The FrailSafe project

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INSERM
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European Union funding
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Frailty?

- "A syndrome characterized by diminished strength/endurance and reduced physiologic function that increase an individual's vulnerability for developing increased dependency, and/or death"

- A dynamic process; it seems **preventable**, **may be delayed** or **reversed**.

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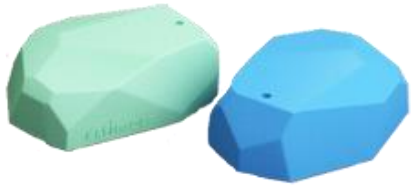
The frail safe study

1) Better **understand frailty** and its relation to other health conditions.
2) **Identify** quantitative and qualitative **measures of frailty through advanced data mining** approaches meant to predict short and long-term outcome and risk of frailty.
3) Develop **real life sensing** and an **intervention platform**.
4) Provide a **digital patient model of frailty** sensitive to several dynamic parameters, including physiological, behavioural and contextual.
5) Create **"prevent-frailty" evidence-based recommendations** for older persons.
6) Strengthen the motor, cognitive and other "anti-frailty" activities through the delivery of monitoring alerts, guidance and education.
7) Achieve the above through **a safe, unobtrusive and acceptable system** for the ageing population while reducing the cost of health care systems.

- **Objective: Develop and test advanced technology devices for the detection of Frailty and the prediction of its evolution**
- **Added value??**

The frail safe devices



Frailty Understanding

Frailty preventing strategies

Conventional Geriatric Assessment

frail safe System

System Improvement

Patient in their natural environment

Ecological aspect

Usual clinical settings

Multiple signals in real time conditions

Time Framework

"Single shot" evaluation

Big data analysis
Objectivity in the extrapolation

Data analysis capacity

Limited data
Subjective interpretation

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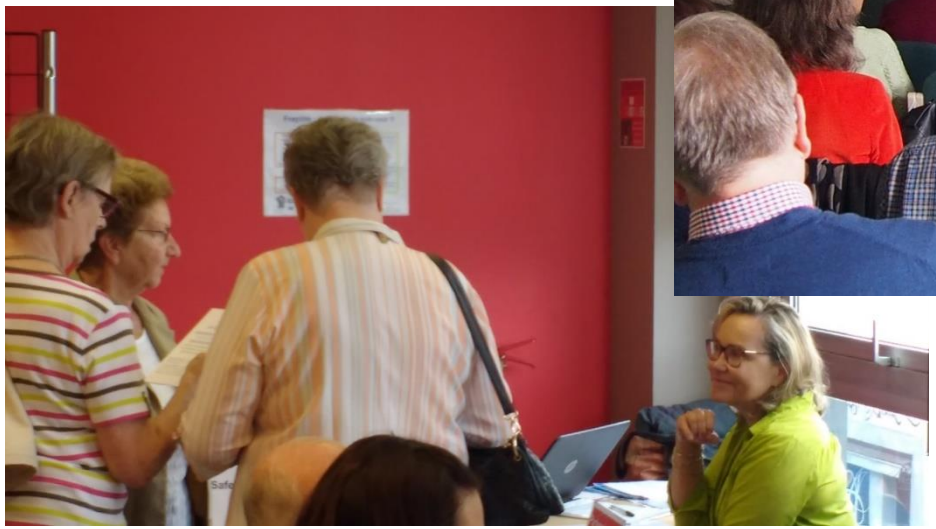
frail safe
Etude FrailSafe
ONPA 22 avril 2016
Pr A. BENETOS



Inclusion criteria

Inclusion criteria
Age ≥70 years Informed consent provided
Exclusion criteria
Lack of wish to participate Consent withheld Inability to give consent because of incapacity Inability to walk Inability to speak Greek or French (see clinical centers) Diagnosis of clinically significant cognitive impairment or score less than 24 on the Mini–Mental State Examination Diagnosis of advanced malignancy, other terminal illness or an estimated life expectancy of less than 12 months Active psychiatric disorder based on medical records or clinical opinion at the time of recruitment, current substance users, or excessive alcohol drinkers.

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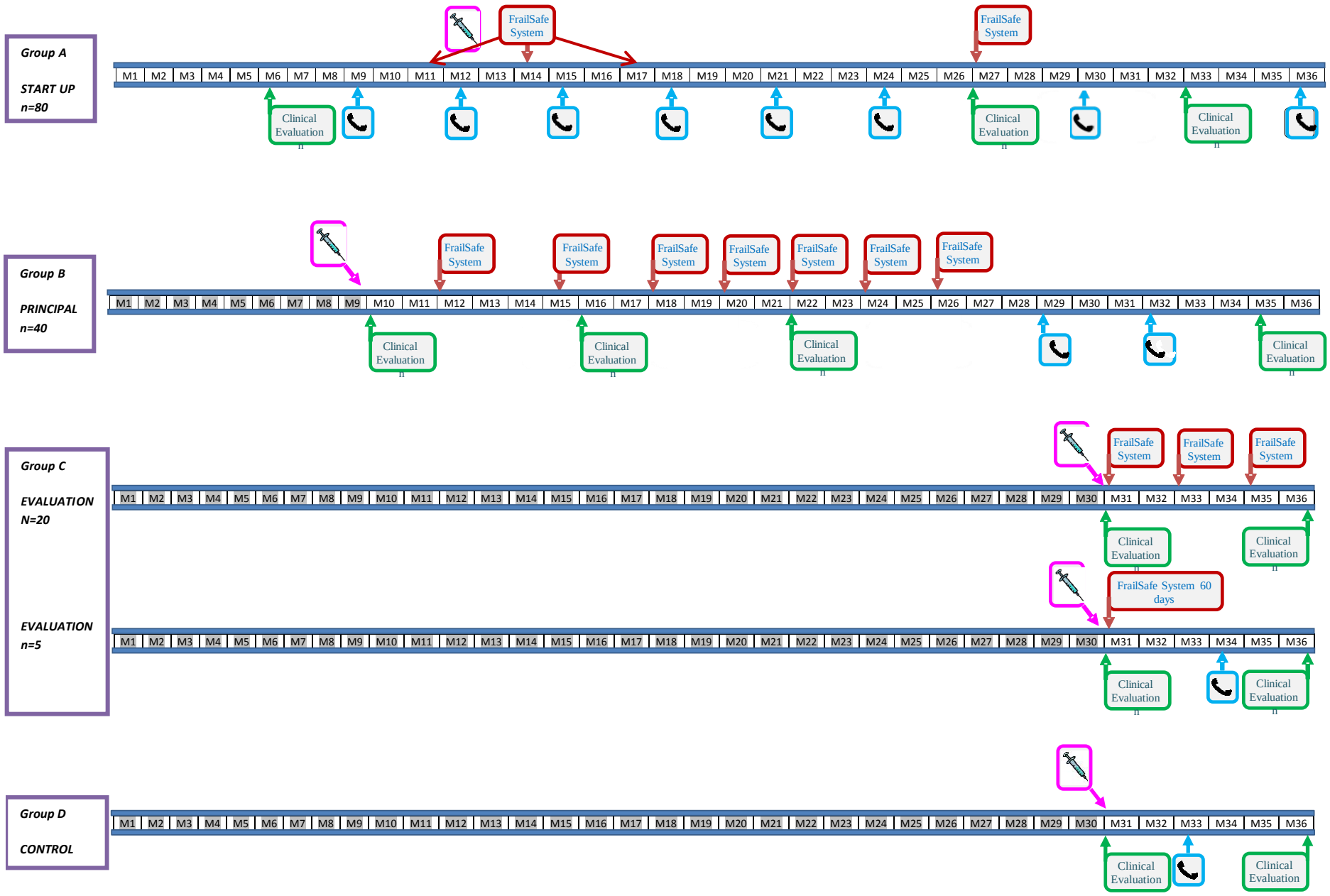
FrailSafe Evaluation per group (A, B, C, D)



Monitored outcomes

Hard Outcomes

Fall
Fracture
Hospitalisation (non programmed)
Institutionalisation
Death
Decline in ADL or IADL capacity (significant change is defined as decline in at least 1 point in the ADL score and/or 1 point in IADL score)

Proxy outcomes:

MMSE and/or MoCa (cognitive function)
Gait speed (physical function)
GDS (psychological status)
Weight loss (general health)
Health status self-assessment

Clinical parameters

Medical Domain (M)	Each polypathology /Comorbidities (M)
	Comorbidity's impact (M, P, s, c)
	Polymedication (M, p, c)
	Orthostatic hypotension (M, p)
	Visual impairment (M, S, p)
	Hearing impairment (m, S, c)
General Condition Domain (M, ψ)	Unintentional weight loss (M, ψ)
	Self-reported exhaustion (M, ψ)
Physical Condition (P, m, c)	Balance (single foot standing) (P, m)
	Gait-related task speed* (P, c) (Timed Get Up and Go test)
	Gait - speed 4 m (P, m)
	Lower limb strength (P, m)
	Grip strength –dynamometer (P, m)
	Qualitative evaluation of mobility (P, m)
	Low physical activity (P, M, s, ψ)
Nutrition (M, Ψ, c, s)	Too low BMI (M, Ψ, p, c, s)
	Too high BMI (M, Ψ, P, c, s)
	Waist circumference (M, Ψ, P, c, s)
	Lean body mass (M, P, ψ)
	Total MNA score (M, Ψ, p, c, s)
Cognitive Domain (C, ψ, m, s)	MMSE scores (C, ψ, m)
	MoCA score(C, ψ, m)
	Subjective memory complaint(C, ψ, m, s)
	Natural language analysis (C, Ψ)
Psychological Domain (Ψ, S, c)	GDS-15*(Ψ, S, c)
	Self-rated anxiety (Ψ, S, c)
	Natural language analysis (C, Ψ)

Social Domain (S, Ψ, m)	Leisure activities (S, Ψ, p, m)
	Membership of a club (S, Ψ, p, m)
	Number of visits and social interactions per week (S, Ψ, p, m)
	Number of telephone calls exchanged per week (S, ψ, m)
	Approximate time spent on phone per week (S, ψ, m)
	Approximate time spent on videoconference per week (S, ψ)
	Number of written messages sent by the participant per week (S, ψ, m, p)
Environmental Domain (S, P, m)	Subjective suitability of the housing environment according to participant's evaluation (S, P, m)
	Subjective suitability of the housing environment according to investigator's evaluation (S, P, m)
	Number of steps to access house (S, P, m)
Wellness (Ψ, S, M, P, c)	Quality of life self-rating (Ψ, S, M, P, c)
	Self-rated health status (M, Ψ)
	Self-assessed change since last year (M, ψ)
	Self-rated anxiety (Ψ, S, M, P, c)
	Self-rated pain (M, P, ψ)
Lifestyle (P, M, ψ,s)	Smoking (M, Ψ, p, s)
	Alcohol (M, Ψ, S)
	Physical Activity (P, M, ψ,s)

Tags (reflecting impact of each item on CIFI)

Physical: P dominant, p recessive

Medical: M dominant, m recessive

Social: S dominant, s recessive

Cognitive: C dominant, c recessive

Psychological: Ψ dominant, ψ recessive

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Technical parameters

FrailSafe device/ application	Variables monitored	Clinical relevance with frailty aspects' tagging
WWBS	ECG measurements:	Heart rate variability in response to the activities (M, P, ψ)
	IMU measurements:	Detection of falls and of fall risk (P, M) Activity classification (P, M, s)
	Respiration movements:	Breathing amplitude and respiratory rate variability in response to the activities (M, P, ψ)
	Activity attributes:	Activity monitoring, activity patterns' recognition (P, M, s) Distances covered (P, M, s) Gait speed (P, M, c)
GPS logger	Speed of movement Distance covered while being outdoors Distance away from starting point	Gait speed (P, M, c) Indication for vehicle usage (P, c) Activity pattern (P, M, s)
Beacons	Aggregated time passed in each room	Each room usage, indication of time repartition during the day between activities that are mostly attributed to certain rooms of the house. Indirect index of indoors activity (S, P, ψ)
Red-wings serious game	Average grip strength Maximum grip strength Time applying optimal grip strength Total distance covered Total time played	Grip strength, indicating overall body strength (P, m) Stamina (P, m) Cognitive function (executive function, reflexes, information and reaction treatment speed and efficacy, concentration) (C) Brain-motor coordination and efficacy (C, P)
Virtual supermarket serious game	Total time played and wondering into the virtual supermarket Errors in the types and quantities of the items bought Errors in the paying process	Executive function, visual and verbal memory, attention, spatial navigation (C)
Blood pressure monitoring	Blood pressure Heart rate	Cardiovascular parameters (M)
Tags (reflecting impact of each item on each of the aspects of frailty) Physical/functional: P dominant, p recessive; Medical: M dominant, m recessive; Social: S dominant, s recessive; Cognitive: C dominant, c recessive; Psychological: Ψ dominant, ψ recessive		

Parameters monitored by the WWBS

Measured parameter	Type	Extracted clinical measurements (examples)
Electric signal measuring the ECG ECG signal quality ➢ Heart rate ➢ R-R intervals ➢ Heart rate variability	ECG measurements	Average heart rate / day, maximum heart rate / day etc. (this can be connected with the activity class and generate measurements such as average heart rate / day while walking etc)
Accelerometer in X-Y-Z axes	IMU	Patterns of (slow/fast) movements such as walking, falls etc
Gyroscope in X-Y-Z axes		
Magnetometer in X-Y-Z axes		
Electric signal measuring the chest pressure on the piezoelectric point Respiration signal quality ➢ Breathing rate ➢ Breathing Amplitude	Respiration measurements	Average breathing rate / day, maximum breathing rate / day etc. (this can be connected with the activity class and generate measurements such as average breathing rate / day while walking etc).
Activity performed	Activity attributes (calculated by Smartex using IMUs)	Steps, step period
Estimation of energy activity		
Step period		
Pace (number of steps)		

Parameters monitored by the GPS logger

Measured parameter	Extracted clinical measurements (examples)	Analysis using data mining techniques
Latitude	Speed of movement, distance covered while being outdoors. Based on the speed, there is an indication if the participant is walking, on a vehicle etc.	Attempt to correlate the outdoor moving patterns of the participants with the frailty status
Longitude		
Elevation		
Speed		
Accuracy		
Bearing (orientation)		
Steps		

Clinically meaningful parameters:

- total distance
- total duration
- total number of steps
- radius covered
- area covered
- average walk speed
- total walk time
- total stop time
- total vehicle time
- walk time percentage
- vehicle time percentage
- stop time percentage
- track number
- track average distance
- track average duration
- track maximum distance
- track maximum duration

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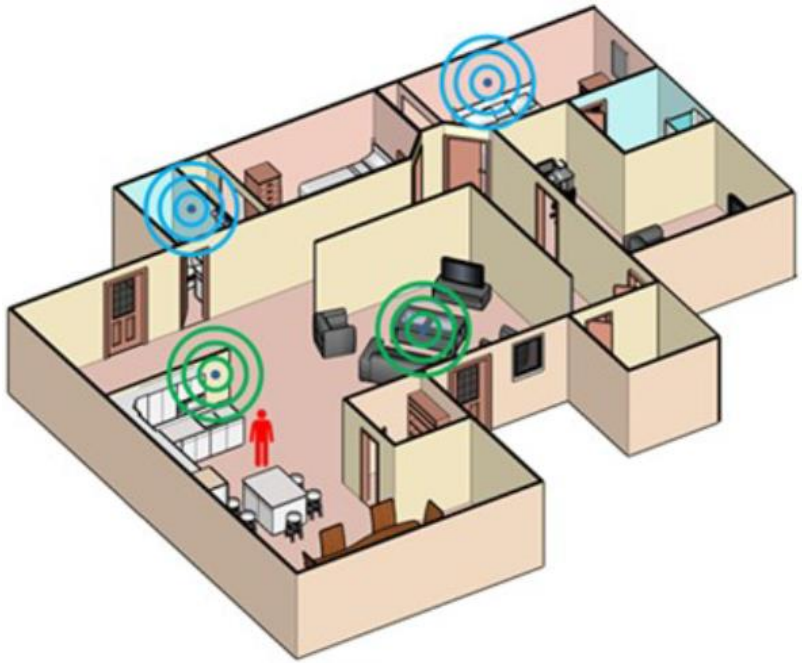
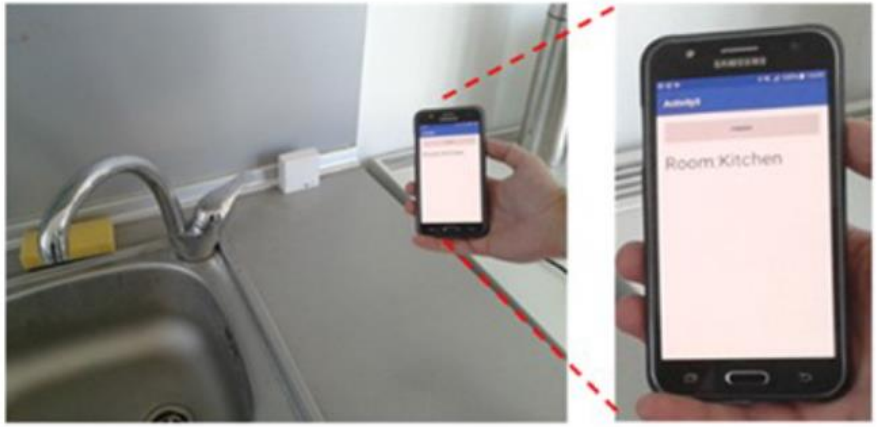
Indoor Localisation Application





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Parameters monitored by serious games

Game 1: Force Analyzer	Daily values for: • Max force • Average max force • Average endurance • Max endurance • Average game duration • Max game duration
Game 2: Red Wings	Daily values for: • Max force • Average max force • Average endurance • Max endurance • Average score • Max score • Average game duration • Max game duration
Games 3: Railway	Average/max daily values for: • Score • Distance • Chest mobility • Arm mobility • Movement velocity
Game 4: Simon	Average/max daily values for: • Hits number • Fails number • Game duration • Sequence length
Game 5: Memory	Average/max daily values for: • Response time • Game duration • Hit percentage • Fail percentage
Game 6: Reflex	Average/max daily values for: • Reflects time • Game duration • Hit count • Failure count
Game 7: Virtual Supermarket	Average/max daily values for: • Game duration • Item time • Item number ratio • Item quantity ratio • Not requested item number ratio • Not requested item quantity ratio • Money ratio
Game 8: Gravity Ball	Daily values for: • Best time • Gravity deviation • Trajectory deviation
Game 9: Floating Archery Target	Average/max daily values for: • Accuracy • Hand response time • Head response time
Game 10: Memory AR	Average/max daily values for: • Visual accuracy • Visual reflex • Memory accuracy • Game duration • Head trajectory

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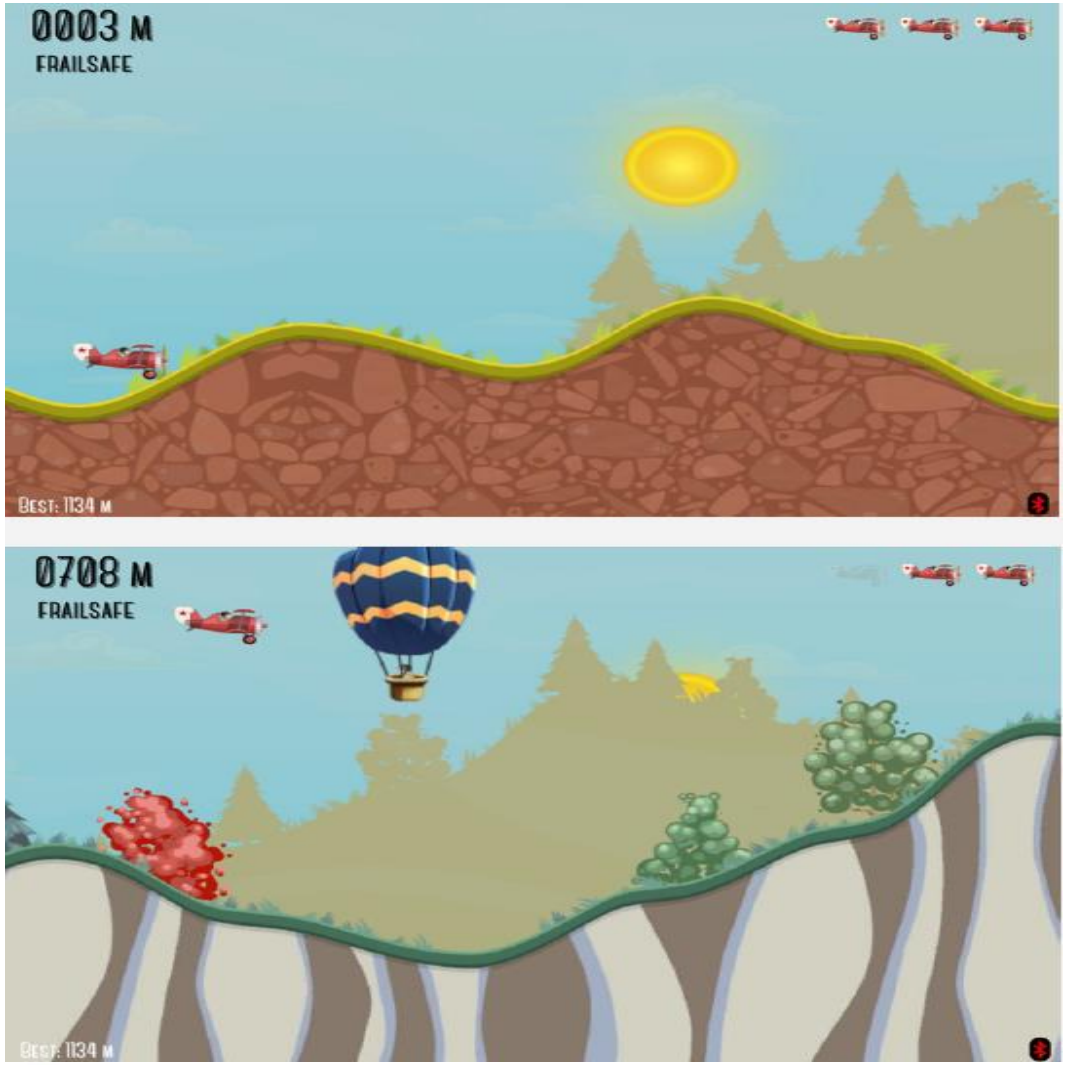
The RedWings game



The virtual supermarket game

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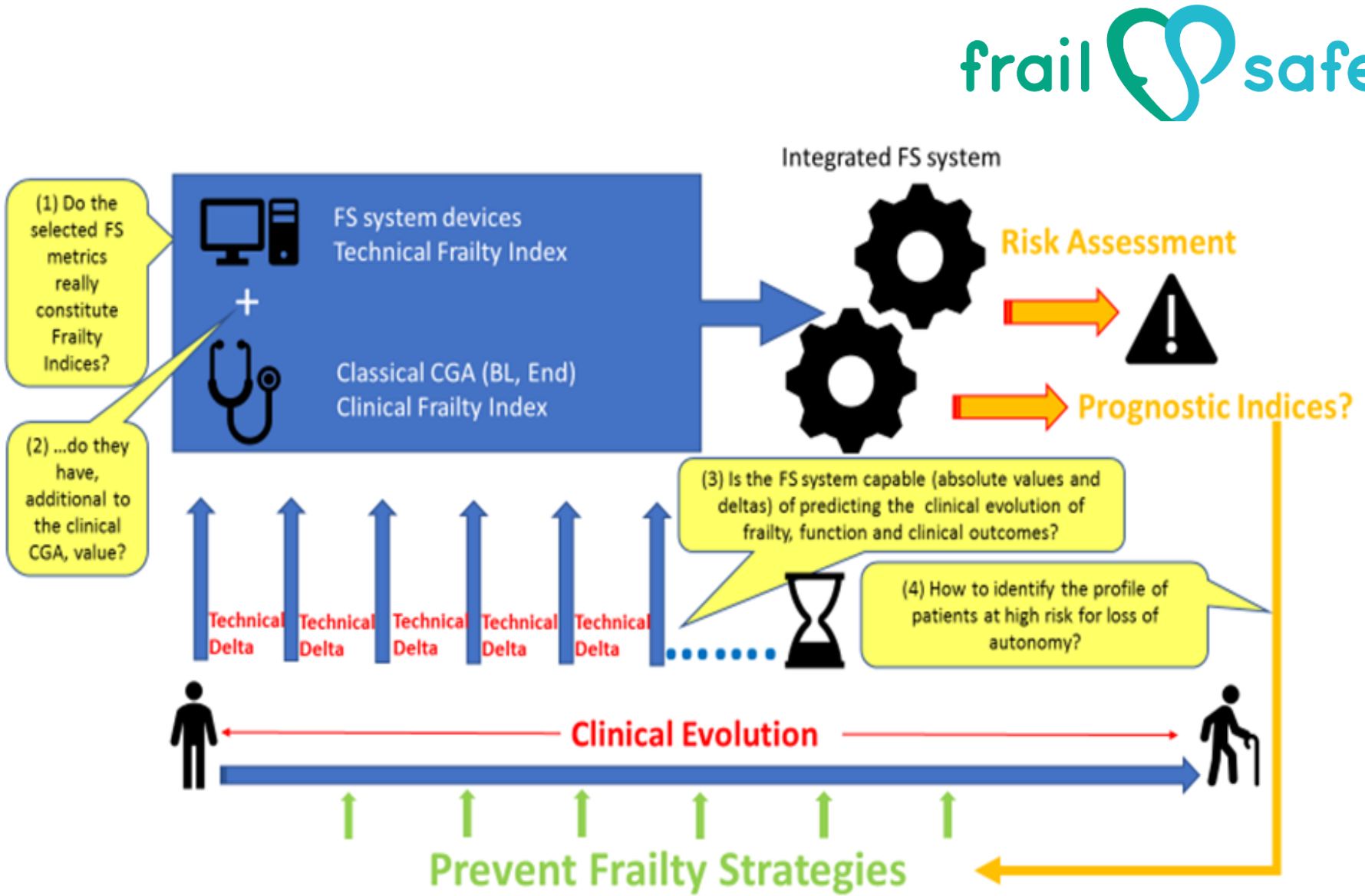

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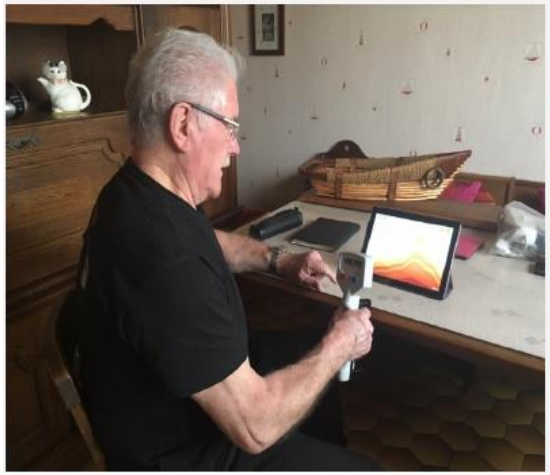
Participants' feedback

- « I like the idea that our feedback and opinion can change the FrailSafe final product"
- « it's a good way to satisfy one's curiosity!"
- "you get a more comprehensive assessment of your health status on a long period of time"
- " I was interested because using new technologies for the prevention of older people's health seems intriguing!"
- "it's a nice way to spice up your everyday routine!"



Project partners

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University of Patras
GREECE

Smartex, S.R.L.
ITALY

AgeCare Ltd
CYPRUS

BrainStorm Multimedia
SPAIN

Gruppo SIGLA S.R.L.
ITALY

AGE Platform Europe
BELGIUM

HYPERTECH S.A.
GREECE

CERTH/ITI
GREECE

University Hospital (CHU) of Nancy and INSERM
FRANCE

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More information

- **Website**: www.frailsafe-project.eu
- Register to our **Newsletter**
- **Facebook**: FrailSafe
- **Twitter**: @EUfrailsafe
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Thank you for your attention!

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