration that a perfect diagnostic test is characterized by an AUC value of 1.

Moreover, it should be noted the results derived from additional statistical analysis. The set of predictive variables that compose the model were able to explain the 31% of the dependent variable (R^2 of Nagelkerke = 0.31). Also, in accordance with the results of the Hosmer–Lemeshow test for goodness of fit, the model demonstrates good calibration (x^2= 1.24; p= 0.975). In other words, what we observe in reality (the FHA) suitably fits to the predicted by the model (the classification of patients in high and low risk).

Thus, as the model has been in the context of the VHS and with a sample from the Valencia Region, the obtained results cannot be considered sufficiently strong and accurate.

Objective 5. To study the profile of the elderly people identified as high and low risk of FHA.

– Hypothesis 8: *High risk elderly people have a higher prevalence of CD than low risk people.*

According to the results obtained in the second study of this thesis we can say that ***the hypothesis 8 is verified***. The patients identified as high risk of FHA show higher prevalence of the following CD diagnosis than the low risk group: chronic respiratory disease (high risk 36.54% vs. low risk 18.21%; $p = 0.003$); chronic heart disease (high risk 67.31% vs. low risk 23.02%; $p < 0.001$); dementia (high risk 21.15% vs. low risk 11%; $p = 0.042$); palliative care (high risk 28.85% vs. low risk 0%; $p < 0.001$); and hemiplegia (high risk 5.77% vs. low risk 1.03%; $p = 0.016$). In spite of that in the case of the chronic pain diagnosis a higher prevalence is observed in the high risk patients than in low ones (7.69% vs. 6.19%), the difference is not statistically significant ($p = 0.68$). We observe the same in the case of diabetes: the high risk group presented a higher prevalence than the low group (48.08% vs. 34.36%), but with tendency to significance ($p =$ 0,058).

– Hypothesis 9: *People identified as high risk are older than low risk ones.*

The hypothesis 9 is not validated. In spite of the average age of the high risk group is higher that the low risk one (78.65 ± 6.87 vs. 74.58 ± 6.72), the differences are not statistically significant ($p = 0.589$).

– Hypothesis 10: *There are significant differences in the rate of men and women between within the high and low risk groups identified by the model.*

The hypothesis 10 is not confirmed neither, as the rate of men and women both in the group of patients identified as high risk (38.46% of men, 61.54% of women) and low risk (38.14% of men, 61.86% of women) is similar ($p = 0.97$).

– Hypothesis 11: *High risk elderly people use more healthcare resources than the low risk ones.*

Taking into consideration the data of the predictive variables related to the previous use of healthcare resources as well as the data collected of the dependent variable (FHA), ***the hypothesis 11 is confirmed***.

On the one hand, patients identified as high risk show data confirming a statistically significant higher use of previous hospital and PC resources that the low risk group:

- More visits to the hospital emergency department (high risk 2.60 ± 1.45 vs. low risk 0.36 ± 0.60; $p < 0.001$).
- More visits to emergency department at the PC centre (high risk 1.10 ± 1.73 vs. low risk 0.68 ± 1.13; $p = 0.001$).
- More urgent visits received at home by PC professionals (high risk 0.47 ± 0.0 vs. low risk 0.09 ± 0.40; $p < 0.001$).
- More urgent telephone calls to the PC centre (high risk 0.40 ± 0.87 vs. low risk 0.04 ± 0.24; $p < 0.001$).

On the other hand, in relation to the FHA, the group of patients identified as high risk is characterized by:

- Higher rate of patients with FHA (high risk 80.77% vs. low risk 19.59%; $p<0.001$).
- Higher average of FHA (high risk 1.23 ± 1.13; low risk 0.23 ± 0.24; $p < 0.001$).
- Longer hospital length of stay linked with the FHA (high risk 14.69 ± 31.74 days vs. low risk 1.81 ± 6.37 days; $p < 0.001$).

Objective 6. To put in action and to study the practical utility of the stratification tools in the VHS.

- Hypothesis 12: *It is possible the introduction of the algorithms associated to stratification tools within the EHIS.*

- Hypothesis 13: *It is possible the connection of the stratification tools outputs with intervention programmes and/or individualized care pathways.*

In 2012 the AVS activated a pilot programme – called Valcronic – aimed at improvimg the management of chronic patients at PC centres through the use of ICTs. The selection of potential users was carried out with the support of a stratification tool, which algorithm was computationally introduced in the

electronic clinical history of the VHS (Abucasis). This tool was an adaptation of CARS instrument.

The algorithm linked to CARS was implemented in the chronic patients' population from four PC centres of the Valencia Region. As a result, the population was divided into three risk groups: high, moderate and low. Different care protocols were defined for each risk group:

- High risk patients received biomedical devices to monitor their conditions and a Tablet to send the information derived from them to the PC professionals of reference.
- The moderate risk group only received biomedical devices, so their members sent the information through their own Tablet, smartphone or PCs. The contacts plan and frequency to take biometrics were lower than the high risk patients.
- Low risk patients were provided with access to a website specifically designed for the Valcronic programme – where they could find useful information to improve their lifestyle habits (e.g. diets) and to strengthen their self-care skills of their conditions (what to do in case of an increase of glucose in blood, for instance).

In summary, in the framework of the third study of this thesis ***the hypotheses 12 and 13 are confirmed***. It has been possible to computationally introduce stratification tools in the EHIS and to connect the outputs of this stratification with a telemonitorig programme adapted to the profiles of the different patient groups accordingly to their risk level of suffering FHA.

Objective 7. To study the impact of a telemonitoring programme – aimed at improving the management of chronic patients at the VHS – on elderly patients identified at risk of FHA.

- Hypothesis 14: *The users improve their quality of life after one-year in the programme.*

Taking into consideration the whole sample of patients studied, the average value of the self-perceived health-related quality of life – assessed with the

questionnaire EQ-5D – is higher after one-year in the programme although without statistical significance (pre 0.63 ± 0.27 vs post 0.67 ± 0.27; *p*= 0,18).

After analyzing the impact of the programme in sub-groups of patients – classified according to different independent variables – those diagnosed with diabetes indeed experienced a significant improvement of their quality of life (pre 0.63 ± 0.30 vs. post 0.71 ± 0.28; p= 0.04). Moreover, it should be pointed out that patients between 65-75 years old (pre 0.60 ± 0.30 vs. post 0.67 ± 0.36; p= 0.07) and those diagnosed with hypertension (pre 0.59 ± 0.37 post 0.64 ± 0.38; p= 0.09) showed an improvement with tendency to significance.

However, some groups of patients did not improve their quality of life after one-year in the programme. The deterioration of EQ-5D values were observed in the patients older than 75 years (pre 0.63 ± 0.32 vs. post 0.61 ± 0.30; p= 0.68); diagnosed with COPD (pre 0.67 ± 0.35 vs. post 0.62 ± 0.29; p= 0.86); and those living alone (pre 0.59 ± 0.26 vs. post 0.58 ± 0.29; p= 0.16).

Moreover, the number of patients showing problems – moderate or severe – in the health dimensions assessed by the EQ-5D was reduced after one-year in the programme: mobility problems (reduction of 5.4%); problems to carry out self-care (4.06%); problems to perform usual activities (6.76%); pain or discomfort (3%); and anxiety or depression (17.57%).

So, ***the hypothesis 14 is partially confirmed*** as most of the patients benefit of the effects of the programme – although without statistical significance –, but some specific groups of the sample even suffer a deterioration of their quality of life. Moreover, it is worth mentioning that the rate of patients reporting problems related to mobility, self-care, usual activities, presence of pain/discomfort and symptoms of anxiety or depression decrease after one-year in the programme; especially in the case of emotional aspects.

– Hypothesis 15: *The users reduce the consumption of healthcare resources after one-year in the programme.*

The hypothesis 15 is confirmed given that the 51.39% of the sample reports a notable reduction of their number of visits to PC centres and the 37.5% only used the PC resources due to indispensable causes (for instance, due to acute diseases as influenza). Moreover, there is other data that can complement and/

or support this reduction in the consumption of resources. More than half of the users' sample (50.68%) expressed they were more aware of the importance to control their diseases and symptoms; and, also, the 38.36% reported the acquisition of new and healthier health habits. Finally, the 40.27% of the sample pointed out a notable or moderate improvement of the communication with their professionals of reference at the PC centre.

General conclusions

On the one hand, it has been confirmed that there are instruments available in the literature suitable to be applied and introduced in the EHIS of the VHS. Their implementation has made possible the connection of the outputs of the population stratification to select potential users to being included in a pioneering telemonitoring programme (Valcronic) in the Valencia Region aimed at improving the management of patients with CD. In this sense, in the Chapter IV it is shown the results related to the impact of the programme in the quality of life of a users' sample. The assessment of this kind of indicators is key in order to optimize the public resources and to obtain objective evidences for re-directing and improving intervention programmes, strategies and policies towards the real needs of the population.

On the other hand, this thesis has produced new knowledge with the development of a predictive model of FHA in elderly population with CD through logistic regression analysis. This model – developed with the collaboration of PC professionals with know-how in the management of this kind of patients – is based in an algorithm composed of five predictive variables: clinical (diagnosis of chronic respiratory disease, chronic heart disease, diabetes and presence of palliative care) and associated to the previous use of healthcare resources (number of visits to the hospital emergency department). These variables have something in common: they are easily accessible in the EHIS of the VHS; specifically from Abucasis and MDS. This feature makes viable that the developed algorithm may be computationally implemented within the PC management systems; so population stratifications could be done – on the basis of the predictive variables – periodically and the derived outcomes could be visible and accessible for the professionals. In this way, professionals could dispose an updated and dynamic database of patients at high risk of suffering

FHA and, subsequently, they could activate action plans proactively without needing an adverse event as triggering of the health and care action.

In this line, the European Commission is currently encouraging and supporting through economic resources the realization of studies to promote the strength of Big Data[1] analysis and computational models and in-silico[2] systems in the field of public health. From these studies, on the one hand, Big Data analysis may contribute to: a) increasing the effectiveness and quality of clinical treatments and care programmes; b) strengthening disease prevention by identification of risk factors of population; c) improving the pharmacovigilance and patient safety though taking more effective clinical decisions; d) predicting needs of adverse events of population; e) increasing efficiency, reducing costs and improving the performance of the healthcare systems (Habl et al., 2016). For its part, from the studies of computational models it is expected improving the understanding of the influence of different types of factors (biological, social, economic or related to the patients' life styles), as well as developing new biomedical products by modelling and computational simulations. Respecting the differences, the algorithm developed in this thesis may help to provide information on what factors are associated to the occurrence of adverse events and, so, can negatively affect in the population health. Moreover, the algorithm can provide prospective information of the health status of population, subpopulation, and individual levels.

The use of population stratification strategies for care purposes – within a continuity care approach – entails several aspects of interest for the development of strategic plans and action programmes, as well as for the design and reorientation of public policies at macro-level.

The stratification tools can be employed to analyze a target population with the purpose of dividing it in sub-groups according to specific dependent variables. In the context and scope of our studies, vulnerable patients were detected by analyzing objectively the fulfillment of some criteria through the revision of their clinical history. In this way, it was expected to offer knowledge about new and automatized strategies offering relevant and useful information for healthcare professionals. So, the possible assessment bias – associated, for instance, to a higher or lower contact with the patient or to the application of heterogeneous

[1] Big Data in Health refers to large routinely or automatically collected datasets, which are electronically captured and stored.

[2] Two examples are the calls "Personalised computer models and in-silico systems for well-being" y "In-silico trials for developing and assessing biomedical products" of the current Horizon 2020 Programme.

criteria by different professionals in the assessment of their group of patients – may be reduced through the use of the stratification outcomes. However, it is important to mention that the application of stratification tools could imply some risks or limitations. On the one hand, in spite of the EHIS usually dispose of a wide set of sections to fulfill relevant information of the patient (e.g. socio-demographics, diagnosis, treatments, tests or social needs) it is not always fulfilled in a homogeneous, concise and/or complete way (Tse & You, 2011); especially in the case of elderly and multimorbidity patients (e.g. García-Molina et al., 2016). This could mean that the stratification analysis (and other kinds) may not be based on updated and reliable information of the population. On the other hand, sometimes the data from the population available in the health information systems does not accurately represent the more complete and complementary knowledge that the healthcare professionals – especially those from PC – dispose of the patients of their groups. In this sense, in a recent study a stratification system was applied through the data included in the electronic clinical history to identify patients at risk. The clinicians considered useful that 76% of the classified cases for a subsequent intervention planning (González et al., 2016, in press). Based on this, it is suggested that a combination of the stratification outcomes with the knowledge, references and advices of the health professionals may be more effective and efficient (Shadmi & Freud, 2013). In this line, in the Chapter III it is proposed a combination between these two methods as a definitive stratification tool. A first phase in which the mathematical algorithm is calculated through the automatized data collection at the EHIS, combined with – in a second stage – gathering of some social variables. Thus, the tool may offer a more complete and comprehensive risk profile of the patient.

In accordance with the aforementioned in previous sections of this thesis, PC – from a multidisciplinary perspective – has a fundamental role in the approach of the CD and care of elderly people as PC professionals dispose of a wider knowledge of the clinical, social and familiar profile of their patients and they are closer to them than other assistance levels. However, it is important to introduce new approaches and methods supporting PC professionals for an effective, efficient and sustainable management of this kind of patients. EHIS are a really strong resource, nevertheless professionals do not use to proactively revise the available records in. So, these systems are sometimes underused (Howard et al., 2013). A systematized use of EHIS favours a decrease in the PC workload and a better communication between professionals (Goetz et al., 2012; O'Malley et al., 2015). In this sense, it is necessary fostering a work

culture and technological infrastructure that facilitate the coordination between professionals and the information systems for an effective and real exploitation of the data available in. This is why the introduction of smart, intuitive, flexible and firendly computerized systems supporting clinical decisions is key to improve and not to overload functions and tasks. Very recently a work has been published presenting a computerized support system for clinical decisions for the management of depression at PC (Aragonés et al., 2017, in press). This tool supports professionals in the selection of the most suitable treatment a priori according to the disease and the patient characteristics. We find another example in which a computerized decision-making support system was developed to manage the medication of elderly people at EHIS (Alagiakrishnan et al., 2016). So, in line with the work presented in Chapter III, the stratification tools studied in this thesis would provide relevant automatic and systematic information as a basis for the design, activation and assessment of subsequent interventions adapted to the specific profile of each patient.

The three studies that compose this thesis are contextualized in the VHS. Through the research projects and contracts in which the thesis is framed, proposals for the improvement in the management of elderly patients with CD at PC services have been studied. The Conselleria de Sanidad (2014) itself suggests this level of care as one of the fundamental pillars to care the chronicity and the elderly population due to PC is characterized by a longitudinal care and closeness for the population. Based on this:

a. GPs are a key factor to coordinate the interventions of specialists and other necessary resources;
b. home care is stimulated;
c. the role of nursing in reinforced; and
d. social workers are recognized as a key component in a multidisciplinary team for the approach of these patients.

In the studies of this thesis, the role of multidisciplinary teams at PC – composed of professionals from medicine, nursing and social work – has been reinforced to tackle patients' needs with case-management models from an integrated care perspective.

The current Health Plan of the Valencia Region (Plan de Salud de la Comunidad Valenciana) (Conselleria de Sanidad, 2016) is estructured on four core ideas:

a. Strengthening of the equity and reduction of inequalities in health.
b. Innovation, reorientation and reorganization of the healthcare system – especially to approach the ageing population and the predominance of the CD.
c. Triple perspective based on health promotion, improvement of the care provided and guarantee of a correct use of healthcare resources.
d. Promotion of higher autonomy and lower dependence of the social and health services by the population.

In line with the exposed throughout this chapter, the systematized, protocolized and/or computationally automatized use of stratification systems would foster the achievement of some elements of the aforementioned Health Plan of the Valencia Region. Accordingly, stratification systems:

– Entail an assessment of the target population as a whole trying to ensure the same opportunities to all patients of being users of specific programmes and/or simply of being monitored.

– Have a clear innovative component as they entail significant changes in the care organization aimed at improving their outcomes. Moreover, they entail a change in the care approach, becoming more proactive and suitable for the continuity care that chronicity requires.

– Aimed at optimizing the resources available at PC related to human ones and those related to health information systems (mainly Abucasis) to improve the quality of care provided, patients' health status and quality of life and, also, to reduce the use of healthcare services (visits to PC and potentially avoidable hospital admissions).

From the limitations of the studies that compose this thesis – as well as from the results obtained – further and future research arise. The main weakness to be highlighted is the low sensitivity (42%) of the predictive model developed (in the framework of the Chapter III). This value is lower to those showed by the two stratification tools initially applied in the thesis (Chapter II) that were originally developed in the United States; concretely, Pra showed a sensitivity of 54% and CARS of 64%. Thus, it would be necessary, on the one hand, to validate the algorithm in a larger sample of patients that better represent – geographically – the elderly population of the Valencia Region. On the other hand, it would be interesting to apply the proposed stratification model – composed of two phases

– in a representative sample and, in turn, to connect the derived results with personalized care pathways. Regarding to this last point, we have developed several follow-up and individualized care protocols for elderly patients with a recent urgent hospital admission associated to an exacerbation of their CD. Currently, these protocols are being pilot-implemented in the Comprehensive Healthcare Centre of Burjassot (Valencia) to analyze their performance, impact on patients and on PC professionals. Based on the obtained results and feedback the necessary adjustments will be done in order to improve the efficacy and efficiency of the protocols.

Chapter VI

Policy recommendations

On the basis of the results and conclusions presented in previous sections of this thesis, this last chapter briefly presents some policy recommendations that may be taken into consideration to improve the management of elderly patients with CD at the VHS and other healthcare systems with similar characteristics.

Many MS from the EU have included the reorganization of healthcare services and moving forward to a new care provision approach in their short-term agenda due to the generalized challenges that Western societies are currently facing; such as population ageing and the increased prevalence of CD among others (see Chapter I for more details).

Governments are increasingly being called and stressed to offer and invest in a more comprehensive and preventive care approach, especially addressed to elderly people and/or chronic patients. This means that healthcare systems should be sustainable and cost-effective at the same time they respond to the main needs of their citizenship (European Commission, 2013; Ulmann, 2014).

Thus, in this chapter Polibienestar team – after a round-table discussion – suggests three policy recommendations which are listed at Table 1 where, also, it is pointed out the stakeholders that should be involved for their deployment.

Table 1 | Polibienestar's policy recommendation in the field of management of elderly patients with CD at the VHS

Policy recommendation	Stakeholders involved
1. Introduction of stratification tools in healthcare systems to identify patients at risk of a future adverse event	Policy makers; VHS and AVS; PC centres; PC managers; PC front-line staff; Technology managers from AVS; Technology developers and suppliers of Abucasis.

2. Design of interventions following an integrated and continuity care approach	Decision makers; VHS and AVS; Conselleria de Igualdad y Políticas Inclusivas; Municipalities; Managers of PC centres, social services and Health Departments; Service providers from the private sector; Technology managers from AVS; Technology developers and suppliers.
3. Improvement of electronic healthcare records for a better management and for research purposes	Spanish Ministry of Health; VHS; Technology developers of the AVS; PC staff.

1. Introduction of stratification tools in healthcare systems to identify patients at risk of a future adverse event

Goal:

Early identification of patients at risk provides useful information to health and social care systems and, thus, to their care staff to carry out the necessary preventive and intervention actions aimed at reducing the probability of adverse events take place at short or medium term. The deployment of these tools is aimed to reduce, for instance, avoidable hospital admissions, to improve the management of frail patients at PC and to offer high quality and proactive care at PC.

Background:

In 2013 the VHS launched a stratification protocol based on the 3M Clinical Risk Groups (CRG); a population classification system that uses inpatient and ambulatory diagnosis and procedure codes, pharmaceutical data and functional health status to assign each individual to a single, severity-adjusted group (Hughes et al., 2004). This system was implemented by the General Directorate of Pharmacy and Medical Products including a computer application that allows the visualization of the CRG group in which every patient is classified as well as his/her expected and observed cost (Consellería de Sanidad, 2014). Within the VHS, this classification system is updated monthly and is usually taken into consideration by health staff in a reactively basis after a hospital discharge.

Furthermore, in 2012 the AVS computationally-introduced in Abucasis an adapted version of the Community Assessment Risk Screen (CARS) tool which outcomes were only used to identify potential users for a pilot telemonitoring programme (Valcronic) implemented in four PC centres.

In other Spanish and European regions healthcare administrations have a larger trajectory using population stratification systems. In this regard, the European project ASSEHS (Activation of Stratification Strategies and Results

of the interventions on frail patients of Healthcare Services) carried out a study on impact of risk stratification tools taking as regions' sampling Puglia and Lombardia from Italy and Cataluña from Spain (Martí et al., 2016). Some of the benefits highlighted in this study were the following:

- All regions pointed out that risk stratification does play a role in budget distribution.
- The implementation of stratification tools requires an active role of health professionals with different backgrounds and functions and, in some cases, the activation of new roles. In this regard, in Cataluña risk stratification supported the modification of traditional roles connecting PC, hospital care and LTC; in País Vasco nurses and case managers acquired new roles in hospitals; and in Italy (both in Puglia and Lombardia) the care of chronic patients by GPs was strengthened.
- Cataluña and País Vasco reported an improvement of the care around the patient due to the development of new care pathways coordinated by PC.
- In all regions, health front-line staff and managers were moderately satisfied with the deployment process of stratification tools.

Our recommendation:

To implement systematized, automatized and computerized stratification strategies at the VHS by including predictive algorithms within EHIS. These strategies should be focused in the most frail population groups and in those meaning a burden – both in terms of level of visits to different care resources and in terms of costs – for the care systems; such as elderly people with CD.

These stratification systems must be proactive and promote a patient-centred approach through these main features:

a. To be weekly updated in order professionals and the administration dispose the most updated information as possible.
b. The derived outcomes are connected with the computerized electronic clinical history (Abucasis).
c. The access to the derived outcomes is open and available to all professionals with allowed access to Abucasis.

d. PC professionals receive alarms once a week through Abucasis with the set of patients identified as high risk within their quota.
e. The stratification outcomes must be connected with a wide and varied health and social care packages in order high risk patients can be easily referred to the most appropriate services, resources and plans.

Four approaches to achieving this are:

- Establishment of a **protocol** by policy makers and healthcare administration for an appropriate and effective use of stratification systems by the different actors involved: VHS, AVS and the net of PC centres (managers and front-line staff).
- Introduction of **mathematical algorithms** associated to stratification tools within the computerized electronic clinical history by technology managers from AVS in charge of EHIS together with technology developers and suppliers of Abucasis (Indra company). It would be also necessary to do arrangements to make this new option visible and user-friendly in Abucasis.
- Organization of **training and workshops** by managers from each PC centre in order to promote a common knowledge and awareness of the functioning of stratification strategies implemented and the emergence of new roles (if necessary). It is also important that each Health Department of the VHS and PC centre include these strategies within their Strategic Plan and, consequently, they establish monitoring and quality assessment criteria to evaluate periodically their performance, impact and acceptance.
- **Support and engagement** of PC front-line staff (GPs, nurses, social workers, administrative officers, etc.) with access to Abucasis for an effective and efficient implementation of stratifications systems at daily work.

Stakeholders involved: Policy makers; VHS and AVS; PC centres; PC managers; PC front-line staff; technology managers from AVS; technology developers and suppliers of Abucasis.

2. Design of interventions following an integrated and continuity care approach

Goal:

The elderly are a population group commonly with both clinical and social needs, such as related to nutrition, polypharmacy, treatment adherence, social and/or family support, loneliness or low performance of instrumental activities of daily living. Furthermore, these needs use to endure for long periods of time once they are detected, even, in many cases until the end of life. So, elders require a care approach based on comprehensiveness and continuity.

Background:

As it was stated in section 2 at Chapter I, the current care system in Spain and in the Valencia Region lacks an integration of health and social care resources. Moreover, the care approach is characterized by a traditional reactive-based model, with a focus on dealing with risk factors to avoid specific conditions or harmful lifestyles (e.g. smoking), but not specifically to promote active and healthy ageing.

At Chapter IV a study about the impact of Valcronic programme in older adults from the VHS is presented. In general, results report an improvement of the quality of life within the sample after one year involved in (Doñate-Martínez et al., 2016). However, some sub-groups of the sample experienced a deterioration of their quality of life values: patients over 75 years old, with COPD and living alone. These results may mean that Valcronic was effective enough for older adults, for those with well-controlled CD and those with family support at home; but not for those with more complex needs. This programme only considered PC resources but any social service or at community level.

Along Europe there are many countries working with the same separated care system than in Spain, but there are also other countries with a real integrated care practice which can be followed as a model; this is the case of some regions in Sweden. In this regard, the Norrtaelje model is a Swedish initiative put into practice in Stockholm that transformed the funding and organization of health

and social care for better quality of care of elderly people with complex needs (Bäck et al., 2015). This transformation was possible only with the existing budget and without the necessity of additional funds. This experience suggests that aligning health and social care in terms of high level organization and funding is a successful first step to promote integration of both sectors. Moreover, this transformation must be in-line with national priorities and policies but ultimately is successful only if the culture, resource allocation and management are changed throughout the final service provider.

In this regard, Polibienestar did a pilot study in two PC centres in the Valencia Region aimed to test the effectiveness and efficiency of case-management of elder patients with CD through multidisciplinary teams. After 6-9 months, the programme reduced the number of hospital admissions, improved the management of medication consumption and produced a more rationalized use of home and community care resources (Ródenas et al., 2008). An additional example at the VHS to be highlighted is another pilot study carried out for 9 months by Polibienestar based on the development of an integrated care programme offering these main itineraries: a) physical exercise to address frailty and risk of falling; b) management of polypharmacy; and c) social support to address loneliness. Patients experienced a reduction in frailty, in risk of falling, as well as in loneliness values (Alhambra-Borrás et al., 2017, in press).

Our recommendation:

To design a unique portfolio with health and social care services following a continuity care approach specifically addressed to elderly people including resources within and outside of the healthcare system with the involvement of different local actors.

These approaches may be taken into consideration to achieving this:

- Establishment of **agreements** on specific administrative activities between decision-makers from the healthcare sector and social services field.
- Connection of different factors included in the **comprehensive geriatric assessment** (such as clinical and social variables of the patient, related to his/her housing, his/her economic situation and related to the clinical and social situation of his/her informal caregiver if available) to different services

both within and outside of the healthcare field.

- Establishment of **multidisciplinary case-management teams at PC centres** – composed of GPs, nurses and social workers – in charge of the decision making after the comprehensive geriatric assessment.
- Establishment of **common guidelines and strategies** between the healthcare administration of the VHS and the Conselleria de Igualdad y Políticas Inclusivas, including social services from the municipality and other community services, resources or facilities. This net of services and resources are multidisciplinary and multi-sectorial (public ones or from the Private sector) and should be deployed at the closest level to the patient: at local, Health Department area or neighborhood level.
- Coordination and communication of both care systems facilitated by ICTs through the **deployment of new functions in the available EHIS** with the support of technology developers of the AVS. In this sense, for instance, GPs, nurses or social workers may write notes or advertisements (with relevant advancements or needs of the patient, etc.) at the electronic clinical history of the patient in order other professionals could read and be aware of them.
- Organization of **training and workshops** by managers of PC centres, social services and Health Departments addressed to both health and social care staff is aware of the set of services and resources available within their contexts in order to make the most appropriate and complete referrals.

Stakeholders involved: Decision makers; VHS and AVS; Conselleria de Igualdad y Políticas Inclusivas; municipalities; managers of PC centres, social services and Health Departments; service providers from the private sector; technology managers from AVS; technology developers and suppliers.

3. Improvement of electronic healthcare records for a better management and for research purposes

Goal:

Electronic health records at PC, among other levels, mean a huge source of information from whole populations that have become indispensable for healthcare provision, management and, increasingly more, in research.

In spite of their potential, there are still some barriers and weaknesses within the EHIS of the VHS – and in Spain in general – that would be necessary to address in order to increase their functionality and impact.

Background:

In the last years the EHIS have been increasingly introduced and improved into the healthcare systems from the different Autonomous Communities within Spain. However, the main problem to be highlighted in this regard is the lack of a standardized and unique electronic healthcare history at national level and the lack of interoperability of the different electronic healthcare histories used among the Autonomous Communities.

Furthermore, in the focus groups carried out with GPs, nurses and social workers in the framework of the second paper presented within this thesis (Chapter III), the register of patients' information in Abucasis was addressed. All the participants of the focus group considered the EHIS as very valuable tools for an appropriate management of the clinical and care information of their patients, however some deficiencies in their use and performance were reported. The main ones are the following:

a. Lack of awareness of the functions offered by Abucasis to register the information, especially those with a lowest use at daily practice.
b. Lack of awareness of the authorized functions of other healthcare profiles (GPs, nurses, social workers or administrative staff) and the type of

information they can fulfill or have access to.

c. Incorrect registration of the information within Abucasis.
d. Heterogeneous registration of the information. In many occasions, professionals register information according to their own criteria and preferences and not following common guidelines.

These weaknesses may bring negative consequences and difficulties for the exploitation of the data registered in Abucasis to carry out research studies. Moreover, it is worth to note other aspects related to the performance and management of the system:

a. The introduction of changes in Abucasis (e.g. modification of the appointments system) is usually carried out without taking into consideration the views of the healthcare staff that use it.

b. Occasional low functioning that slow down the appointments. This aspect may cause that professionals do not register accurately or completely the information in Abucasis neither in the most appropriate function during the appointment.

Our recommendation:

To strengthen the role of EHIS in the VHS through: a) usability and correct use by professionals with authorized access; b) efficient management of Big Data produced at PC; c) awareness about the exploitation of registered data at EHIS to carry out small and large scale research aimed at knowing the current health outcomes of whole populations or specific sub-groups and at carrying out predictions to know future needs of the VHS.

This policy recommendation suggests the following measures:

– Advancement of national infrastructures and policies to create a **unique electronic clinical history system** at national level; or development of a software that facilitates the **interoperability** between the different systems used by each Autonomous Community. This is an old challenge that the Spanish Ministry of Health is currently working on, but it should be tackled as soon as possible.

- Organization of **training and workshops** by the VHS and technology developers of the AVS addressed to professionals with authorized access to EHIS aimed at encouraging a correct, homogeneous and shared use of the different functionalities that each EHIS presents.
- Involvement of PC professionals in the decision making about changes to be introduced in Abucasis (or other systems) by following a **co-design approach** or other group interviews and data collection.
- Facilitation of **exploiting the data** registered at EHIS to carry out different types of analysis, such as predictive ones. For instance, PC Big Data offers a great potential to: a) live, dynamic and smart monitoring of population health; or b) develop predictive algorithms or in-silico systems that would favour a more efficient management of resources carrying out large scale predictions of patients' health and needs to plan preventive actions, intervention and policies in order to respond the challenges forecasted.

Stakeholders involved: Spanish Ministry of Health; VHS; technology developers of the AVS; PC staff.

Summary

In this last Chapter a global summary of the previous ones is presented. Firstly, a brief theoretical framework is presented; secondly, the objectives of the thesis are listed and, later, the three papers that compose it (framed in the Chapters II, III and IV) are summarized describing their objectives, methodologies employed and the main results obtained. Finally, an overview of the main conclusions is presented.

Theoretical framework

The starting point in which the thesis is characterized, basically, by two phenomena that western countries have continued to experience in the last twenty years: a) the demographic change and the consequent population ageing; and b) the chronic diseases (CD) increased prevalence and burden. Both phenomena have (and it is expected they will continue in the future) a notable impact in the consumption of care resources by different population groups and in the (re-)organization of the healthcare and social systems among other Welfare State pillars. So, the current scenario (and in the foreseeable future) is characterized by a population each time living longer and with a percentage of older people (or very old) being progressively higher. Moreover, the prevalence of CD means an important impact on healthcare systems, as they are the main cause of death in the European Union and, in many cases, they are associated to dependency situations and long-term care (LTC).

In order to approach more effectively the conditions associated to ageing and chronicity, care systems – both healthcare and social services – should place the patient in the centre of the care relationship, so care services and their professionals have a more active role in the management of the population health. Also, systems should introduce improvements in the disease management processes aimed to carry out more efficient actions and, last but not least, social services and healthcare resources should be coordinated and integrated taking into consideration a comprehensive view of the patient.

PC services can play an indispensable role to encourage these changes in the care culture by introducing improvements in the management, care and referral of elderly patients and/or with CD. However, in order to not overload

the daily functions of PC professionals it would be interesting and useful the implementation of support decision making systems related to the management of these patients. Thus, this thesis banks on the potential use of stratification systems in elderly population with CD at PC services.

Objectives

The main objective of this work has been the application, development and implementation of stratification tools aimed at identifying elderly patients at risk of suffering hospital admissions in the following 12 months in the Valencian Healthcare System (VHS).

The VHS, and more specifically the services of PC, is characterized by a set of factors that facilitate the study of this main objective; such as the access to health information systems with a wide range of patients' data or a relevant know-how in the care of elders with chronic multimorbidity.

Throughout the following specific objectives it is expected to offer results aimed to improve decision making systems and to support PC professionals at their daily functions. Thus, on the basis of the implementation of stratification systems, those patients identified with higher vulnerability can be referred to appropriate and individualized care pathways according to their health and social needs.

In order to approach and address the aforementioned main objective, the following specific objectives and hypothesis have been stated:

Objective 1. To know the available tools in the scientific literature aimed at identifying elderly patients at risk of future hospital admission (FHA) and to identify among them potential ones to be applied in the VHS.

- Hypothesis 1. *There are tools with probed validity and efficacy including variables which data can be easily collected through different databases from the VHS.*

Objective 2. To apply the tools identified by the literature review in a sample of

elderly patients of the Valencia Region and to know their performance stratifying it in risk groups.

- Hypothesis 2*: The application of the selected tools is viable and the variables that compose them are easily accessible by accessing to the electronic health information systems (EHIS).*

- Hypothesis 3*: The efficacy and diagnostic accuracy of the selected tools is moderate.*

Objective 3. To identify potential variables to be included in a new tool for detecting elderly chronic patients at risk of FHA.

Objective 4. To develop a mathematical model able to identify elderly patients at risk of suffering hospital admissions in the following 12 months after their evaluation.

- Hypothesis 4: *There is a set of socio-demographic, clinical, social and related to the use of healthcare resources variables with statistical significance able to identify elderly patients at risk of FHA.*

- Hypothesis 5: *The variables included in the model are easily accessible in the EHIS.*

- Hypothesis 6: *The algorithm associated to the mathematical model can estimate the risk of FHA through a risk score and a threshold.*

- Hypothesis 7: *The efficacy and diagnostic accuracy of the model are good.*

Objective 5. To study the profile of the elderly people identified as high and low risk of FHA.

- Hypothesis 8: *High risk elderly people have a higher prevalence of chronic conditions (CD) than low risk people.*

- Hypothesis 9: *People identified as high risk are older than low risk ones.*

- Hypothesis 10: *There are significant differences in the rate of men and women*

between within the high and low risk groups identified by the model.

– Hypothesis 11: *High risk elderly people use more healthcare resources than the low risk ones.*

Objective 6. To put in action and to study the practical utility of the stratification tools in the VHS.

– Hypothesis 12: *It is possible the introduction of the algorithms associated to stratification tools within the EHIS.*

– Hypothesis 13: *It is possible the connection of the stratification tools outputs with intervention programmes and/or individualized care pathways.*

Objective 7. To study the impact of a telemonitoring programme – aimed at improving the management of chronic patients at the VHS – on elderly patients identified at risk of FHA.

– Hypothesis 14: *The users improve their quality of life after one-year in the programme.*

Chapter II

Objective

The objective of the paper *Application of screening tools to detect risk of hospital readmission in elderly patients in Valencian Healthcare System (Spain)* is to determine the viability of the application of two screening tools to detect patients at risk of FHA – originally developed and validated in the United States – in a sample of elderly people from the VHS.

Methodology

Probability of Repeated Admission (Pra) and The Community Assessment Risk Screen (CARS) were selected from a literature review to be tested in the VHS. For this purpose, a retrospective study was carried out with a sample of 500 elders from six PC centres from the Valencia Region. Most of data required by each tool was collected through different EHIS (specifically, Abucasis, Minimum Data Set – MDS – and GAIA). Direct contact with every patient – by phone or face-to-face visits at the PC centre – was realized to fill out two Pra's items. Data related to the dependent variable (FHA) was collected by MDS. The following statistical analyses were carried out: a) descriptive; b) discriminant (with Student's T, ANOVA, Kruskall-Wallis and Mann-Whitney U tests); c) operating characteristics of each tool (sensitivity, specificity, positive predictive value and negative predictive value); and d) area under the ROC curve.

Results

The main results obtained were:

- The average number of FHA and the mean hospital length of stay were significantly higher in the high risk groups than in the low ones identified both by Pra and CARS.
- The rate of patients with FHA identified as high risk (sensitivity) was of 54% in the case of Pra and 64% in CARS.
- The rate of patients without FHA identified as low risk (specificity) was of 81% in Pra and 64% in CARS.
- The diagnostic accuracy (assessed through AUC test) was of 0.67 in Pra and 0.69 in CARS.

Chapter III

Objective

The paper *Risk stratification at primary care centres in Valencia (Spain) to activate integrated care pathways for elderly patients with chronic conditions* presents the development of a new predictive model to identify elderly patients at risk of FHA from PC centres of the VHS.

Methodology

In order to develop the predictive model, three research phases were carried out with the involvement of a comprehensive healthcare centre (combining PC and specialized care) from Valencia. In the first phase focus group methodology was used with a multidisciplinary PC experts' panel in order to identify potential variables for predicting the risk of FHA. From the agreed outcomes, in the second phase a retrospective pilot study was carried out with a sample of 100 elderly patients from the same aforementioned PC centre. Data associated to the variables previously identified by the expert panel was collected from this sample: age; sex; active diagnosis of CD (chronic respiratory disease, chronic heart disease, dementia, chronic pain, necessity of palliative care, hemiplegia and diabetes); adherence to pharmacological treatment; risk of falls; number of previous urgent hospital admissions; number of previous visits to the emergency department (ED) at hospital; number of previous visits to PC centre; number of previous urgent visits received at home by PC professionals; number of previous phone calls to PC centre; availability of knowledge and skills for an appropriate care; social and/or family support; and economic difficulties. According to binary logistic regression analysis, the variables with the strongest association with the FHA were: number of previous visits to ED at hospital and number of previous emergency visits at home. Other variables related to the previous use of PC resources detected in the first stage were also taken into consideration but, in this case, only if they were urgent cases: number of previous visits to ED at PC centre and number of previous emergency phone calls to the PC centre. Additionally, variables of active diagnosis, age and sex were included as researchers and experts from focus group considered and agreed as relevant for clinical assessments and socio-demographic clusters. Finally, data associated

to this last set of variables were collected and tested – by a retrospective design – in a sample of 343 patients through, also, binary logistic regression analysis. Moreover, in this third step, additional statistical analysis were done: a) descriptive; b) discriminant (with Student's T and ANOVA tests); c) ROC curves to identify a cut-off point from which to classify the sample in high and low risk groups; d) operating characteristics of each tool (sensitivity, specificity, positive predictive value and negative predictive value); and e) area under the ROC curve.

Results

The main results obtained were:

- The variables with the strongest predictive ability of FHA and, therefore, compose the predictive model are: diagnosis of chronic heart diseases, chronic respiratory diseases, diabetes, presence of palliative care and number of previous visits to ED at hospital.
- The percentage of variance explained by the final model was 31% and the estimated risk showed very good agreement with the observed incidence.
- A risk scoring system was established. This system ranks each patient from 0 to 1 and describes the estimated probability of FHA. Patients with risk scores between 0-0.49 are classified as low risk and those with scores between 0.5-1 as high risk.
- The rate of patients with FHA identified as high risk (sensitivity) was of 42%.
- The rate of patients without FHA identified as low risk (specificity) was of 96%.
- The diagnostic accuracy (assessed through AUC test) was of 0.76.
- Patients identified by the model as high risk have significantly more cases of CD and had a higher previous use of healthcare resources (both at PC and hospital).
- Average values in the number of FHA and hospital length of stay are significantly higher in the group of patients identified as high risk than the low ones.

Chapter IV

Objective

In the last paper of this thesis, *Impact of a primary-based telemonitoring programme in HRQOL, satisfaction and usefulness in a sample of older adults with chronic diseases in Valencia (Spain)*, the impact of a telemonitoring programme on health-related quality of life (HRQOL) and perceptions of satisfaction and usefulness is studied in a sample of older adults with CD in the Valencia Region.

Methodology

The studied telemonitoring programme is entitled Valcronic, which has been designed and pilot-implemented by the AVS in two PC centres. This programme offers several care and follow-up modalities of chronic patients – through new technologies – in accordance with their risk of suffering FHA screened by the computerized implementation of an adapted version of CARS tool in Abucasis.

Before the launch of the programme, a sample of 100 older adults was selected from the group of users selected for being part of the Valcronic pilot. This sample fulfilled at basal and after one year involved in the programme (with a dropout of 26% in the sample) the Spanish validated version of the questionnaire EQ-5D to assess their HRQOL. Moreover, after one year participating in the programme, these users also fulfilled a questionnaire – developed on purpose for this study – to assess their satisfaction and usability perceptions of Valcronic. The statistical analysis carried out were, mainly, descriptive (with Mann Whitney and Kruskall-Wallis tests) to know the association between the quality of life indexes (both basal and after one year in the programme) and the different subgroups in which the sample was stratified (according to their risk level, age, sex, CD diagnosis, etc.).

Results

After a one-year involvement in Valcronic programme, the following results regarding its impact were observed:

- The rate of the sample reporting problems in at least one dimension assessed by EQ-5D decreased; the highest decrease was observed in 'Anxiety/depression' dimension.
- The sample experienced an improvement in their HRQOL – as an average of the EQ-5D index –, but not statistically significant. Only users with diabetes improved significantly their HRQOL.
- Users with these characteristics – independently – suffered a decline in their HRQOL values: over 75, with chronic obstructive pulmonary disease (COPD) and living alone at home.
- Most of the sample reported that the programme – specifically the technological devices included in – was easy to use.
- Most of the sample felt safe and comfortable with this kind of telemonitoring at home.
- Around half of the sample decreased notably their number of visits to PC centres during their participation in the Valcronic programme.
- Most of the participants in the study felt more aware of the importance to control their diseases and symptoms.
- More than a third part of the sample introduced new and healthier habits.

Conclusions

Now the main conclusions achieved are presented after comparing the results obtained in the three studies that compose this thesis and the objectives and hypothesis initially set. Objectives 1-2 and hypothesis 1-3 respond to the results of the study *Application of screening tools to detect risk of hospital readmission in elderly patients in Valencian Healthcare System (Spain) (Chapter II). The study Risk stratification at primary care centres in Valencia (Spain) to activate integrated care pathways for elderly patients with chronic conditions* (Chapter III) addressed the objectives 3-5 and hypothesis 4-11. And, finally, with the study *Impact of a primary-based telemonitoring programme in HRQOL, satisfaction and usefulness in a sample of older adults with chronic diseases in Valencia (Spain)* (Chapter IV), objectives 6-7 and hypothesis 12-14 are answered.

Objective 1. To know the available tools in the scientific literature aimed at identifying elderly patients at risk of FHA and to identify among them potential ones to be applied in the VHS.

– ***The hypothesis 1 is confirmed.***

Through the literature review carried out in the first study of this thesis, six screening tools aimed to identify elderly people at risk of FHA were detected. After interjudge agreement assessment, the selected tools were *Probability of Repeated Admission (Pra) and The Community Assessment Risk Screen (CARS),* which were developed and validated in the United States, have less than 10 items, require data of patients from 6-12 months prior the moment of the evaluation and showed – in several studies – good diagnostic accuracy.

Objective 2. To apply the tools identified by the literature review in a sample of elderly patients of the Valencia Region and to know their performance stratifying it in risk groups.

– ***The hypothesis 2 is partially confirmed.***

The application of Pra and CARS in the VHS was viable due to most of their variables can be easily collected through EHIS (Abucasis, MDS and GAIA), with the exception of two Pra's items.

– ***The hypothesis 3 is confirmed.***

By the application of CARS in a sample of 500 elderly patients, it showed a sensitivity and specificity of 64%, a diagnostic accuracy of 67% and a AUC of 0.69. Pra was applied in 432 people and the results showed a sensitivity of 54%, specificity of 81%, a diagnostic accuracy of 77% and a AUC of 0.67.

Objective 3. To identify potential variables to be included in a new tool for detecting elderly chronic patients at risk of FHA.

The potential variables identified in the second study of this thesis with potential to detect patients at risk of FHA are:

a. Socio-demographic:
   - Age.
   - Sex.

b. Clinical data:
   - Active diagnosis: chronic respiratory disease, chronic heart disease, dementia, chronic pain, necessity of palliative care, hemiplegia and diabetes.
   - Adherence to pharmacological treatment.
   - Risk of falls.

c. Use of healthcare resources in the precious 12 months:
   - Number of urgent hospital admissions.
   - Number of visits to the ED at hospital.
   - Number of visits to ED at PC centre.
   - Number of emergency visits at home.
   - Number of emergency phone calls to the PC centre.

d. Social aspects:
   - Availability of knowledge and skills for an appropriate care.
   - Social and/or family support.
   - Economic difficulties.

Objective 4. To develop a mathematical model able to identify elderly patients at risk of suffering hospital admissions in the following 12 months after their evaluation.

– ***The hypothesis 4 is partially confirmed.***

The mathematical model aimed to predict the risk of FHA obtained through binary logistic regression analysis is composed by 4 clinical variables and 1 related to the use of healthcare resources; but not any social or sociodemographic. These variables with statistical significance are: necessity of palliative care (OR= 22.53; p= 0.004), diagnosis of chronic respiratory disease (OR= 2.32; p= 0.015), diagnosis of chronic heart disease (OR= 2.10; p= 0.019), diagnosis of diabetes (OR= 1.94; p= 0.032) and the visits to the hospital ED in the previous 12 months (OR= 1.82; p< 0.001).

– ***The hypothesis 5 is validated.***

The information of the variables included in the mathematical model can be easily collected by the EHIS (Abucasis and MDS) of the VHS.

– ***The hypothesis 6 is verified.***

By ROC curve analysis and after determining the optimal balance between sensitivity and specificity values, a risk score (0-1) was established to describe the estimated probability of FHA. Thus, risk scores of 0.5 or higher identify patients at high risk; and risk scores lower than 0.5 mean low risk of FHA.

– ***The hypothesis 7 is partially confirmed.***

In spite of the positive predictive value (81%) and specificity (96%) of the model are high, its sensitivity is relatively low (42%). Moreover, the AUC value showed by the model is 0.76, which means the diagnostic accuracy of the model is good and suitable. Also, the model is able to explain the 31% of the dependent variable (FHA) according to the R^2 of Nagelkerke test. And, finally, on the basis of the Hosmer-Lemeshow test, what we observe in reality (the FHA) suitably fits to the predicted by the model (the classification of patients at high and low risk levels).

Objective 5. To study the profile of the elderly people identified as high and low risk of FHA.

– ***The hypothesis 8 is confirmed.***

The patients identified as high risk of FHA show higher prevalence of CD than the low risk ones. There were statistically significant differences ($p < 0.05$) in the case of chronic respiratory diseases, chronic heart diseases, dementia, palliative care and hemiplegia. Diabetes showed tendency to significance ($p = 0.058$) and the prevalence of chronic pain diagnosis was also higher in high risk patients but without statistical significance ($p = 0.68$).

– ***The hypothesis 9 is not confirmed.***

The average age of the patients identified as high risk is higher than the low risk one but without statistical significance ($p = 0.59$)

– ***The hypothesis 10 is not confirmed.***

The rate of women is higher than the rate of men both in the high and low risk groups, but without statistical significance ($p = 0.97$).

– ***The hypothesis 11 is confirmed.***

The profile of patients identified as at high risk is characterized by a significant higher use of hospital and PC resources ($p < 0.001$) than the low ones: more visits to the hospital ED and PC centre ED, more urgent visits received at home by PC professionals and more urgent telephone calls to the PC centre. Also, the high risk patients are characterized by a higher rate and average of FHA and longer hospital length of stay linked to the FHA ($p < 0.001$ in all cases).

Objective 6. To put in action and to study the practical utility of the stratification tools in the VHS.

– ***The hypotheses 12 and 13 are confirmed.***

It has been possible to computationally introduce an adaptation of the CARS tool in the EHIS of the VHS (specifically, in Abucasis). The outputs of this

stratification were connected with a telemonitoring programme (called Valcronic) addressed to chronic patients. This programme was personalized to the different patient groups according to their risk level of suffering FHA.

Objective 7. To study the impact of a telemonitoring programme – aimed at improving the management of chronic patients at the VHS – on elderly patients identified at risk of FHA.

– ***The hypothesis 14 is partially confirmed.***

Most patients benefit – in terms of an increase of their HRQOL – of the effects of one year involvement in the Valcronic programme, but without statistical significance. Those patients diagnosed with diabetes experienced a significant improvement of their quality of life (p= 0.04), and those between 65-75 years old and those diagnosed with hypertension showed an improvement with tendency to significance (p= 0.07 and p= 0.09 respectively). However, some specific groups experienced deterioration in their HRQOL: patients older than 75 years, those diagnosed with COPD and those living alone.

– ***The hypothesis 15 is confirmed.***

51.39% of the sample reported a notable reduction of their number of visits to PC centres after one year involvement in Valcronic programme. Moreover, 50.68% of the sample stated they were more aware of the importance to control their CD and the 38.36% reported the acquisition of new and healthier health habits in their daily routines.

To sum up, it has been confirmed that there are instruments available in the literature suitable to be applied and introduced in the EHIS of the VHS. Their implementation has made possible the connection of the outputs of the population stratification to select potential users to being included in a pioneering telemonitoring programme (Valcronic) in the Valencia Region aimed at improving the management of patients with CD. Moreover, this thesis has produced new knowledge with the development of a predictive model of FHA in elderly population with CD through logistic regression analysis. This model is based in an algorithm composed of five predictive variables: clinical (diagnosis of chronic respiratory disease, chronic heart disease, diabetes and presence of palliative care) and associated to the previous use of healthcare

resources (number of visits to the hospital emergency department). These variables have something in common: they are easily accessible in the EHIS of the VHS; specifically from Abucasis and MDS. This feature makes viable that the developed algorithm may be computationally implemented within the PC management systems; so population stratifications could be done – on the basis of the predictive variables – periodically and the derived outcomes could be visible and accessible for the professionals. In this way, professionals could dispose of an updated and dynamic database of patients at high risk of suffering FHA and, subsequently, they could activate action plans proactively without needing an adverse event as a triggering of the health and care action.

Further and future research is needed. On the one hand, it would be necessary to validate the developed algorithm in a larger sample of patients that better represent – geographically – the elderly population of the Valencia Region. And, on the other hand, it would be interesting to apply the proposed stratification model – composed of two phases – in a representative sample and, in turn, to connect the derived results with personalized care pathways.

Resumen

En este último capítulo se presenta un resumen global de los anteriormente desarrollados. En primer lugar, se presenta un breve marco teórico para entender el contexto y punto de partida de la tesis; en segundo lugar se listan los objetivos de la tesis y, posteriormente, se resume cada uno de los tres artículos que la componen (enmarcados en los Capítulos II, III y IV) describiendo brevemente su objetivo, metodología empleada y los principales resultados obtenidos. Para finalizar, se presenta un extracto de las principales conclusiones a las que se ha llegado.

Contexto teórico

La situación de partida en la que se encuadra la presente tesis se caracteriza, básicamente, por dos fenómenos que desde hace un par de décadas están experimentando los países occidentales: a) el cambio demográfico y consecuente envejecimiento poblacional; y b) el aumento de la prevalencia de las enfermedades crónicas (EC). Ambos tienen (y se prevé que continuarán teniendo) un notable impacto en el consumo de recursos asistenciales por parte de diferentes grupos poblacionales y en la (re-)organización de los sistemas sanitarios y sociales, entre otros pilares del Estado de Bienestar. Este escenario actual (y previsiblemente futuro) se caracteriza por una población que cada vez vive más años y en la que el porcentaje de personas mayores (o muy mayores) es progresivamente más alto. Además, de forma adicional, la prevalencia de las EC supone un importante impacto sobre los sistemas de salud dado que éstas son las principales causas de muerte en la Unión Europea y, en muchos casos, están asociadas a situaciones de dependencia y cuidados de larga duración (CLD).

Con el objetivo de llevar a cabo un abordaje más efectivo de las enfermedades asociadas al envejecimiento y a la cronicidad los sistemas asistenciales deberían situar al paciente en el centro de la relación asistencial, de manera que los servicios asistenciales y sus profesionales tengan un papel mucho más activo a la hora de gestionar la salud de la población. Asimismo, se deberían introducir mejoras en el proceso de gestión de la enfermedad con el objetivo de realizar acciones más eficientes y, por último, pero no por ello menos importante, sería necesario que los servicios sociales y recursos sanitarios estuvieran coordinados e integrados teniendo en consideración una visión más holística del paciente.

Los servicios de atención primaria (AP) pueden jugar un papel clave para favorecer este cambio de cultura asistencial introduciendo mejoras en la gestión, atención y derivación de pacientes mayores y/o con EC. No obstante, para no sobrecargar las funciones diarias de los profesionales de AP, sería interesante y útil la implementación de sistemas que les ayuden a tomar decisiones relacionadas con la gestión de este tipo de pacientes. Así pues, la presente tesis apuesta por el potencial del uso de los sistemas de estratificación en población mayor con EC desde los servicios de AP.

Objetivos

El objetivo principal de este trabajo ha sido aplicar, desarrollar e implementar herramientas de estratificación con el propósito de identificar pacientes mayores con riesgo de sufrir ingresos hospitalarios en los 12 meses siguientes dentro del Sistema Valenciano de Salud (SVS).

El SVS, y más concretamente los servicios de AP, se caracterizan por una serie de factores que posibilitan estudiar este objetivo principal; como por ejemplo, el acceso a sistemas de información sanitaria con datos de distinto índole de los pacientes, la presencia de grupos de profesionales interdisciplinares o una gran experiencia tratando con personas mayores con pluripatologías crónicas.

A través de los siguientes objetivos específicos se pretende ofrecer resultados que puedan mejorar los sistemas de toma de decisiones y apoyar a los profesionales de AP en su práctica diaria. Así, con los resultados que se obtienen de la puesta en marcha de sistemas de estratificación se pueden derivar a los pacientes identificados con mayor vulnerabilidad a itinerarios asistenciales apropiados e individualizados en función de su perfil de necesidades clínico-asistenciales.

Para poder abordar y alcanzar el objetivo principal se han especificado los siguientes objetivos específicos e hipótesis:

Objetivo 1. Conocer las herramientas disponibles en la literatura científica cuyo propósito es identificar pacientes mayores con riesgo de sufrir ingresos hospitalarios futuros (IHF) e identificar de entre ellas algunas potenciales de ser aplicadas en el SVS.

– Hipótesis 1: *Existen herramientas con validez y eficacia probada que incluyen variables cuyos datos pueden recogerse fácilmente a través de diferentes bases de datos del SVS.*

Objetivo 2. Aplicar herramientas identificadas en la literatura en una muestra de pacientes mayores de la Comunidad Valenciana y conocer su funcionamiento estratificándola en grupos de riesgo.

– Hipótesis 2: *La aplicación de las herramientas seleccionadas es viable y las variables que las componen son fácilmente accesibles mediante el acceso a los sistemas de información sanitaria electrónicos (SISE).*

– Hipótesis 3: *La eficacia y capacidad diagnóstica de las herramientas seleccionadas es moderada.*

Objetivo 3. Identificar variables potenciales de ser incluidas en una herramienta nueva para detectar pacientes mayores crónicos con riesgo de sufrir IHF.

Objetivo 4. Desarrollar un modelo matemático capaz de identificar pacientes mayores con riesgo de sufrir ingresos hospitalarios en los 12 meses posteriores a su evaluación.

– Hipótesis 4: *Existe un conjunto de variables socio-demográficas, clínicas, sociales y relativas al uso de recursos sanitarios con significatividad estadística capaz de identificar pacientes mayores con riesgo de sufrir IHF.*

– Hipótesis 5: *Las variables introducidas en el modelo son fácilmente accesibles en los SISE.*

– Hipótesis 6: *El algoritmo asociado al modelo matemático puede estimar el riesgo de sufrir IHF mediante una escala de puntuación y un punto de corte.*

– Hipótesis 7: *La eficacia y capacidad diagnóstica del modelo son buenas.*

Objetivo 5. Estudiar el perfil de las personas mayores identificadas como de alto y bajo riesgo de sufrir IHF.

– Hipótesis 8: *Las personas mayores de alto riesgo presentan una mayor prevalencia de EC que las personas de bajo riesgo.*

- Hipótesis 9: *Las personas identificadas como de alto riesgo son de mayor edad que las personas de bajo riesgo.*

- Hipótesis 10: *Hay diferencias significativas en el porcentaje de hombres y mujeres en los grupos identificados como de alto y bajo riesgo.*

- Hipótesis 11: *Las personas mayores de alto riesgo hacen un mayor uso de recursos sanitarios que las personas de bajo riesgo.*

Objetivo 6. Activar y estudiar la utilidad práctica de las herramientas de estratificación en el SVS.

- Hipótesis 12*: Es posible introducir los algoritmos asociadas a herramientas de estratificación en los SISE.*

- Hipótesis 13*: Es posible conectar los resultados de las herramientas de estratificación con programas de intervención y/o itinerarios asistenciales individualizados.*

Objetivo 7. Estudiar el impacto de un programa de telemonitorización – cuyo propósito es mejorar la gestión de pacientes crónicos en el SVS – sobre pacientes mayores identificados con riesgo de sufrir IHF.

- Hipótesis 14: *Tras un año en el programa, los usuarios mejoran su calidad de vida.*

- Hipótesis 15: *Tras un año en el programa, los usuarios reducen el consumo de recursos sanitarios.*

Capítulo II

Objetivo

El objetivo del artículo *Application of screening tools to detect risk of hospital readmission in elderly patients in Valencian Healthcare System (Spain)* es determinar si la aplicación de dos herramientas originalmente desarrolladas y validadas en Estados Unidos en una muestra de personas mayores del SVS es viable para detectar pacientes con riesgo de sufrir IHF.

Metodología

A través de una revisión de literatura, se seleccionaron los intrumentos *Probability of Repeated Admission (Pra)* y *The Community Assessment Risk Screen (CARS)* como herramientas a testar en el SVS. Para ello, se realizó un estudio retrospectivo con una muestra de 500 personas mayores de seis centros de AP de la Comunidad Valenciana. Los datos de cada una de las herramientas se recogieron a través de diferentes sistemas SISE – concretamente, Abucasis, CMBD y GAIA – y contactando con cada uno de los pacientes a través de entrevista telefónica o visita presencial en el centro de salud (esta última vía de contacto directo se empleó para recoger información sobre dos ítems del Pra). Los datos relativos a la variable de respuesta (IHF) se recogieron por medio de CMBD. Se llevaron a cabo los siguientes análisis estadísticos: a) descriptivos; b) discriminantes (con las pruebas T-Student, ANOVA, Kruskall-Wallis y Mann-Whitney); c) características operativas de cada herramienta (sensibilidad, especificidad, valor predictivo positivo, valor predictivo negativo); y d) área bajo la curva a través de curvas ROC.

Resultados

Los principales resultados que se obtuvieron son:

- Los valores promedios de los IHF y la duración de la estancia hospitalaria fue significativamente mayor en el caso de los grupos identificados como de alto riesgo que en los de bajo riesgo – tanto por el Pra como por el CARS.
- La proporción de pacientes que sí habían sufrido IHF y que se habían

identificado como de alto riesgo (sensibilidad) fue de 54% en el caso del Pra y de 64% en el CARS.

- La proporción de pacientes que no habían sufrido IHF y que se habían detectado como de bajo riesgo (especificidad) fue de 81% en el Pra y de 64% en el CARS.
- La eficiencia diagnóstica (evaluada a través del área bajo la curva) fue de 0,67 en el Pra y 0,69 en el CARS.

Capítulo III

Objetivo

El artículo *Risk stratification at primary care centres in Valencia (Spain) to activate integrated care pathways for elderly patients with chronic conditions* presenta el desarrollo de un nuevo modelo predictivo con el objetivo de detectar pacientes mayores con riesgo de IHF desde los centros de AP del SVS.

Metodología

Para desarrollar este modelo se llevaron cabo tres fases de investigación con la participación de un centro de salud integral (que combina AP y especializada) de Valencia. En la primera fase se empleó la metodología de grupos focales con un panel de expertos de AP multidisciplinar para identificar variables potenciales de predecir el riesgo de sufrir IHF. A partir de los resultados acordados, en la segunda fase, se realizó un estudio piloto de carácter retrospectivo con una muestra de 100 pacientes mayores – del mismo centro de salud anteriormente citado – de la que se recogieron los datos asociados a las variables previamente identificadas por el panel de expertos: edad; sexo; diagnósticos activos (enfermedad respiratoria crónica, insuficiencia cardíaca, demencia, dolor crónico, cuidados paliativos, hemiplejia y diabetes); adherencia al tratamiento farmacológico; riesgo de caídas; número de ingresos hospitalarios urgentes previos; número de visitas a urgencias hospitalarias previas; número de visitas al centro de AP previas; número de visitas de emergencia a domicilio previas; número de llamadas telefónicas de urgencia al centro de AP previas; disponibilidad de conocimientos y habilidades adecuadas para el auto-cuidado; apoyo socio-familiar; y dificultades económicas.

A través de análisis de regresión logística se observó que las variables con mayor asociación con los IHF fueron: número de visitas previas a urgencias hospitalarias y el número de visitas previas de urgencia a domicilio. Otras variables relacionadas con el uso de recursos de AP detectadas en los grupos focales llevados a cabo en la primera fase del estudio de este artículo se tuvieron también en consideración para estos análisis; pero en este caso, solo si se trataban de visitas de carácter urgente (número de vistas previas a urgencias

de AP y número de llamadas telefónicas de urgencia al centro de AP). De forma adicional, se incluyeron las variables diagnósticos activos, edad y sexo para realizar categorías sociodemográficas. Finalmente, los datos asociados a este último conjunto de variables se recogieron y testaron – de forma retrospectiva – en una muestra de 343 pacientes a través, también, de análisis regresión logística binaria. En esta tercera fase se efectuaron análisis estadísticos adicionales: a) descriptivos; b) discriminantes (con las pruebas T-Student y ANOVA); c) curvas ROC con el objetivo de identificar un punto de corte a partir del cual clasificar a la muestra en grupos de alto y bajo riesgo; d) características operativas del modelo desarrollado (sensibilidad, especificidad, valor predictivo positivo, valor predictivo negativo); y e) área bajo la curva a través de curvas ROC.

Resultados

Los principales resultados obtenidos son:

- Las variables con mayor capacidad predictiva de los IHF y que, por tanto, componen el modelo predictivo son: diagnóstico de enfermedad cardíaca crónica, enfermedad respiratoria crónica, diabetes, presencia de cuidados paliativos y el número de previos de visitas a los servicios de urgencia hospitalarios previos.
- El porcentaje de varianza explicada por el modelo final fue del 31% y el riesgo estimado por el modelo tuvo una muy buena concordancia con la incidencia real observada de IHF.
- Se estableció un sistema de puntuación de 0 a 1 que indica la probabilidad que tiene un paciente de sufrir un IHF. Los pacientes con puntuaciones entre 0 y 0,49 se clasifican como de bajo riesgo y aquéllos entre 0,5 y 1 como de alto riesgo.
- La proporción de pacientes que sí habían sufrido IHF y que el modelo identificó como de alto riesgo (sensibilidad) fue del 42%.
- La proporción de pacientes que no habían sufrido IHF y que el modelo identificó como de bajo riesgo (especificidad) fue del 96%.
- La eficiencia diagnóstica del modelo (evaluada a través del área bajo la curva) fue de 0,76.
- Los pacientes identificados por el modelo como de alto riesgo sufrían

significativamente más casos de patologías crónicas y habían hecho un mayor uso previo de recursos sanitarios (tanto en AP como hospitalaria).

– Los valores promedios de los IHF y la duración de la estancia hospitalaria fue significativamente mayor en el caso del grupo identificado como de alto riesgo que el de bajo.

Capítulo IV

Objetivo

En el último artículo que compone la tesis, *Impact of a primary-based telemonitoring programme in HRQOL, satisfaction and usefulness in a sample of older adults with chronic diseases in Valencia (Spain)*, se estudia el impacto de un programa de telemonitorización sobre la calidad de vida relacionada con la salud (CVRS) y sobre las percepciones de satisfacción y usabilidad del mismo en una muestra de adultos mayores con enfermedades crónicas (EC) de la Comunidad Valenciana.

Metodología

El programa de telemonitorización objeto de estudio se llama Valcronic; ha sido diseñado e implantado de forma piloto por la AVS en dos centros de AP. Dicho programa ofrece diversas modalidades de atención y seguimiento a crónicos – por medio de las nuevas tecnologías – en función de su nivel de riesgo de IHF identificado a través de la implementación computarizada en Abucasis de una versión adaptada de la herramienta CARS.

Antes de que el programa comenzara, se seleccionó una muestra de 100 adultos mayores de entre el conjunto de usuarios seleccionados para formar parte del pilotaje de Valcronic. Esta muestra cumplimentó de forma basal y tras un año de participación en el programa (con una pérdida muestral del 26%) la versión validada en España del cuestionario EQ-5D para valorar su CVRS. Asimismo, tras un año en el programa, estos usuarios también cumplimentaron un cuestionario – desarrollado a propósito de este estudio – para valorar sus percepciones de satisfacción y usabilidad de Valcronic. Los análisis estadísticos que se realizaron fueron, principalmente, de tipo descriptivo dado el enfoque exploratorio del estudio. No obstante, también se realizaron análisis discriminantes (con las pruebas Mann Whitney y Kruskall-Wallis) para conocer la relación entre los índices de calidad de vida (tanto basal como tras un año en el programa) y los diferentes subgrupos en los que se estratificó la muestra (según el nivel de riesgo, la edad, el sexo, los diagnósticos de patologías crónicas, etc.).

Resultados

Tras un año de participación en el programa Valcronic se observaron los siguientes resultados de su impacto:

- El porcentaje de la muestra con problemas en al menos una de las dimensiones evaluadas por el EQ-5D se vio disminuida; la mayor reducción se observó en la dimensión 'ansiedad/depresión'.
- La muestra experimentó una mejora de su CVRS – como promedio del índice EQ-5D – pero sin significatividad estadística. Únicamente los usuarios con diabetes mejoraron significativamente su CVRS.
- Los usuarios con las siguientes características – de forma aislada – empeoraron los valores de su CVRS: mayores de 75 años, con EPOC y viviendo solos.
- La mayor parte de la muestra indicó que el programa – más específicamente, los dispositivos tecnológicos – era fácil de usar.
- La mayoría de la muestra se sintió segura y cómoda con este tipo de telemonitorización de sus patologías desde casa.
- Alrededor de la mitad de la muestra disminuyó notablemente el número de visitas a los centros de AP durante su participación en Valcronic.
- La mayoría de los participantes en el estudio llegó a tener mayor conciencia sobre la importancia de controlar sus enfermedades y sintomatología.
- Más de una tercera parte de la muestra introdujo en su día a día hábitos nuevos y más saludables.

Conclusiones

A continuación se presentan las principales conclusiones a las que se ha llegado tras comparar los resultados obtenidos en los tres estudios que componen la tesis y los objetivos e hipótesis inicialmente planteados. Los objetivos 1-2 e hipótesis 1-3 se responden a través de los resultados del estudio Application of screening tools to detect risk of hospital readmission in elderly patients in Valencian Healthcare System (Spain) (Capítulo II). Por su parte, el estudio Risk stratification at primary care centres in Valencia (Spain) to activate integrated care pathways for elderly patients with chronic conditions (Capítulo III) responde a los objetivos 3-5 e hipótesis 4-11. Y, finalmente, con el estudio Impact of a primary-based telemonitoring programme in HRQOL, satisfaction and usefulness in a sample of older adults with chronic diseases in Valencia (Spain) (Capítulo IV) se da respuesta a los objetivos 6-7 e hipótesis 12-14.

Objetivo 1. Conocer las herramientas disponibles en la literatura científica cuyo propósito es identificar pacientes mayores con riesgo de sufrir ingresos hospitalarios futuros (IHF) e identificar de entre ellas algunas potenciales de ser aplicadas en el SVS.

– ***La hipótesis 1 queda confirmada.***

A través de la revisión de literatura realizada en el primer artículo de esta tesis, se identificaron seis herramientas de estratificación destinadas a la identificación de personas mayores con riesgo de IHF. Tras realizar una revisión por pares de forma independiente de cada herramienta, se seleccionaron los instrumentos *Probability of Repeated Admission (Pra) y The Community Assessment Risk Screen (CARS)*, los cuales están desarrollados y validados Estados Unidos, se componen de menos de 10 ítems, requieren datos de los pacientes de un periodo entre 6 y 12 meses previos al momento de la evaluación y los datos están disponibles, en su mayoría, en los sistemas de información sanitaria del SVS y ambos tienen una capacidad diagnóstica buena.

Objetivo 2. Aplicar herramientas identificadas en la literatura en una muestra de pacientes mayores de la Comunidad Valenciana y conocer su funcionamiento estratificándola en grupos de riesgo.

– ***La hipótesis 2 queda confirmada.***

La aplicación en el SVS de los instrumentos Pra y CARS es viable dado que la mayor parte de sus variables pueden recogerse fácilmente a través de los SISE (Abucasis, CMBD y GIA), con la excepción de dos ítems del Pra.

– ***La hipótesis 3 queda confirmada.***

La herramienta CARS mostró una sensibilidad y especificidad por valor del 64% en ambos casos al aplicarla en una muestra de 500 pacientes, una capacidad diagóstica del 67% y un AUC de 0,69. Por su parte, el instrumento Pra fue aplicado en una muestra de 432 pacientes y los resultados mostraron que tenía una sensibilidad del 54%, especificidad del 81%, una capacidad diagnóstica del 77% y un AUC de 0,67.

Objetivo 3. Identificar variables potenciales de ser incluidas en una herramienta nueva para detectar pacientes mayores crónicos con riesgo de sufrir IHF.

Las variables identificadas como potenciales para detectar pacientes con riesgo de sufrir IHF son relativas a:

a. Datos socio-demográficos:
   - Edad.
   - Sexo.

b. Datos clínicos:
   - Diagnósticos activos: enfermedad respiratoria crónica, enfermedad cardíaca crónica, demencia, dolor crónico, necesidad de cuidados paliativos, hemiplejia y diabetes.
   - Adherencia al tratamiento farmacológico.
   - Riesgo de caídas.

c. Uso de recursos sanitarios en los 12 meses previos:
   - Número de ingresos hospitalarios urgentes.
   - Número de visitas a urgencias hospitalarias.
   - Número de visitas al centro de AP.
   - Número de visitas de urgencia a domicilio – por parte de profesionales de AP.
   - Número de llamadas telefónicas de urgencia al centro de AP

d. Aspectos sociales:
   - Conocimiento y habilidades para realizar un auto-cuidado adecuado.
   - Disponibilidad de apoyo socio-familiar.
   - Dificultades económicas.

Objetivo 4. Desarrollar un modelo matemático capaz de identificar pacientes mayores con riesgo de sufrir ingresos hospitalarios en los 12 meses posteriores a su evaluación.

– ***La hipótesis 4 queda parcialmente confirmada.***

El modelo matemático obtenido a través de análisis de regresión logística binaria con el objetivo de predecir el riesgo de IHF se compone de 4 variables de tipo clínico y 1 asociada al consumo de recursos sanitarios; pero ninguna de carácter socio-demográfico o social. Dichas variables con significatividad estadística para predecir IHF son: necesidad de cuidados paliativos (OR= 22,53; p= 0,004), diagnóstico de enfermedad respiratoria crónica (OR= 2.32; p= 0.015), diagnóstico de enfermedad cardíaca crónica (OR= 2,10; p= 0,019), diagnóstico de diabetes (OR= 1,94; p= 0,032) y número de visitas a urgencias hospitalarias en los 12 meses previos (OR= 1,82; p< 0,001).

– ***La hipótesis 5 queda confirmada.***

La información asociada a las 5 variables que componen el modelo puede recogerse fácilmente a través de los SISE (Abucasis y CMBD) del SVS.

– ***La hipótesis 6 queda confirmada.***

A partir de los análisis realizados con curvas ROC y tras determinar un equilibrio óptimo entre los valores de sensibilidad y especificidad, se estableció un rango de puntuación de riesgo que indica la probabilidad (de 0 a 1) de sufrir un ingreso hospitalario en los 12 meses siguientes. De este modo, las puntuaciones iguales o superiores a 0,5 identifican pacientes con alto riesgo de IHF, y las puntuaciones inferiores a 0,5 implican un riesgo bajo de IHF.

– ***La hipótesis 7 queda parcialmente confirmada.***

A pesar de que el valor predictivo positivo (81%) y especificidad (96%) del modelo son altos, su sensibilidad es relativamente baja (42%). El valor del AUC

mostrado por el modelo es de 0,76, lo que significa que la capacidad diagnóstica del modelo es buena y aceptable. Asimismo, el modelo es capaz de explicar el 31% de la variable de respuesta (IHF) de acuerdo a los resultados obtenidos en la prueba R^2 de Nagelkerke. Finalmente, de acuerdo a los resultados del test de bondad de ajuste Hosmer-Lemeshow, el modelo está bien calibrado; es decir, lo que se observa en la realidad (los IHF) se ajusta adecuadamente a lo esperado bajo el modelo (la clasificación de pacientes en alto y bajo riesgo).

Objetivo 5. Estudiar el perfil de las personas mayores identificadas como de alto y bajo riesgo de sufrir IHF.

– ***La hipótesis 8 queda confirmada.***

El grupo de pacientes identificado como de alto riesgo de sufrir IHF mostró una mayor prevalencia de diagnósticos de EC que el grupo de bajo riesgo. Estas diferencias son estadísticamente significativas ($p< 0,05$) en los diagnósticos de enfermedad respiratoria crónica, enfermedad cardíaca crónica, demencia, cuidados paliativos y hemiplejia. En el caso de la diabetes, se observa una mayor prevalencia en el grupo de alto riesgo con tendencia a la significatividad ($p= 0,058$) y la prevalencia del diagnóstico de dolor crónico fue también mayor en el caso de los pacientes de alto riesgo, pero sin ser estadísticamente significativa ($p= 0,68$).

– ***La hipótesis 9 no se confirma.***

La edad media del grupo identificado como de alto riesgo es mayor que la de bajo riesgo, pero sin significatividad estadística ($p= 0,589$).

– ***La hipótesis 10 no se confirma.***

El porcentaje de mujeres es más alto que el de hombres en los grupos identificados como de alto y bajo riesgo, pero sin significatividad estadística ($p= 0.97$).

– ***La hipótesis 11 queda confirmada.***

El perfil de los pacientes identificados como de alto riesgo se caracteriza por un mayor uso previo de recursos hospitalarios y de AP que el grupo de bajo riesgo estadísticamente significativo ($p< 0,001$): más visitas a urgencias hospitalarias, más visitas a urgencias del centro de AP, más visitas de emergencia a domicilio

por parte de profesionales de AP y más llamadas de urgencia al centro de AP. Asimismo, los pacientes identificados como de alto riesgo se caracterizabas por un mayor porcentaje de pacientes con IHF, un promedio más alto de IHF y estancias más largas asociadas a los IHF ($p< 0{,}001$ en todos los casos).

Objetivo 6. Activar y estudiar la utilidad práctica de las herramientas de estratificación en el SVS.

– ***Las hipótesis 12 y 13 quedan confirmadas.***

Ha sido posible introducir de forma computacional una versión adaptada de la herramienta CARS en los SISE del SVS (específicamente en Abucasis). Asimismo, los resultados de dicha estratificación se conectaron a un programa de telemonitorización (llamado Valcronic) destinado a mejorar la gestión de pacientes crónicos. Este programa se personalizó y adaptó a las características de diferentes grupos de pacientes en función de su nivel de riesgo de sufrir un IHF.

Objetivo 7. Estudiar el impacto de un programa de telemonitorización – cuyo propósito es mejorar la gestión de pacientes crónicos en el SVS – sobre pacientes mayores identificados con riesgo de sufrir IHF.

– ***La hipótesis 14 queda parcialmente confirmada.***

La mayor parte de los pacientes se benefician – en términos de una mejora en su CVRS – de los efectos de participar en el programa Valcronic durante un año, aunque sin significatividad estadística. Los pacientes con diagnóstico de diabetes experimentan una mejoría en su calidad de vida significativa ($p= 0{,}04$) y los pacientes con edades entre 65-75 años y aquéllos con hipertensión mostraron una mejoría con tendencia a la significatividad ($p= 0{,}07$ y $p= 0{,}09$ respectivamente). No obstante, algunos grupos de pacientes experimentaron un deterioro en su CVRS tras un año en el programa: en los pacientes mayores de 75 años de edad, aquéllos con diagnóstico de EPOC y aquéllos que vivían solos.

– ***La hipótesis 15 queda confirmada.***

El 51,39% de la muestra indica que había reducido notablemente el número de visitas a su centro de AP tras un año en el programa Valcronic. Asimismo,

el 50,68% de la muestra estudiada indicó que eran más conscientes de la importancia que tiene controlar sus EC y sintomatología asociada; y, además, el 38,36% indicó que había adquirido hábitos de salud nuevos y más saludables.

Para resumir, se ha podido confirmar que existen herramientas disponibles en la literatura aptas para ser aplicadas e introducidas en los sistemas de información sanitaria del SVS. Su implementación ha posibilitado la conexión de los resultados de estratificación poblacional para seleccionar usuarios potenciales de beneficiarse de un programa de telemonitorización (Valcronic) pionero en la Comunidad Valenciana cuyo propósito es mejorar la gestión de pacientes con patologías crónicas. Además, la presente tesis ha generado conocimiento nuevo a través del desarrollo de un modelo de predicción de IHF en población mayor con patologías crónicas a través de análisis de regresión logística binaria. Este modelo se basa en un algoritmo compuesto por cinco variables predictoras: clínicas (diagnóstico de diabetes, enfermedad cardíaca crónica, enfermedad respiratoria crónica y presencia de cuidados paliativos) y asociadas al consumo previo de recursos sanitarios (número de visitas a urgencias hospitalarias). Dichas variables tienen en común que son fácilmente accesibles a través de los sistemas de información sanitaria del SVS; concretamente, desde Abucasis y CMBD. Esta cualidad hace viable que el algoritmo desarrollado pueda implantarse dentro de los sistemas de gestión de AP de forma computacional, de manera que se puedan realizar estratificaciones de la población – en función de las variables que lo componen – de forma periódica y los resultados derivados sean visibles para los profesionales. De este modo, los profesionales de AP dispondrían de forma actualizada y dinámica una base de datos de pacientes de alto riesgo de sufrir IHF y los profesionales podrían activar protocolos de actuación e intervención de forma proactiva sin que haya un evento adverso desencadenante de la actuación clínico-asistencial.

Se precisa realizar nuevas y futuras investigaciones a partir de los resultados obtenidos en esta tesis. Por una parte, sería necesario realizar una validación del algoritmo con una muestra de pacientes mucho mayor y que represente – geográficamente – mejor a la población mayor de la Comunidad Valenciana. Y, por otra parte, sería interesante aplicar el modelo completo de estratificación propuesto que se compone de dos fases en una muestra representativa y, a su vez, conectar los resultados derivados con itinerarios asistenciales personalizados.

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Application of screening tools to detect risk of hospital readmission in elderly patients in Valencian Healthcare System (VHS) (Spain)

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ABSTRACT

The Sustainable Social and Healthcare Model (SSHM) is aimed to establish new care pathways in primary care systems contributing to the decrease of health services use and costs and improve the integration and efficiency of social and health care for elderly people with long-term care (LTC) needs. One of these strategies is the segmentation of population in risk groups through standardized tools. This paper is a retrospective study aimed to determine the viability of the implementation of the screening tools Probability of Repeated Admission – Pra – and The Community Assessment Risk Screen – CARS – to detect patients at risk of hospital readmission in a sample of 500 elderly people (65+) from the VHS in Spain. Patients were recruited from three Health Departments. Data from selected tools and predictive variables were collected through the healthcare database from the VHS. The most important results indicate that both instruments predict with high efficacy the proportion of patients not readmitted (negative predictive value between 91% and 92%). Moreover, the tools performed with a moderate efficiency being the Pra less sensitive (54%) and more specific (81%) than CARS (with a sensitivity and specificity of 64%). Results from this study suggest that the application of instruments as Pra and CARS are of interest to the Valencian Health Administration as they can be a good strategy to improve the management of elderly patients at risk with comorbidities and guiding clinical decision.

1. Introduction

Western countries have seen a significant increase in life expectancy and in the number of elderly people (León, 2011). Life expectancy at birth has increased significantly in most developed countries worldwide; in Spain, following the European trend, it has risen from an average of 75.4 years of age in 1980 to 82.5 in 2011 (Eurostat, 2012). Moreover, the age structure of the European population is projected to change dramatically, with an expectation that elderly people aged 65 and over will become a higher share of the population; rising from 87.5 million in 2010 to 152.6 million in 2060, that means a variation of share from 17% to 30% of the population (European Commission, 2011).

Although there is no consensus between experts on the long-term consequences of the aging population, it is clear its impact over fiscal sustainability both due to the decrease of working population, as well as the increase of pressure on public health care expenditure (Esteve, Garcés, & Sánchez, 2013; European Commission, 2009). Elderly people often suffer comorbidity and chronic diseases that entail a decrease in their quality of life and an increase of the probability to become inactive and dysfunctional (Anderson, 2003; Landi et al., 2004). These risks imply in the end high medical needs and costs; as, for example, if poorly managed, chronic diseases can account for as much as 70% of health expenditure, partly because of the significant costs involved in hiring a workforce to care for sick elderly people (Economist Intelligence Unit, 2011). To control the increase of public health expenditure and, especially, related to LTC, it will be necessary to invest resources in improving health services, in linking health and social care and a preventive approach of chronic diseases (Commission Communication, 2006; Garcés & Ródenas, 2013; Garcés, Ródenas, & Hammar, 2013).

In Spain, population of 85 years old and over represented in 2009 7.7% of the total of hospital discharges, a 0.4% increase from the previous year. The greater relative participation of this age group in total of admissions has been increasing gradually in recent years, from 5.2% in 2000 (NIS, 2010). In Valencia, according to the Agencia Valenciana de Salud, in 2011 41% of all hospital discharges

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were as well of people over 65 years old. Currently, healthcare systems as well as research professionals try to respond to the rising burden of chronic diseases and its economic, social and health consequences through new models, approaches and strategies to provide comprehensive care delivery achieving a better coordination between different kinds of services and across the continuum of care and, also, reducing the percentage of medical expenditure (Nolte, Knai, & McKee, 2008).

This paper is framed within a holistic model of health care for people with LTC needs; the SSHM. This model is based on the concept of 'social sustainability' (Garcés, 2000) and it was developed and validated using case management methodology to link the network of health and social resources with the support of multidisciplinary teams (Garcés, Carretero, & Ródenas, 2011; Ródenas, Garcés, Carretero, & Megía, 2008). The application of SSHM implemented new care pathways in primary care systems, contributed to decreasing the use and cost of health services and to improve the integration and efficiency of social and health care for elderly people with LTC needs in a Mediterranean Welfare State scenario. In the SSHM health care professionals – as they represent the first and most frequent contact with users – have an important role screening patients with specific needs and problems associated with chronic diseases. In this way, according to this model as well as to others (e.g. Brand et al., 2004) one of the first strategies to improve the management of patients with comorbidity is the segmentation of population in risk groups through standardized tools. Presently we can find many studies with the purpose of identifying risk factors of future hospital admissions and readmissions of elderly people (e.g. Holloway, Thomas, & Shapiro, 1988; Marcantonio et al., 1999; Mudge et al., 2011; Nägga, Dong, Marcusson, Olin, & Wressle, 2012). A review shows a variety of variables of poor-health or frailty that are potential risk factors: comorbidities, increasing severity class, increasing age, general poor health, high previous utilization of the healthcare system, difficulty in getting caregivers or lack of social support (Vest, Gamm, Oxford, Gonzalez, & Slawson, 2010). Thanks to the identification of these kind of factors, a wide range of risk assessment tools are available for detecting elderly patients at high risk for hospitalizations or emergency department (ED) encounters (e.g. Oeseburg, Wynia, Middel, & Reijneveld, 2009; Shepperd et al., 2009). In Spain, unlike other countries as the United States (USA) or United Kingdom, the use of this kind of standardized tools to screen patients at risk it is not very widespread. In spite of most of the models and consequent results obtained from research and studies undertaken might not be generalized to foreign contexts – due to, for example, the differences in the healthcare systems or in social and cultural factors – the application of standardized and validated instruments in other countries and study of their accuracy could be an useful starting point for the development of one's own screening models.

So, the objective of the present study was to determine the viability of the implementation of the screening tools Probability of Repeated Admission – Pra – and The Community Assessment Risk Screen – CARS to detect patients at risk of hospital readmission – selected from the literature – in a sample of older population from the VHS (Spain).

2. Materials and methods

2.1. Study design

This was a retrospective study to examine the predictive ability of Pra and CARS instruments with the aim of identifying patients at risk of hospital readmission during the subsequent 12 months in a sample of elderly people from the Valencian Region (Spain). The data collection of predictive variables was from 2008, and the readmission variables were collected within the following year (2009) as reference date.

2.2. Target population and sample

The target population of this study were patients of 65 years and over attended by the VHS in three Health Departments connected with the following three hospitals: Arnau de Vilanova, Doctor Peset and Ribera. These hospitals are characterized to have available 539, 302 and 301 beds (MSPS, 2010) and to have 23,500, 13,416 and 20,831 hospital discharges, respectively (Instituto de Información Sanitaria, 2012). The elderly population in these areas in 2008 was 153,895 people (Conselleria de Sanitat, 2009). The criteria to include these Departments for our study were mainly three: (1) a similar total population; (2) a special interest and implication to improve the provision of care and management of chronic diseases; and (3) a different kind of administrative model at hospitals – public in the case of Doctor Peset and Arnau de Vilanova hospitals, and private in the case of the Ribera's.

Patients were screened and recruited from 30 family doctors from six health centers. Our sample was selected randomly between the patients attended by the participating doctors from the 1st until 31st December 2008. Exclusion criteria for participation were absence of patient data in databases, aged under 65 and exitus.

In total, our sample was composed of 500 patients, with a sampling error of ±4.37% yielding a 95% confidence level. However, we dropped 68 cases for analyses related to Pra tool due to data loss from patients; meaning, a sample dropout rate of 13.6%. The mean age of the entire sample was 74.76 years (±6.54) and 58% were women. 15% of the patients in the study were hospitalized one or more times in the following year after risk evaluation. The mean number of readmissions of this group was 1.41 (±0.77) and the mean length in days of hospital stay was 6.58 (±7.68).

2.3. Instruments

The selection of two instruments to screen the risk of hospital readmission was carried out through a systematic bibliographic search. Six screening tools were selected to be widely assessed by interjudge agreement through the application of several criteria. At Table 1, it is mentioned the main characteristics of these tools although this paper is not aimed to deeply evaluate or summarize them.

In accordance with the quality assessment carried out, the instruments selected were *The Community Assessment Risk Screen – CARS* – and *Probability of Repeated Admission – Pra*. Their common features were that both were developed and tested in the USA, had less than 10 items, required previous data of patients from a considerable period of time (6–12 months prior to the evaluation) and showed similar accuracy in the prediction of future readmissions. And, in accordance with the methodological approach of the current study, their main limitation was that both Pra and CARS were designed to be fulfilled by post or telephone interview.

Pra is a tool used in research and clinical practice to predict rehospitalization more than once within four years in elderly people (Boult et al., 1993). This instrument includes 8 factors found to be the strongest indicators of future hospitalization: age, gender, global self-reported health, history of diabetes or coronary heart disease, previous physician visits or previous hospitalizations in the previous year, and caregiver availability (Boult et al., 1993; Boult, Pacala, & Boult, 1995). This tool uses a regression equation – developed by the John Hopkins University – that weighs responses to each survey question to provide an overall score between 0.07 and 0.80. This score rates the individual probability that the patient will be a re-hospitalized with a multiple of more than once in the

Table 1
Screening tools characteristics.

Tool	Country of development	Target population	Predictor	Data source	Cut-off point
Community Assessment Risk Screen – CARS	USA	≥65 years	Hospital admissions or visits to ED in the following 12 months	Telephone interview	4≥ High risk 3≤ Low risk
Emergency Admission Risk Likelihood Index–EARLI	UK	≥75 years	Urgent hospital admissions in the following 12 months	By post or interview	1–10 Low risk 11–15 Moderate risk 16–20 High risk 21–19 Very high risk
Method to identify elderly people at risk for high hospital utilization	USA	≥65 years	High use of hospital services in the following 3 years	Interview + laboratory tests	7> High risk 3< Low risk
Patients At Risk for Rehospitalization – PARR	UK	≥65 years	Hospital admissions in the following 12 months	Database	Several options 50; 10; 80≥ High risk
Probability of Repeated Admissions – Pra	USA	≥65 years	Hospital admissions in the following 4 years[a]	By post or telephone interview	≥0.50 High risk 0.36–0.49 Moderate risk ≤0.35 Low risk
Triage Risk Screening Tool – TRST	USA	≥64 years	Use ED, hospitalization or health care in the following 30–120 days	Interview	≥2 High risk <2 Low risk

[a] A subsequent study found that the accuracy in predicting one or more hospital admissions during a 1-year follow-up period is comparable to the original time frame of 4 years (Studenski et al., 2003).

four years after the administration of the survey. In this way, a Pra score of 0.5 is interpreted as a 50% chance the patient will be hospitalized in the future. So, patients with a Pra score of 0.5 or higher are regarded as being at high risk, those with a score between 0.36 and 0.49 as moderate risk and those with a score lower than 0.35 are regarded as a low risk of being readmitted.

The CARS includes 3 factors to predict future hospitalizations: preexisting chronic diseases (heart disease, diabetes, myocardial infarction, stroke, chronic obstructive pulmonary disease – COPD – or cancer), the number of prescription medications and hospitalizations or ED use in the preceding 6–12 months (Shelton, Sager, & Schraeder, 2000). In the first item, if the patient has two or more comorbidities the score is 2 points, in the second factor if he/she has 5 or more prescription medications it is scored with 3 points and in the last item if the person has used healthcare services previously the score is 4 points. A total score is obtained by adding the points of each question, with a possible range of 0–9. So, patients with a total score of 4 or higher are classified in the high risk group, and those with a smaller score than 4 are classified in the low risk group.

2.4. Data collection

Data related to the variables that compose both Pra and CARS were collected with a reference date of December 2008 from several health information systems of the VHS: (1) 'Abucasis' – with data related to clinical history, diagnostic tests, appointments, medical alerts, etc. – and 'GAIA' – that registers the prescribed medications to patients through electronic prescription – at primary care centers; and (2) at hospitals 'MDS' (*Minimum Data Set*) that registers the patients' discharges among other data: main and secondary diagnostics, clinical and/or surgical procedures, demographic variables (birthdates and gender), and hospital stays. To get access to this information, our project was evaluated and approved by the Scientific and Ethical Committee from the Valencian Ministry of Health and Research Committees from the participating hospitals in accordance to bioethics and data protection rules.

Data collection was performed jointly with health staff (doctors and nurses) at the primary health centers and hospitals. To fill out two items from the Pra questionnaire (global self-reported health and caregiver availability) it was necessary to contact by phone with every patient to obtain information related to 2008. Once the information was collected, we removed any kind of identifying information; preserving only the SIP number (*Population Information System*) as a reference number to access medical and admission histories of patients.

Finally, we carried out a search of hospital admissions of each patient during the year 2009 through MDS from the regional network of hospitals. We collected if patients were readmitted or not, the number of admissions and the length of stay in days of every readmission. After that, the SIP number was associated with a random number to identify patients, and removed to preserve privacy.

2.5. Statistical analysis

500 and 432 subjects with complete CARS and Pra data, respectively, were used for statistical analysis. Statistical analysis was performed using SPSS 17 software with the whole sample and not differentiating between hospitals or healthcare centers. Analyses were conducted in four main phases in accordance with scientific literature and similar studies (e.g. Gómez de la Cámara, 1998; Hanley & McNeil, 1982; Wagner et al., 2006).

Firstly, descriptive analyses were made to characterize the sample according to the variables of Pra and CARS tools.

Subsequently, to test for differences between the several risks groups we compared the readmission variables (number of readmissions and hospital length of stay in days) using Student's *t*-test of difference between independent sample means or one-way ANOVA test, and also through non-parametric analysis (Kruskall–Wallis and Mann–Whitney *U* tests). In the case of Pra, results were completed through post hoc analysis with Tukey's HSD and Mann–Whitney *U* tests.

In the third stage, we tested operating characteristics of each tool: sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy. In the case of Pra tool, we carried out these analysis, subdividing patients into High risk group and Low/Moderate risk group.

Finally, the predictive ability was analyzed through receiver operating characteristic (ROC) curves to show sensitivity and specificity of future readmissions in the following year after the assessment. The performance of the model was assessed using area under the curve (AUC) analysis.

3. Results

The distribution of the sample according to Pra risk groups was 15.28%, 36.11% and 48.61% in High, Moderate and Low risk, respectively; and in the case of CARS 40.6% and 59.4% in High and

Table 2
Differences between the different risk groups.

		Pra			*F*	*p*-Value	CARS		*t*	*p*-Value
		High	Moderate	Low			High	Low		
Number of admissions in 2009	Mean	0.47	0.25	0.12	6.79	<0.001	0.36	0.11	4.75	<0.001
	SD	0.86	0.61	0.45			0.76	0.40		
Length of stay in 2009	Mean	2.97	0.98	0.43	8.10	<0.001	1.76	0.44	3.91	<0.001
	SD	7.72	3	2.08			5.28	2.01		

Table 3
Operating characteristics.

	Pra[a] (*n* = 432)	CARS (*n* = 500)
Sensitivity	54%	64%
Specificity	81%	64%
Positive predicted value	30%	24%
Negative predicted value	92%	91%
Diagnostic accuracy	77%	67%

[a] To carry out this analysis for Pra tool authors did a dichotomous assessment subdividing patients into high risk group and low/intermediate risk group.

Low groups. The overall mean Pra score was 0.36 (±0.12) and the overall mean CARS score was 3.92 (±2.68).

Taking into consideration the total sample, the average number of admissions in 2009 was statistically significantly different across all Pra risk groups and between the two CARS risk groups, showing in both cases the 'High' risk group more admissions than 'Moderate' and 'Low' risk groups (see Table 2). In the same way, the mean hospital length of stay was statistically significantly different across Pra risk groups and between the two CARS risk groups, showing in both tools greater length of stay of the 'High' risk group in comparison with 'Moderate' and 'Low' risk patients (see Table 2). In the case of Pra, through post hoc analysis, multiple comparisons showed that both number of hospital readmissions and length of stay were significantly higher in patients at 'High' risk than those at 'Moderate' or 'Low' level. Also, there were no significant differences in both variables between 'Moderate' and 'Low' groups of patients. Results obtained through non-parametric tests followed the same line with statistical significance in all cases.

Table 3 shows the values of the operating characteristics of Pra and CARS. It is worth noting the high negative predictive value in both instruments.

ROC curve analysis for prediction of the presence or absence of hospital readmissions for Pra and CARS models resulted in AUCs of 0.67 and 0.69, respectively (see Fig. 1).

4. Discussion

Given the need to deal with the current challenges of our healthcare systems to achieve an efficient and sustainable management of the consequences of demographic aging, the European Commission has proposed different European Innovation Public–Private Partnerships (PPP) in the Europe 2020 Strategy. Among these PPP, we can find the European Innovation Partnership on Active and Healthy Aging (EIP on AHA), which is focused on three main pillars related to care processes; (a) prevention, screening and early diagnosis; (b) care and cure; and (c) active aging and independent life. Moreover, the SSHM offers an alternative to the current model of care in Spain to encourage a more effective management system based on the definition of risk groups of patients to offer more specific and tailored action plans.

This paper offers a practical implementation of both EIP on AHA and SSHM, as it presents the application of two screening tools aimed to identify patients at risk of hospital readmission in a sample of elderly patients at regional level (Valencia, Spain). The first instrument selected through literature review was Pra, mainly, due to its wide use in the North American Health System and has been applied and validated in several European countries (Wagner et al., 2006). And, the second one selected was CARS, as it entails an easier-to-use application and correction, as well as all its variables can be obtained in the Valencian health information systems.

This study is the first application of the Pra and CARS tools in the Spanish Healthcare system. The most important results indicate

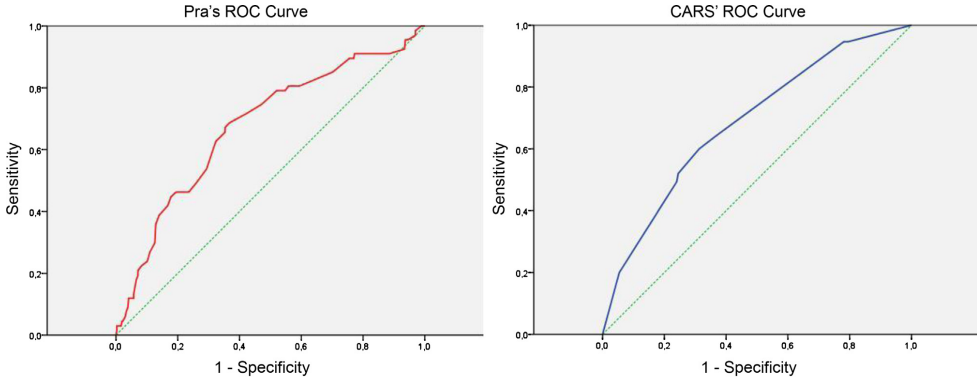

Fig. 1. ROC curves for presence or absence of hospital readmission in 2009 according total Pra and CARS scores.

that both instruments predict with high efficacy the proportion of patients not to be readmitted with an NPV between 91% and 92%. The tools performed with a moderate efficiency: the Pra was less sensitive (54%) and more specific (81%) than CARS (with a sensitivity and specificity of 64%). The accuracy detecting patients at risk of readmission by Pra in our sample is similar to other studies (e.g. Jensen, Friedmann, Coleman, & Smiciklas-Wright, 2001). Our results also indicate that both tools have an acceptable level of accuracy in the prediction of hospital admissions during the following year in our sample; with reported AUCs of 0.67 in Pra and 0.69 in CARS. These scores are similar to those found in other studies using the Pra tool (Boult et al., 1993, 1995; Bowles & Cater, 2003; Wagner et al., 2006) and CARS (Shelton et al., 2000). Moreover, the risk levels obtained by both Pra and CARS are significantly associated with later admissions suffered by our patients ($p < 0.001$) and there are significant differences ($p < 0.001$ in all cases) between the several risk groups in the variables 'number of future admissions' and 'length of stay of the future admissions'. Other authors (Sidorov & Shull, 2002) obtained similar results related to significant differences across all three Pra risk groups in the mean number of readmissions and in the mean length of stay.

This study has practical implications for a subsequent application, test and/or validation of these tools – or different ones – into Valencian or Spanish context. Although Pra is usually administered by mail or telephone, and CARS is normally filled in by medical staff through an interview directly with the patient or by telephone, in the present study we have collected the necessary data to fulfill all CARS and most of the Pra variables through three databases from the VHS. Using this administrative method for data collection, and without dropping any item as in other studies (Coleman et al., 1998; Vojta et al., 2001), our sample's dropout rate for Pra analysis has been only 13.6%. So, as other tools (Crane et al., 2010), Pra and CARS have demonstrated that readily accessible data available in medical databases could be used to identify elderly patients at high risk of re-hospitalization.

The main limitations of this study are the following. First, the poor values of AUC, sensitivity and specificity as well as PPV imply that both Pra and CARS do not identify efficiently elderly population at risk of future hospital admissions. Another limitation is the method of data collection employed within the study based on medical databases in comparison with the originally designed methodology based on the use of primary data collected in real time. Therefore, this difference could imply constraints in the comparison of their efficiency from other studies in the literature. However, as we have aforementioned, our results are consistent with those obtained in other studies, which means a strength of this paper. Another weakness of the study is that the instruments selected were validated in North American samples which possibly impacts on our results and, as well, in the comparisons with those obtained by other authors in other countries. The main differences reside in the utility of both instruments to detect patients at risk in every context. In this sense, both Pra and CARS were designed to answer the specific needs of a population attended by the North American healthcare system, characterized by a mix of public and private funding and provision. For its part, the Spanish system provides universal coverage and is almost fully funded from taxes and predominantly within the public sector. These issues, among others, may entail differences in aspects as the number of prescribed medications consumed by elders, the process to refer patients to hospital services or the number of visits to primary care centers by patients. In spite of this, it is important to take into consideration that the objective in the current paper was to study the viability of the implementation of Pra and CARS tools in a sample of elders from a Spanish region with a different Welfare State, not to validate them in our national context. Consequently, all these issues may affect the clinical application of these specific tools in the Spanish healthcare system.

Chronic diseases represent a major challenge to primary health care providers as they demand more services and monitoring due to the increase of patients' vulnerability, consumption of inpatient and outpatient care, relapses and hospital admissions (Condelius, Edberg, Jakobsson, & Hallberg, 2008). So, chronic diseases usually imply a burden on health care systems that require specialized support and initiatives to achieve a cost-efficient management and changes in the governance models (Garcés et al., 2011; Morgan, Zamora, & Hindmarsh, 2007). In Spain there is a lack of integration of services and care based on patients' needs and health status after their discharge from hospital to home. There is wide scientific evidence that agrees with the argument that primary health care services facilitates a better management and monitoring of chronic patients in the transition from hospital to home (Rosenthal, 2008). In this sense, the primary care staff/clinicians can play a crucial role to monitor patients' health status and recovery with medical care at home. Moreover, according to the SSHM, as the primary health professionals are the first interacting with patients, they can benefit using standardized tools as Pra and CARS to screen and act following the most appropriate health care resources and pathways (Ródenas et al., 2008).

So, identifying patients with high risk of future hospital admissions can be useful in the design of programs and in the management of specialized resources to elderly patients with specific needs and difficulties related to chronic diseases (e.g. Freund et al., 2010). Presently, we can find in the literature several comprehensive primary care models with a great potential to improve quality of care and quality of life of older patients with complex health care needs; as the Geriatric Resources for Assessment and Care of Elders – GRACE – model (Counsell, Callahan, Buttar, Clark, & Frank, 2006) or the Program of All-inclusive Care for the Elderly – PACE (Kodner, 2006). These two models are based on care by teams of professionals – based in primary care settings – and, among other aspects, both develop and implement a comprehensive care plan over time and imply a proactive monitoring of patients' clinical status and adherence to the care plan. In the Valencian Region there is a comprehensive program called Valcronic with similar characteristics (AVS, 2012) aimed mainly to improve the management of chronic patients involving closely primary care staff (clinicians and nurses). In this program, patients receive specialized and personalized care pathways based on different kinds of interventions according to their health status and risk of future hospital admission: home-based care, education/counseling and support through ICTs. One of the screening tools employed computationally is CARS, which has efficiently facilitated the identification and target patients to the most appropriate intervention. So, in our context, the standardized use of tools to detect patients at high risk of re-hospitalization makes sense through its computerized application within health information systems of the VHS. In other countries with a more tradition using this kind of screening tools, researchers have refined and improved the accuracy of predictive risk models to detect early hospital readmissions; as the PARR-30 aimed to identify inpatients at high risk of readmission to a National Health Service hospital in England within 30 days (Billings et al., 2012) or a model developed and tested in the USA to detect acute care hospitalization within 60 days of admission to home health care (Rosati & Huang, 2007). Moreover, the segmentation and screening of population provided by this kind of instruments is planned to be implemented in a more comprehensive simulation tool. Grimaldo, Orduña, Ródenas, Garcés, and Lozano (2014) proposes a computer-based simulator for integrated LTC systems for elderly people that allow to

repeatedly simulating successive interactions of the target population within the healthcare system. The proposed tool can provide useful predictions to policy makers about the consequences of the application of different policies on several scenarios and taken into consideration different agents prior to finally determining the real policy to be adopted.

5. Conclusions

In summary, this research provides a first attempt to test validated screening tools in the VHS. For healthcare administrations the application of this kind of instruments can be a good strategy to improve the management of elderly patients at risk with comorbidities and to guide clinical decision. Consequently, the use of the available social and health care services could be optimized and, finally, could be sustainable (Garcés et al., 2011; Garcés & Monsonís, 2013). So, results from this study suggest that the application of tools as Pra and CARS are of interest to the Valencian Health Administration. However, further research is needed to define and design optimal methods to identify different risk groups of patients with specific LTC needs and to establish specialized social and health care pathways. So, the next step will be the development and implementation of one's own tool validated in a Spanish sample and based on our specific health and social features.

Conflict of interest statement

None.

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Annexes

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To whom it may concern:

This letter certifies that the manuscript entitled "*Risk stratification at primary care centres in Valencia (Spain) to activate integrated care pathways for elderly patients with chronic conditions*" authored by Ascensión Doñate-Martínez from Polibienestar Research Institute – University of Valencia, has been accepted as an oral paper which will be published in the 2017 Conference Supplement of the International Journal of Integrated Care (ISSN: 1568-4156).

Yours sincerely

Susan Royer

Managing Editor

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Impact of a primary-based telemonitoring programme in HRQOL, satisfaction and usefulness in a sample of older adults with chronic diseases in Valencia (Spain)

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ABSTRACT

Background: Chronic patients are frequent users of healthcare services and are prone to hospital admissions. In Valencia (Spain) the Valcronic programme aims to manage chronic patients through different levels of telemonitoring and telecare. This paper examines the impact of the Valcronic programme on self-perceived HRQOL in a one-year period and on perceptions of satisfaction and usefulness in a sample of older adults with chronic diseases.
Methods: The sample ($n = 74$) was randomly selected from Valcronic users and was stratified considering different variables. HRQOL was assessed using the EQ-5D questionnaire at two points in time: before the beginning of the Valcronic programme and after a one-year follow-up. Satisfaction and usefulness were evaluated one year after users' inclusion.
Results: The whole sample experienced improvement, although not significant, of its HRQOL; patients over 75 showed impairment. Patients with at least one problem in the EQ-5D dimensions decreased after one year (82.43% vs. 74.32%). Users' perceptions of satisfaction and usefulness were highly positive.
Conclusions: Our sample benefited from the Valcronic programme, experiencing an improvement in their HRQOL, a decreased use of health resources or high satisfaction levels.
Implications: Further adjustments are needed to address a comprehensive response to the needs of the global population of reference.

1. Introduction

Spain has been following the international trend of growth in the number of chronic patients in recent decades; over 15 million people suffer from chronic diseases in Spain and their care accounts for 70% of healthcare expenditure (García-Goñi, Hernández-Quevedo, Nuño-Solinís, & Paolucci, 2012). Chronic patients are frequent users of different healthcare services, especially primary and specialized care, and they also represent a vulnerable group at high risk of being hospitalized (Martín, Carmona, Escortell, Rico, & Sarría, 2011). These patients have long-term care (LTC) needs related to both health and social issues, and they experience notable impairments in their quality of life. Also, the interaction between different chronic conditions causes a greater impairment in health related to quality of life (HRQOL) caused by the exacerbation of specific disease combinations (Hunger et al., 2011).

According to the traditional and current physician-centred model of care, patients with chronic conditions usually receive fragmented, incomplete, inefficient or ineffective care; this may lead to avoidable and unnecessary use of health services (Fortin et al., 2004 Vogeli et al., 2007). In recent years, integrated care through programmes providing interdisciplinary intervention and monitoring addressed to chronic patients are an ongoing priority and necessity in public health administrations (EIP-AHA, 2012; Busse et al., 2010). These programmes are usually based on a model of care centred on the patient, encouraging different kinds of interventions throughout the cycle of the disease: early detection, prevention of deterioration, health promotion, treatment of exacerbations, management and self-management, LTC, rehabilitation or palliative care (Nuño, Coleman, Bengo, & Sauto, 2012). The integration of care services entails a wide range of benefits related to a higher quality of care, a cost-efficiency approach, individualization of care or higher levels of satisfaction both in patients and professionals (e.g. Garcés and Ródenas, 2015; Rosen et al., 2008; Singh, 2008).

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Within the Spanish context, the Valcronic programme manages chronic care patients through different levels of telemonitoring and telecare (AVS, 2012). This initiative was implemented as a pilot in 2012 – and is currently active – in the Valencia Region in a population of around 12,000 chronic care patients. The programme is centred on the patient and services are adapted to the specific needs of each user. Mainly, it offers prevention of decline, patient empowerment in the self-management of their diseases as well as the incorporation of new technologies for the care and communication between health professionals and patients. In this regard, Valcronic means innovations at the technological level by the use of ICTs in the management of patients and the stratification tools of population within health information systems (Ródenas et al., 2014).

There are no specific studies about the pilot implementation of the Valcronic programme in the context of the Valencia Region providing evidence regarding its impact on users' health outcomes that would be useful for decision-making processes. Therefore, the objective of this study was to examine the impact on self-perceived HRQOL in a one-year period and perceptions of satisfaction and usefulness of a pilot-implemented primary-based telemonitoring programme in a sample of older adults with chronic diseases in the Valencia Region (Spain).

2. Materials and methods

2.1. Design

The paper presents both a longitudinal – with a one-year follow-up – and cross-sectional study in which we used an exploratory and descriptive design. The study was carried out in 2 primary healthcare centres (PHCCs) in a Health Department located in the Valencia Region (Spain): Sagunto and Puerto de Sagunto II. These centres comprised a population of 108,342 and in 2012 these centres received 181,884 visits to general practitioners (GPs) and 120,225 to nursing services (AVS, 2013).

2.2. Sample

The target population of this study were older adults with chronic conditions participating in the Valcronic programme and they were at high or moderate risk of hospital admissions (around 4800 patients). A random sample of 100 older adults was drawn from those users of the participating PHCCs.

2.3. Intervention

The intervention was performed through the Valcronic programme (AVS, 2012), a telemonitoring programme to manage patients with chronic conditions – specifically diabetes mellitus, chronic pulmonary obstructive disease (COPD), heart failure and hypertension – and their combination in comorbid and multimorbid patients. This was funded and implemented by the Regional Ministry of Health of Valencia (Spain). The programme offered telemonitoring of biologic variables – blood pressure, heart and respiratory rates, pulse oximetry oxygen saturation, level of glucose and weight – through biomedical devices according to the patients' pathologies. Data was sent to the health centres via different devices (tablets, smartphones or computers). The implementation of different kinds of telemonitoring and telecare was in accordance with the stratification of patients on low, moderate and high risk of future hospital admission. Patient screening was based on an adaptation of the *The Community Assessment Risk Screen – CARS* (Shelton, Sager, & Schraeder, 2000) tool within computerized information databases in the primary care system of the Valencian Healthcare System (VHS) (Ródenas et al., 2014), which was later confirmed by primary GPs.

2.4. Procedure

Prior approval to conduct this study was obtained from the coordinators of the PHCCs involved. In addition, informed consents from participants had previously been obtained at the beginning of the Valcronic programme.

Staff from the involved PHCCs randomly selected potential participants for this study from a list of Valcronic users stratified as having a moderate or high risk of hospital admissions. Nurses and administrative staff contacted potential participants via telephone, and once users gave verbal consent, their telephone numbers were provided to the researchers. Interviews (both from the basal analysis and from the one-year follow-up) were structured and conducted by two researchers using the same procedure and schedule.

For data processing and statistical analysis the sample was stratified in groups considering different variables:

- Risk level of hospitaladmission: high risk (HR) and moderate risk (MR).
- Age: younger than 65, 65–75 and older than 75.
- Gender: women and men.
- Chronic conditions: diabetes mellitus, chronic pulmonary obstructive disease (COPD), heart failure (HF) and hypertension (HTN). Nevertheless, the combination of disease was not taken into consideration for the statistical analysis due to the low number of individuals in each subgroup.
- Living alone or with another person at home (a relative in most cases).

2.5. Tools and outcome measures

2.5.1. Sample characteristics

Socio-demographic and clinical characteristics of the sample were self-reported by patients through telephone interviews (diagnosis of chronic conditions and availability of caregiver) or collected through electronic databases (age, gender and risk).

2.5.2. Assessment of HRQOL

HRQOL was assessed at two points in time through telephone interviews carried out by researchers with every patient: (1) baseline (before the beginning of the programme); and (2) after one year of involvement in the Valcronic programme. The tool employed was the EQ-5D questionnaire that consists of a self-reported health state description and a visual analogue scale (VAS) (Brooks, Rabin, & de Charro, 2005; The EuroQol Group, 1990). It describes the health status in five dimensions – mobility, self-care, usual activities, pain/discomfort and anxiety/depression – with three possible response levels (no problems, some problems or extreme problems). These response levels generate a total of 243 different health states which can be transformed into a single utility value (EQ-5D index) using a scoring algorithm which is based on valuations of representative general population samples. In this study, adaptation and validation to the Spanish language was used, which is based on Spanish general population time trade-off values (Badía, Roset, Herdman, & Segura, 1999). In our study, we included the assessment of the EQ-5D index but not the VAS, as this item is cognitively more complex than the descriptive system via a telephone interview; especially to the oldest subjects of our sample.

2.5.3. Assessment of perceptions of satisfaction and usefulness

Authors developed a questionnaire with 11 items in Spanish to quickly and easily measure participants' perceptions of satisfaction and usefulness of the Valcronic programme one year after their

inclusion by telephone. Nine of the items were closed-ended questions with three possible answers requiring only one choice. These items assessed the following variables: information, usability, performance, failures, security, visits to GPs, communication, health awareness and health habits. Another item included in the questionnaire was a numeric scale to assess the global satisfaction of users with the programme. Patients had to rate their satisfaction choosing a value from 0 to 10; 10 was the highest score. Finally, the questionnaire included an open-ended and optional question to collect users' suggestions to improve the programme. The tool was tested for adequacy in a sample of 5 patients and it was reviewed by a panel of experts, but it was not validated or checked for reliability.

2.6. Data analysis

The processing and statistical analysis of data collected during the study was done using PASW Statistics 19 software (SPSS). Previously, any kind of personal data had been removed. Statistical significance was considered at p equal or less than 0.05. Analyses were carried out in three main phases. First, socio-demographic and clinical data of patients were analysed through descriptive methods: mean and standard deviation (SD) for the quantitative variables, and frequency and percentage for the qualitative variables. Secondly, we calculated the percentage of the whole sample reporting moderate and severe problems in the five dimensions of the EQ-5D taking into consideration the different classification categories. Moreover, we calculated the frequencies for the different subgroups in which the sample was classified. In a third phase, non-parametric tests – such as Mann–Whitney and Kruskall–Wallis – were performed to know the relationship between the EQ-5D indexes (both basal and one year after) and the different stratification groups (risk level, age, gender, chronic conditions and living with another person at home). Comparisons between the baseline and one-year follow-up indexes were carried out for the whole sample and within every group. And, finally, descriptive analyses were carried out with data from the questionnaire employed to assess the samples' perception of satisfaction and usefulness. In the case of the last item of the questionnaire, non-parametric tests were also performed to know if there were significant differences between the scores on 'Global satisfaction' within the categories in which the sample was classified. Also, qualitative analysis was conducted on the answers obtained in the optional open-ended question developing categories that include the themes that emerged in the review of responses; and, thus, assigning each response to a category.

3. Results

In June 2012, 100 patients completed the basal analysis of the EQ-5D index. One year later it was performed with a dropout in the sample of 26 non-responders in the case of the EQ-5D tool and 27 for the satisfaction and usefulness perception's questionnaire. Mean reasons were: death (5 people); premature withdrawal from the programme due to issues associated with technology, such as poor internet coverage (9); moving to another city (1); impossibility to contact them or refusal to participate (10); and due to hospitalization (1). Thus, the statistical analyses were carried out with a sample of 74 and 73 patients respectively.

3.1. Sample characteristics

Socio-demographic and clinical data of the entire sample are presented in Table 1. Mean age was 67.95 ± 11.14 and more than half of the sample was men. From the 74 patients evaluated, 54 belonged to the HR; diabetes and HTN were the most prevalent conditions; moreover, 63.51% patients had other chronic conditions—such as asthma, chronic bronchitis, arthrosis or cholesterol. Some patients had the co-occurrence of several chronic pathologies: 19 with diabetes + HTN; 14 with diabetes + HF; 4 with diabetes + COPD; 2 with COPD + HTN; 2 with diabetes + HF + COPD; and 1 with diabetes + HTN + COPD. Finally, 87.84% of the participants lived with a relative at home.

3.2. Assessment of HRQOL

Table 1 describes the results obtained in the pre- and post-indexes according to the different stratifications of the sample. The most frequent health state (combination of the answers to the five dimensions) in both moments of assessment was 11,111 (full health); comprising 17.57% of all participants in the pre-analysis and increasing to 25.98% after one year.

3.2.1. Dimensions of health status

There was a decrease in the percentage of patients of the entire sample that reported at least a problem (moderate or severe) in at least one dimension (basal analysis 82.43% vs. 74.32% one-year follow-up analysis). In comparison to the basal data in the one-year follow-up analysis, the percentage of patients reporting problems decreased in all dimensions—except in 'Usual activities'; the highest decrease was observed in 'Anxiety/depression' with 17.57% fewer cases (see Table 2). In general, figures of the whole sample as well as of the different groups showed this trend towards an increase of patients without problems.

3.2.2. Basal EQ-5D index analysis

According to the results obtained through non-parametric inferential tests, we found statistically significant differences in the basal EQ-5D index between women and men, and between patients with and without a diagnosis of HTN ($p < 0.001$). Thus,

Table 1
Description of the sample and EQ-5D index Pre (basal) and Post (1-year follow-up) values.

	n (%)	EQ-5D index		
		PreMean (SD)	PostMean (SD)	p-values[a]
Total	74 (100)	0.63 (0.27)	0.67 (0.27)	0.18
Age group				
<65	25 (33.78)	0.66 (0.22)	0.72 (0.27)	0.34
65–75	31 (41.89)	0.60 (0.30)	0.67 (0.26)	**0.07**
>75	18 (24.32)	0.63 (0.32)	0.61 (0.30)	0.68
Gender				
Men	49 (66.22)	0.72 (0.24)	0.74 (0.23)	0.52
Women	25 (33.78)	0.45 (0.27)	0.53 (0.30)	0.25
Chronic conditions				
Diabetes	46 (62.16)	0.63 (0.30)	0.71 (0.28)	**0.04**
No diabetes	28 (37.84)	0.62 (0.25)	0.61 (0.26)	0.79
HTN	61 (82.43)	0.59 (0.27)	0.64 (0.28)	**0.09**
No HTN	13 (17.57)	0.82 (0.24)	0.79 (0.21)	0.95
HF	29 (39.19)	0.58 (0.30)	0.64 (0.27)	0.30
No HF	45 (60.81)	0.66 (0.26)	0.69 (0.28)	0.36
COPD	12 (16.22)	0.67 (0.35)	0.62 (0.29)	0.86
No COPD	62 (83.78)	0.62 (0.27)	0.68 (0.27)	**0.08**
Risk group				
High risk (HR)	54 (72.97)	0.65 (0.29)	0.67 (0.27)	0.58
Moderate risk (MR)	20 (27.03)	0.58 (0.26)	0.68 (0.28)	0.15
Living with another person				
Yes	65 (87.84)	0.64 (0.28)	0.68 (0.27)	0.87
No	9 (12.16)	0.59 (0.26)	0.58 (0.29)	0.16

[a] Non-parametric tests: Mann–Whitney and Kruskall–Wallis.

Table 2
Frequencies (and percentage for the whole sample) of patients reporting moderate or severe problems pre and post ($n = 74$).

	Mobility		Self-care		Usual activities		Pain/discomfort		Anxiety/depression	
TOTAL SAMPLE, *n* (%)	Pre 35 (47.29%)	post 31 (41.89%)	pre 15 (20.27%)	post 12 (16.21%)	pre 31 (41.89%)	post 36 (48.65%)	pre 48 (64.86%)	post 45 (60.81%)	pre 39 (52.70%)	post 26 (35.13%)
Age group										
<65	8	5	4	1	12	11	16	13	17	9
65–75	18	15	6	4	10	14	20	21	15	9
>75	9	11	5	7	9	11	12	11	7	8
Gender										
Men	19	15	6	5	14	18	26	27	20	13
Women	16	16	9	7	17	18	22	18	19	13
Chronic conditions										
Diabetes	21	18	6	6	18	21	26	22	24	12
HTN	32	27	15	10	31	31	42	41	37	25
HF	17	15	8	6	16	17	18	21	17	13
COPD	5	6	3	3	5	8	7	7	4	5
Risk group										
High risk (HR)	26	26	12	10	22	28	33	33	26	20
Moderate risk (MR)	9	5	3	2	9	8	15	12	13	6
Living with another person										
Yes	31	25	14	10	27	32	43	39	32	22
No	4	6	1	2	4	4	5	6	7	4

women and patients with HTN showed lower EQ-5D indexes in comparison with men (♀ $0.45 \pm 0.27 <$ ♂ 0.72 ± 0.24) and in comparison with patients without a HTN diagnosis ($0.59 \pm 0.27 < 0.82 \pm 0.24$) respectively. Moreover, we did not find significant differences between the different categories of the variables 'age', 'diagnosis' (diabetes, HF or COPD), 'risk' or 'living with another person at home'.

3.2.3. One-year follow-up EQ-5D index analysis

In the one-year follow-up analysis of the EQ-5D index we found statistically significant differences between women and men ($p < 0.005$); thus, women showed a lower index than men (♀ $0.53 \pm 0.30 <$ ♂ 0.74 ± 0.23). There were no significant differences between the categories of the other variables: 'age', 'diagnosis of chronic diseases', 'risk' or 'living with another person at home'.

3.2.4. Comparison of basal and one-year follow-up EQ-5D indexes

Although numbers indicated that the whole sample experienced an increase of the mean EQ-5D index after one year, the differences between pre- and post-indexes were not significant (see Table 1). Likewise, most of the groups employed to classify the sample showed a higher post-EQ-5D index in comparison to basal data, except these groups of patients (with no significance): 'over 75', 'no diabetes', 'COPD', 'no HTN' and 'living alone at home'. However, the only group that showed a statistically significant increase in the post EQ-5D index in comparison to basal data were 'patients with diabetes' ($p < 0.05$). The groups '65–75 years old', 'no COPD' and 'HTN' showed a significant trend with *p*-values close to 0.10.

3.3. Assessment of perceptions of satisfaction and usefulness

A detailed analysis of the questionnaire items regarding satisfaction and usefulness perceptions is described below taking into consideration the whole sample ($n = 73$):

- *Information*. 87.67% of the interviewers reported that the information provided before the beginning of the programme was adequate and useful in knowing how to use the devices and services of the programme. Just 12.33% found the information moderately useful or inadequate.
- *Usability*. Most of the sample indicated that the devices were easy to use (80.82%); 16.44% found some problems and 2.74% could not use the devices by themselves.
- *Performance*. The devices worked correctly in 67.12% of the cases and with some problems in 32.88% of them.
- *Failures*. 100% of the patients that required technical support when devices or services did not operate reported that the call centre resolved the problems quickly.
- *Security*. Most of the sample (76.71%) felt safe and comfortable with this kind of telemonitoring at home; and 12.33% felt moderately safe. Just 10.96% preferred direct monitoring of their symptoms by the PHCC medical staff.
- *Visits to GPs*. 51.39% of the sample expressed a notable reduction in the number of visits to PHCCs during their participation in the Valcronic programme; and 37.5% indicated they visited the PHCCs just for indispensable issues (with the same frequency as before their involvement in the Valcronic programme). Only 11.11% reduced visits moderately.
- *Communication*. 40.27% of the sample expressed that their communication with the health staff had improved notably or moderately since their inclusion in the Valcronic programme. 59.72% indicated that their relationship with GPs was already good before their inclusion in the programme.
- *Health awareness*. 50.68% of the participants expressed they were notably more aware of the importance to control their diseases and symptoms after their participation in the programme. 21.92% were moderately more aware, and 23.29% indicated that they already controlled their health status before they were involved in the Valcronic programme. Three patients did not answer this question.
- *Health habits*. 38.36% reported they had been following new and healthier habits since their inclusion in the Valcronic programme; 24.62% of the sample moderately; and 32.88% did not change their habits. Three patients did not answer this question.
- *Global satisfaction*. The mean score of global satisfaction of the entire sample was 8.63 ± 1.35 in a scale from 1 to 10 points. Patients with diabetes showed a significantly higher score in this variable than those without this diagnosis (8.93 ± 1.21 vs.

8.14 ± 1.43, respectively). There were no significant differences between the categories in which the sample was stratified.

Out of the 73 people assessed, just 9.59% of them – i.e. 7 users – answered the open-ended question. The responses indicated that the programme could be improved following different lines: 4 patients stated it was necessary to receive more feedback from clinical staff; 3 people requested easier access to personal data within the devices (e.g. clinical or login data); 2 patients demanded higher personalization features in fulfilling questionnaires or taking clinical data; and finally, 1 person requested the availability of other useful information (e.g. specific diets). These are some examples of answers collected:

"*I would like to receive more calls by practitioners in the centre. Sometimes, when I send my data, I do not know if I am well or not because nobody tells me anything.*"

"*I just check my sugar once per week and I do not feel safe. I would like to control it more frequently.*"

"*I am very happy with the devices, but the programme could be improved. I would like useful information for everyday life to be available; for example, recipes or physical activity guidelines for diabetics like me.*"

4. Discussion

This study uses an exploratory and descriptive design to measure and examine the impact of a pilot implementation of the Valcronic programme through the assessment of self-perceived HRQOL of a sample of its users before and one year after their inclusion, and their perceptions of satisfaction and usefulness. It shows results associated to the practical implementation of a stratification system of population in risk groups of hospital admission through the computerized algorithm of the CARS tool in VHS health databases.

This study found that the percentage of patients with at least one problem in the dimensions assessed by the EQ-5D instrument decreased one year after their inclusion in the programme (pre 82.43% vs. post 74.32%). The percentage of users from the whole sample experiencing problems in aspects related to 'Mobility', 'Self-care', 'Pain/discomfort' and 'Anxiety/depression' decreased as well; nevertheless, the percentage increased slightly in the case of 'Usual activities'. The dimension 'Anxiety/depression' experienced a remarkable decrease in the number of patients from the total sample with problems as well as in the different stratification groups—except in the group 'over 75'.

With respect to the assessment of the EQ-5D index, we found that the whole sample experienced an improvement, although not significant, of its self-perceived HRQOL after one year in the programme; only the patients diagnosed with diabetes showed a significant increase in the value of the EQ-5D index. These results follow the trend shown by de Bruin et al. (2012) in a complete review of comprehensive care programs for patients with multiple chronic conditions. In this review, seventeen studies – from a total of thirty-three – reported effectiveness in a follow-up assessment of HRQOL. In agreement with the results of other studies (e.g. Jansson, Németh, Granath, Jönsson, & Blomqvist, 2009; Guallar-Castillón, Redondo, Banegas, López-García, & Rodríguez-Artalejo, 2005; Casado et al., 2001), our sample of women showed a lower HRQOL than men both in the basal analysis and one year later. Patients 'over 75', with 'no diabetes', 'no HTN', 'COPD' and 'living alone at home' showed impairment in their HRQOL.

Our results indicate that patients' perceptions of satisfaction and usefulness were highly positive; like in other studies (Mira-Solves et al., 2014) and other telemedicine programmes for diabetic patients (Bakken et al., 2006). We observed that the global satisfaction of the sample was very high, rating the programme with an average of 8.63 over 10. We can highlight the fact that patients with diabetes showed significantly higher satisfaction than those without this condition. Most of the patients found the devices user-friendly, felt safe with the monitoring at home and communication with the GPs and nurses improved after one year in the programme. It is worth noting that patients experienced changes in their daily life after using the Valcronic programme, as they reported that the number of visits at PHCCs decreased notably and they became more aware of the importance of controlling their diseases and symptoms.

This is the first study with evidence on health outcomes regarding the implementation of the Valcronic programme since its start-up in 2012. We can tentatively consider that patients diagnosed with diabetes particularly benefit from their involvement in the programme, as they were the only group of users with a significant improvement in their HRQOL after one year involved in the programme and their levels of satisfaction were significantly higher than patients without diabetes. However, from the results obtained, we found some gaps in the programme that could be improved. As patients over 75, with COPD and living alone did not experience an improvement in their HRQOL one year after their inclusion in the programme, further assessment may be required to identify their specific needs which should be taken into consideration to adapt the initiative. In this sense, it may be interesting to join the population stratification process employed and the telemonitoring programme itself with other social and health resources available in the context of the study (Garcés, Ródenas, & Sanjosé, 2006). Thus, those patients in need of more comprehensive care could benefit, for example, from the case-management methodology implemented at the primary care level, which could facilitate treatment adherence among other benefits (Garcés, Ródenas, & Hammar, 2013; Ródenas, Garcés, Carretero, & Megía, 2008). Moreover, it may be useful to involve other suppliers of services – such as NGOs or municipalities – that could provide social support through home visitation programmes, especially to the older patients living alone and/or with a weak social network of support (e.g. Stijnen, Jansen, Vrijhoef, & Duimel-Peeters, 2013). In this way, the behavioural risk factors derived from living alone may be reduced (Linardakis et al., 2013). To address the poor data obtained in the EQ-5D dimension 'Usual activities' the programme may be connected with Home Help Service, from which patients and their caregivers – without high dependency demands – could benefit through assistance in activities of daily living (Garcés, Carretero, & Ródenas, 2011; Carretero, Garcés, & Ródenas, 2007). Another point that could be improved is the introduction of guidelines and practical tips within the ICTs – e.g. specific diets for diabetics or exercise activities – which could encourage the acquisition of healthier habits. Finally, although patients showed they were in general satisfied with the quality of communication with health staff, some indicated the need to gain more confidence in the functioning of the remote monitoring system so that more PHCC feedback could take place.

The present study and the Valcronic programme are based on a stratification of population according to the results from previous studies of authors identifying risk groups with different health needs and taking into consideration comorbidities and multimorbidities (Doñate-Martínez, Garcés, & Ródenas, 2014). Also, the programme involves different stakeholders – patients, GPs and nurses – who, in the case of primary end-users, entail a positively-assessed patient empowerment and self-management through the use of ICTs. These are strong points based on criteria and challenges identified by the EIP-AHA of the European Commission (*European Innovation Partnership on Active and Health Ageing*), which is aimed to assess integrated care activities or initiatives developed and undertaken at regional or local levels (EIP-AHA, 2012).

Some limitations of the present study should be noted. First, those related to the sample size which was notably reduced as many users were dropped from the research during the follow-up phase. Second, this study had no control group; however, in accordance with the review by Paré, Jaana, & Sicotte (2007) more than half of the home telemonitoring studies focused on several chronic conditions did not have a control group. In our case, the exploratory and descriptive purpose of the study outlined did not require a control group to compare results with. And, finally, although it was not the aim of this study, we may need to do further research to draw conclusions about the impact of the Valcronic programme by taking into consideration caregivers' and clinicians' input.

5. Conclusions

On the basis of our findings in this paper, by way of conclusions we propose the following points. Firstly, as a continuation of previous results of the authors, this research demonstrates the applicability and strength of the use of computerized models within health information systems to identify high-risk patients with chronic conditions. So, thanks to the introduction of screening algorithms it is possible to guide clinical decisions for target interventions or pathways according to patients' needs in the VHS. Secondly, given the outcomes, Valcronic appears to be an appropriate telemonitoring programme for the management of older adults with comorbidities or multimorbidities as it decreases patients' visits to PHCCs, improves health awareness and perceived quality of life, as well as its positive impact on their perception of satisfaction and usefulness. However, significant improvement is needed to address a comprehensive response to the needs of the global population of reference in the Valencia Region; and including an assessment on the impact of the caregivers' and professionals' burden as well. Moreover, it remains necessary to do further research through larger longitudinal studies to determine which groups or profiles of patients may benefit most from this telemonitoring and which characteristics of the programme contribute most to positive effects in health status.

So, this initiative is an initial point to join resources from healthcare – through primary care – and social welfare systems in the design of more complete care pathways aimed to respond to the global LTC needs of the population with chronic diseases, especially in older adults or older people.

Conflict of interest

Authors declare they do not have any conflict of interest.

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