

Dialogue between a daughter (age 10) and her father (age 57)

Father: *What is $12 + 8$?*

Daughter: (looking at her father like "we did those things years ago ...") *20.*

Father: *What is $12\text{ m} + 8\text{ m}$?*

Daughter: (looking at her father like "what's your point ...") *20 m.*

Father: *What is $12\text{ apples} + 8\text{ bananas}$?*

Daughter: (answering proudly and quickly) *20 fruits.*

Father: *What is $12\text{ apples} + 8\text{ cars}$?*

Daughter: (thinking a while ...) *20 things.*

Father: (realizing that this could actually be the first slide at EUGMS in Oslo) *Right.*

Father: *Do you want to play some golf today?*

Daughter: *No.*

By the way, what is $10 + 57$?

A Friday afternoon in a hospital --- A logician trying to unhide information

Orthopedic surgeon: *We had some 15 femur fractures, and even a couple of pubic ramis.*

Colleague orthopedic surgeon: *More screws than nails?*

Orthopedic surgeon: *Reminds me I need to do something in my Garden during the weekend.*

Health economist: *So you have almost 20 hip surgeries in one week.*

Head of surgery department: *We also had another 30 other trauma cases.*

Health economist: *So you had 50 severe injuries.*

Head of surgery department: *Yes.*

Logician: *How many cervicals among the 15?*

Orthopedic surgeon: *9, I think.*

Logician: **So what is 9 cervicals + 6 trochanters?**

Head of surgery department: *15 traumas, ... or maybe 15 femur fractures.*

Logician: **Maybe $9 S72.0 + 6 S72.1 = 15 S72$ and $15 S72 + 2 S32.5 = 17 S$?**

Epidemiologist: *I'm not sure what a statistician would say about that.*

Logician: *Right.*

Logician: *Any mood differences among those fracture types or related surgical procedures?*

Geriatrician: *It's not systematically assessed, but antidepressant data could perhaps be connected?*

Logician: *How is depression observed before and after a fall? Can we model these causalities?*

...

Health economist: *How could we reduce the number of injuries by 20%? ... and how can we connect all this to care needs and resources?*

Head of surgery department: *That's a good question.*

Logician: **How do we really compute with all these risk factors and related numbers and codes?**

Geriatrician: *This logic of yours, how does it differ from the use of statistics?*

Logician: *Ok, I will try to explain.*

...

Logic-based foundations within fall prevention recommendations

Patrik Eklund

In this presentation we identify the **overall scope and structure of classifications and terminologies** necessary for a European information and registry infrastructure based on existing registries for frailty, injuries, fractures, and interventions, focusing on frailty and fall-related injuries. A common language, indeed based on a formal logic language, a 'lative logic' presenting an entirely new approach to logic-based medicine (complementing evidence-based medicine), including the overall scope and structure of classifications and terminologies, is needed to **harmonize existing national and regional guidelines**, and provide an enrichment of them into an extended European Guideline for Fall Prevention. Spatial and geometric data alone will not suffice, and purely **device and electronic approaches** to active and healthy ageing will turn out to be all too shallow. Nomenclature and terminology based approaches are taking over and will establish success stories. On the one hand, our approach has the ambition to support the development of a **personalized prevention guideline**, developed in cooperation with professionals for professionals, with prevention action focusing on individuals rather than populations. On the other hand, it is intended to be a guide to design, commitment and implementation of **fall prevention programmes within regions and municipalities**. Our approach responds specifically to the needs and visions described in "Growing the Silver Economy in Europe". We position ourselves e.g. with respect to ongoing and new silver economy related policy initiatives within the European Commission as represented by several Directorate-Generals. We strengthen economic sustainability of outcome, which is an important support for the industry. The Commission and its DGs has recognized the need to overcome obstacles caused by fragmentation of data. Our fall prevention approach contributes to bridge these gaps, seen as absence of nomenclature and common language across DGs. Providing that common language, our approach is expected to be useful also for further work within the DGs and in particular for communication and dialogue between the DGs. Our approach also supports the assembly of the global approach with a European wide partnership (Ecosystem for Innovation) and a regional/local approach (Ecosystems of Implementation), including modelling of pre-commercial procurement.

Big and bulky numbers --- Topdown assessment

Simplest statistics is about "**How many?**"

per year

per gender

per geography

1, 2, 3, ..., 10, 20, 30, ... 100, 200, 300, ..., 1 000, 2 000, 3 000, ..., 10 000, 20 000, 30 000, ...

How many Alzheimers (in 2030)?

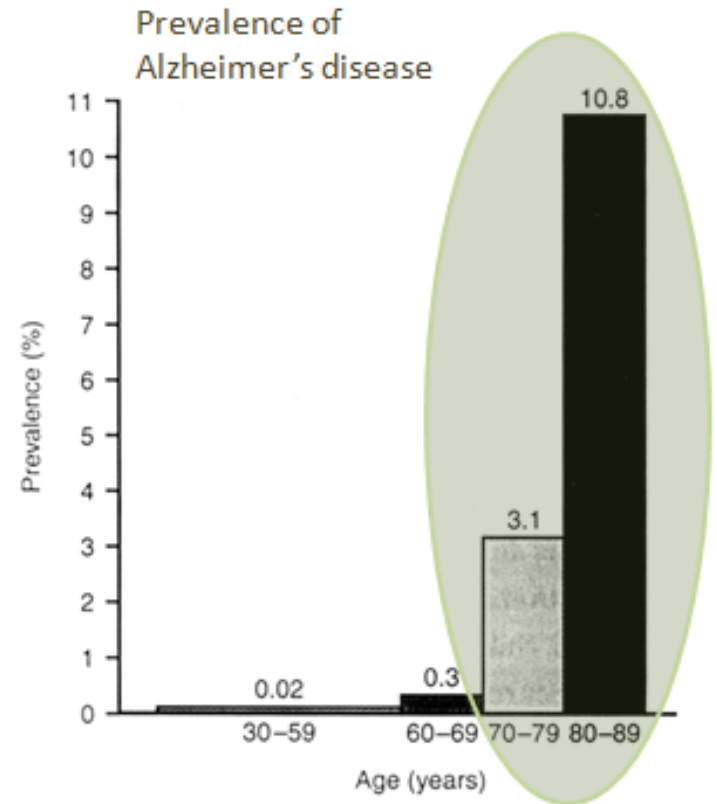
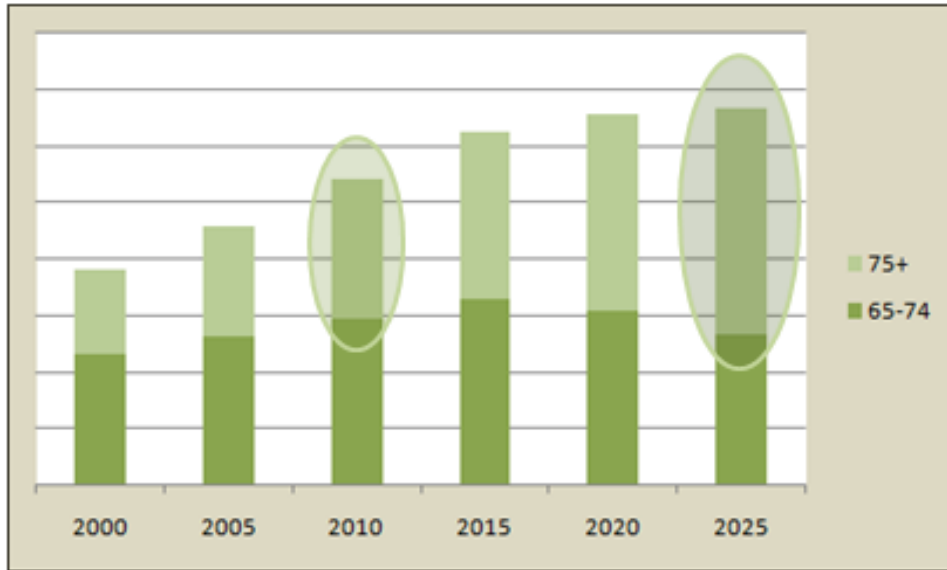
How many injuries (in EU)?

How many hip fractures?

Big groups for big diseases requires big doctors

Big groups for small diseases requires small doctors

It's not about the 65+ group. **We must understand what happens since the 75+ group increases rapidly.**



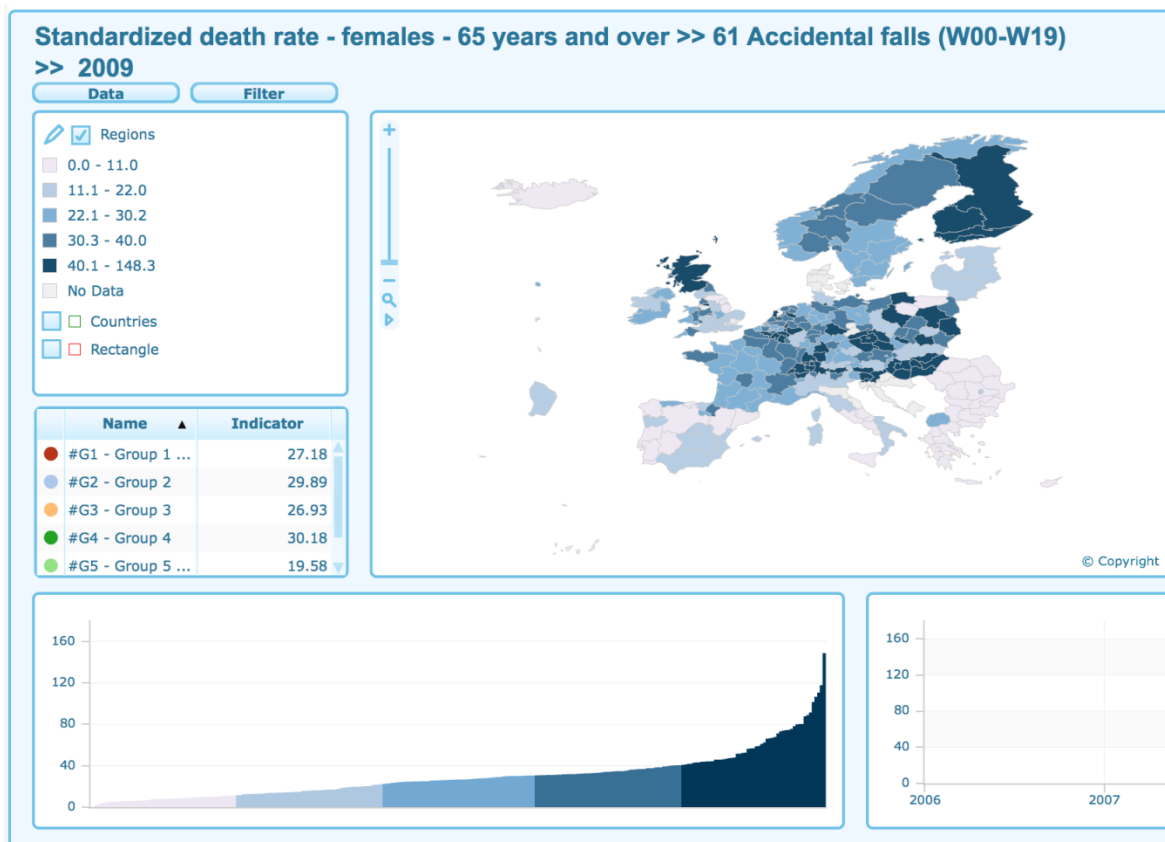
We may need to employ more, but we definitely need to increase competence for home care professionals.

Simple "political arithmetics" will not suffice to solve the problem.

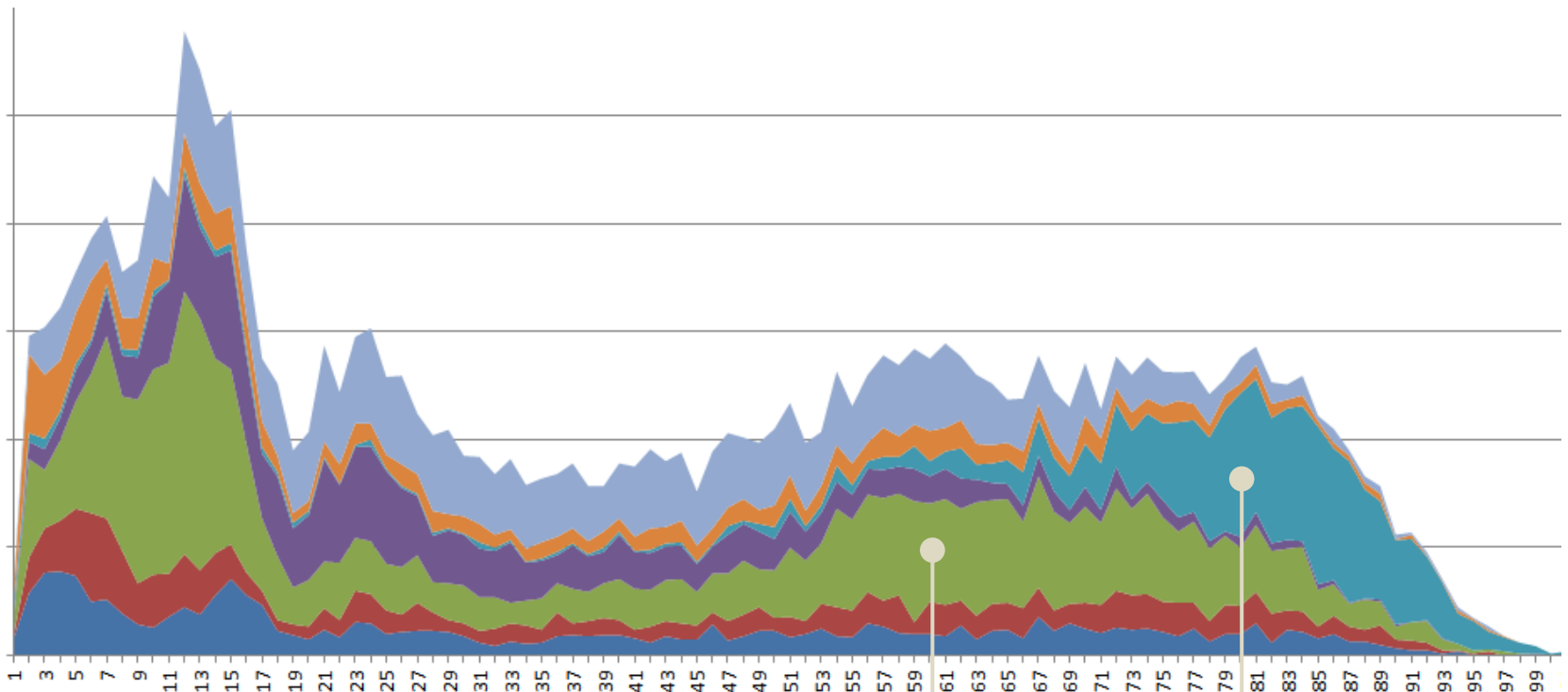
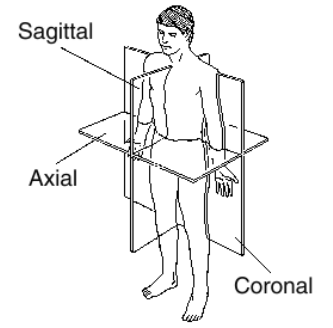
WHO Regional Office for Europe:

Several interactive atlases for the display of sub-national health and socio-economic data have been developed in cooperation with the European Commission, DG Sanco. They are typically on NUTS2 geographic level.

Ref: Age-Friendly Environments in Europe – AFEE

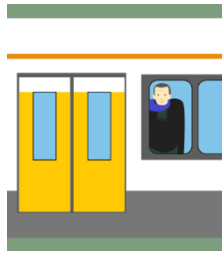
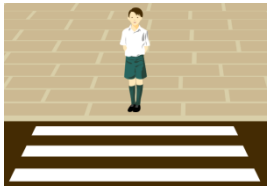
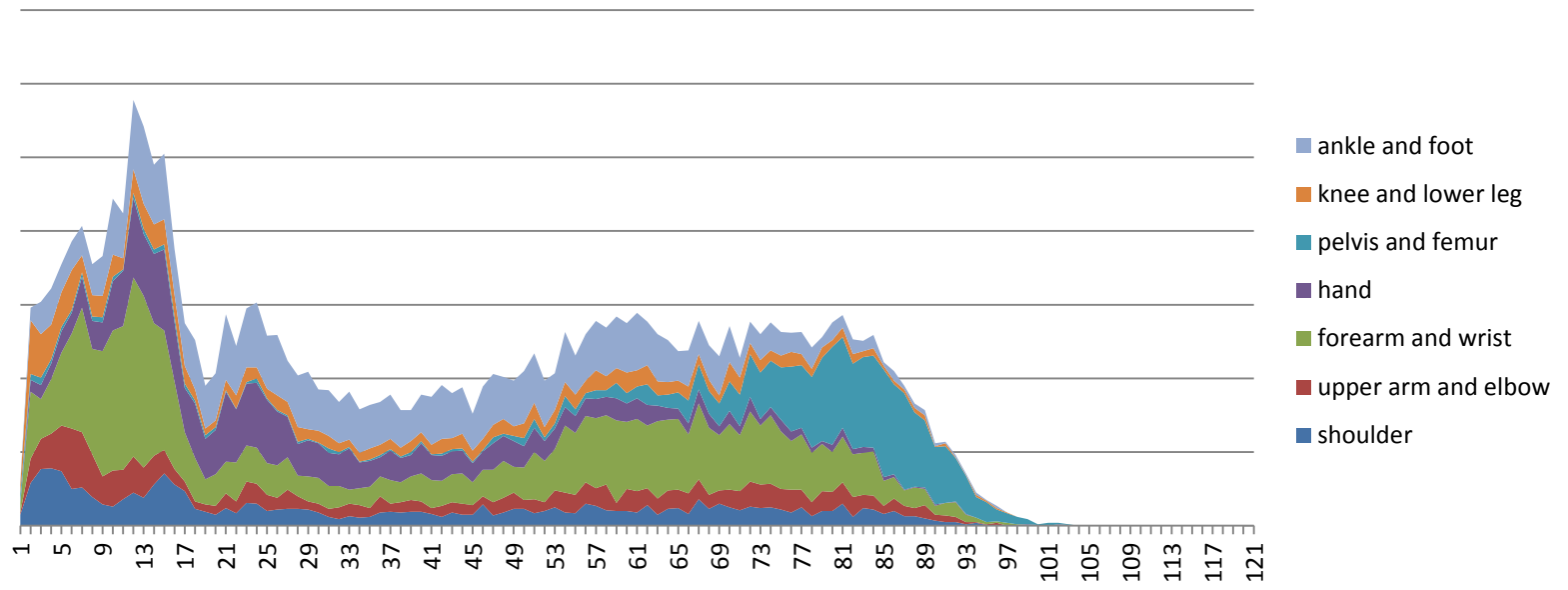


- ankle and foot
- knee and lower leg
- pelvis and femur
- hand
- forearm and wrist
- upper arm and elbow
- shoulder



Sagittal
direction

Coronal
direction



Condition

relative to

intervention

disease (ICD)

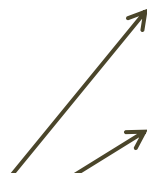


code (e.g. for drug, ATC)



code & procedure (e.g. for surgery, NOMESCO)

functioning (ICF)



procedure (e.g. for physiotherapy)

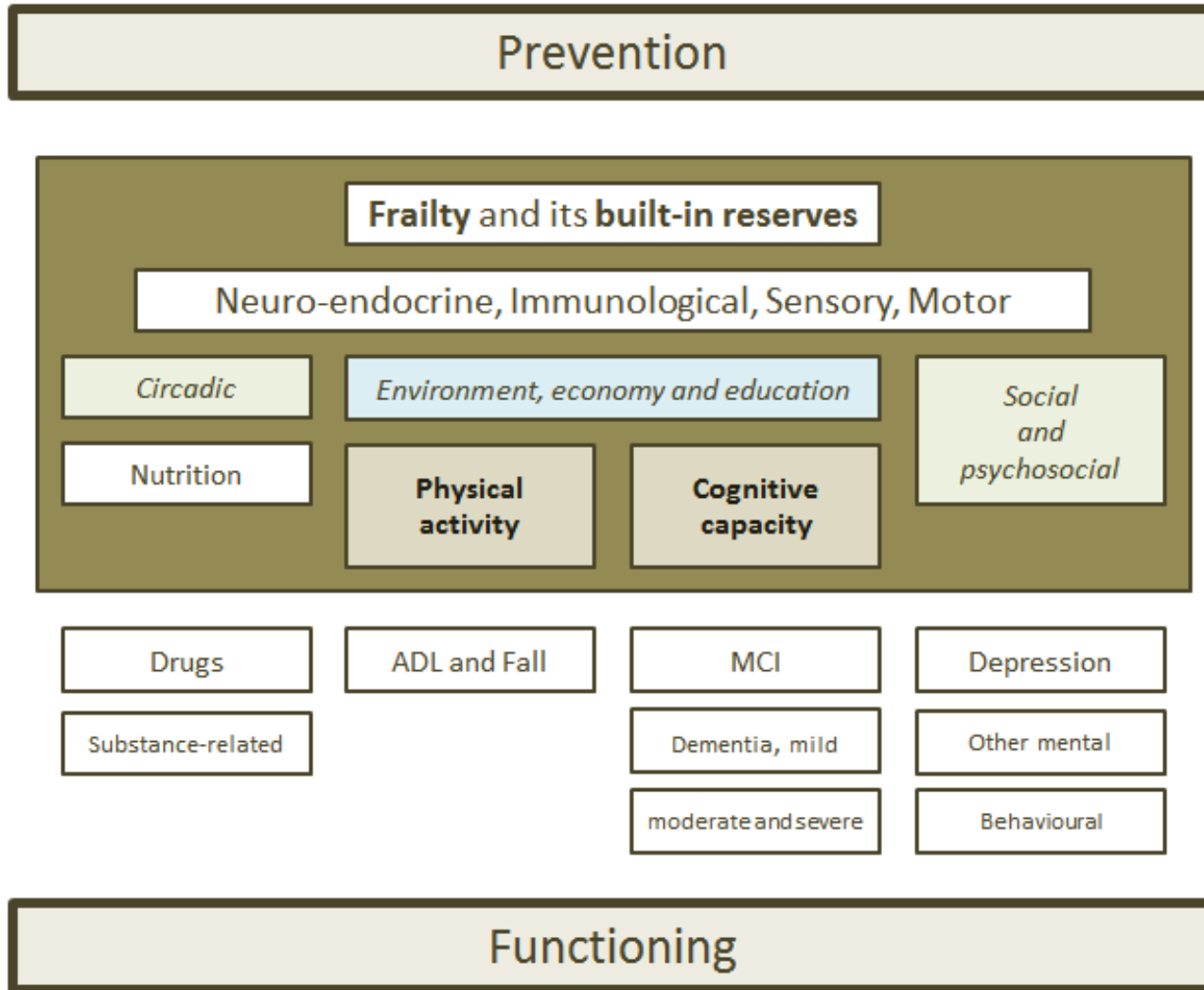
How many per code?

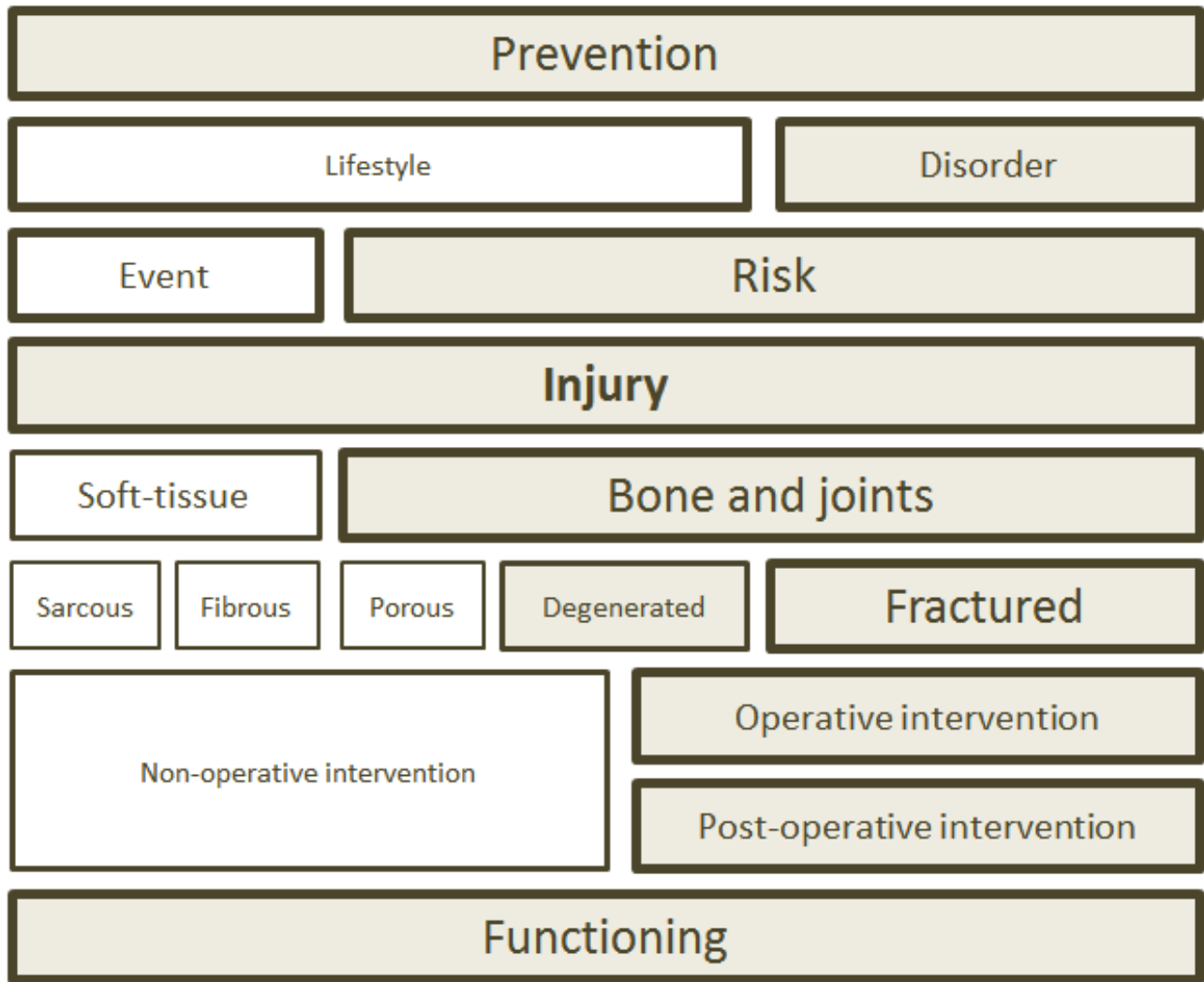
Ho many per combination of code?

Cross tabulation, 2-dim, 3-dim, ..., n-dim, is still just counting "How many?"

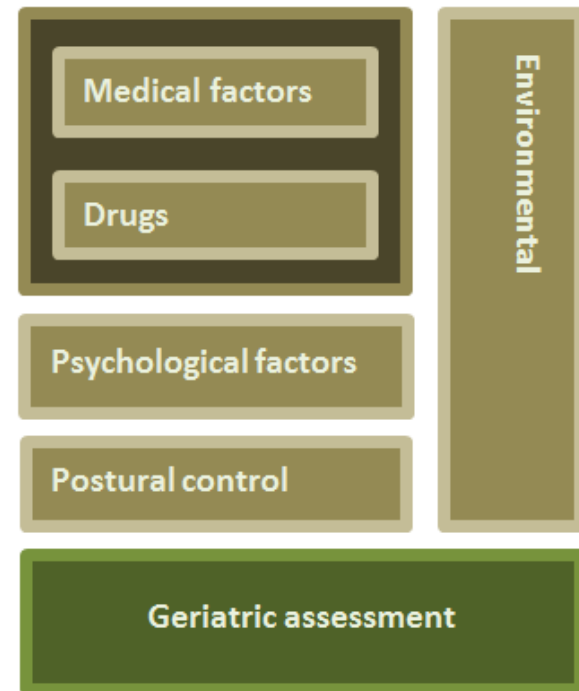
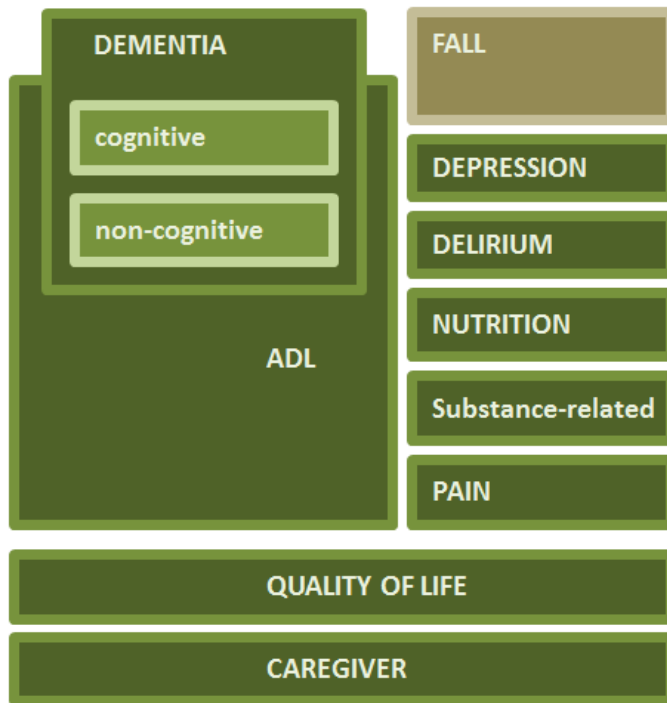
overall scope and structure of classifications and terminologies

gerontology and geriatrics



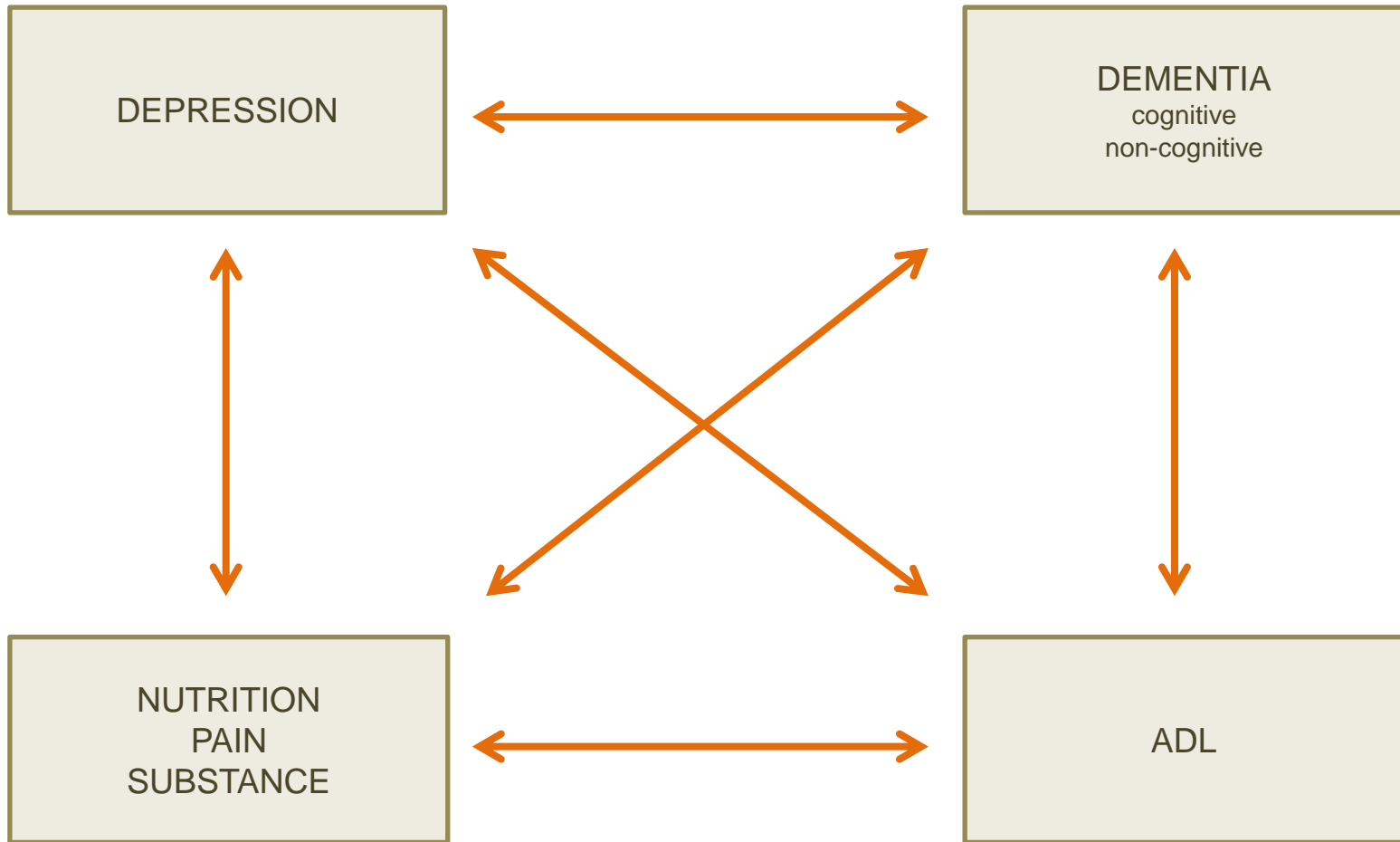


In the case of monitoring and safety in home and residential care environments, **geriatric and fall risk assessment** should be included, and not just a *brief* description, but as a *detailed* one.

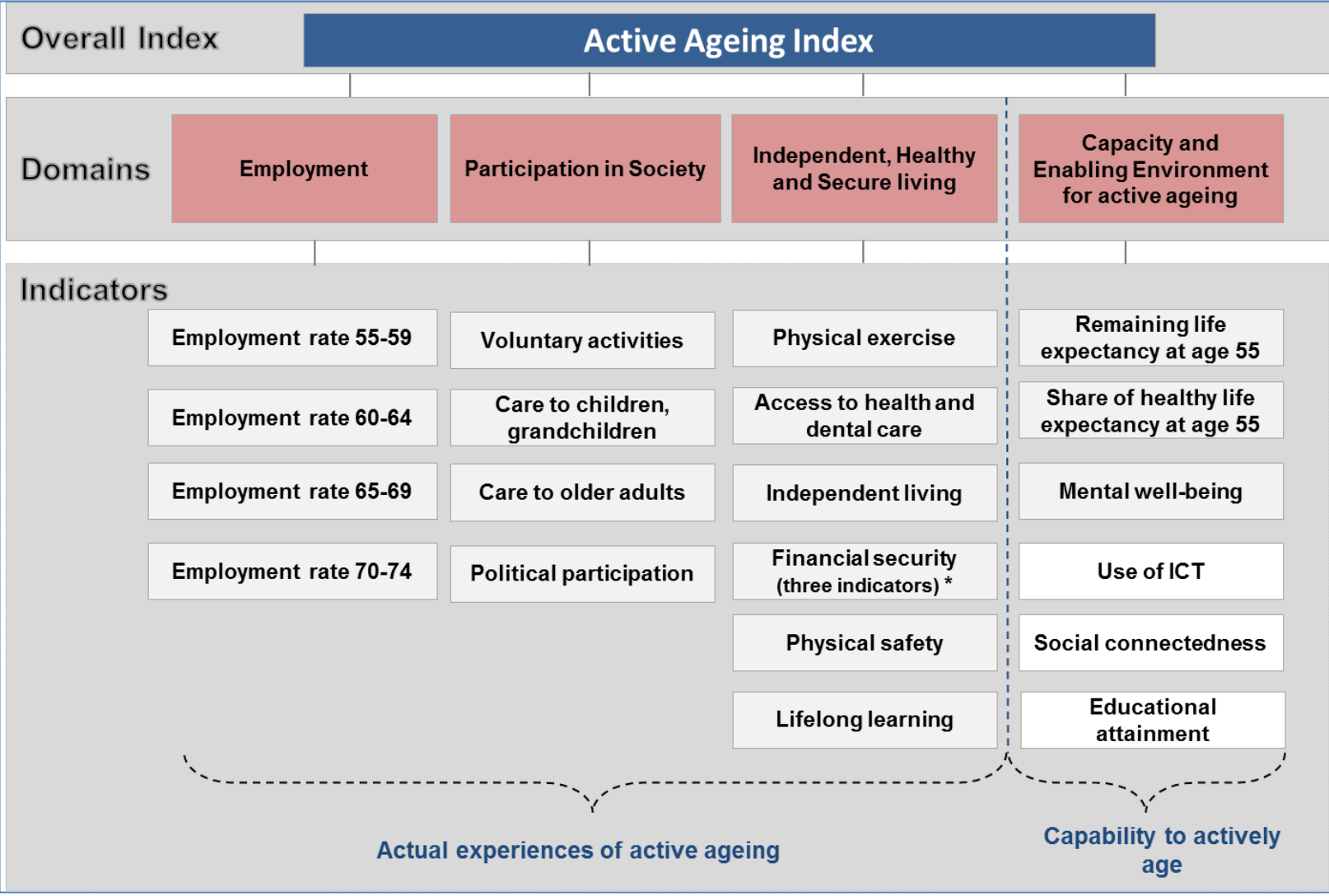


These arrows obviously make sense, but they are not necessarily bidirectional.
There are causal relations, and *iterations*.

There is certainly some **hidden order and causality** geriatrically recognized (even if not uniquely),
but that order, whatever consensus their might be about it, is not logically well defined and described.



AAI is very topdown and quite coarse granular.

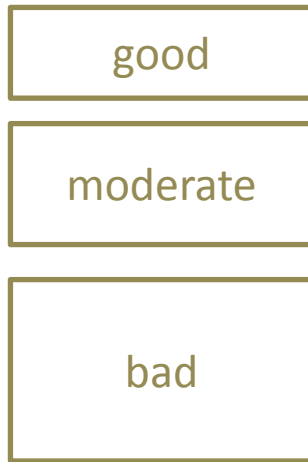


WHODAS (very close to a specific small subset of ICF) and QoL is also very coarse granular.

This is too simple ... without observed data, there will be no assessment

Functioning is ...

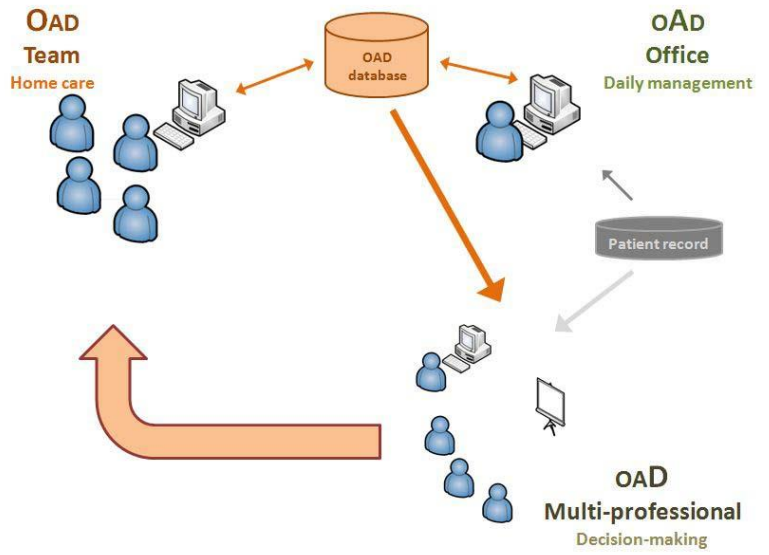
... therefore the care level must be ...



This is better ... as now we do not just have rich data, but also a **common language**.

Multimorbidity,
functioning,
and risk is ...

... therefore we prevent
and intervene like this ...



Observe

Assess

Decide

What is a hip?

Can we *define* it? Does it have a "general-purpose" definition?

Maybe not, and if so, are there "specific-purpose" definitions?

There are so many thousands of hip fractures in country X, and so many in country Y.
Do we have the number of hip fractures in all EU countries?

Yes.

YES! LET US COUNT THEM ALL AND DO SOMETHING ABOUT IT!

What does that number tell us in terms of providing solutions?

Nothing,

or opportunism may say we need more hip implants and pharmacologic treatments of osteoporosis.

We might say the following:

The "condition of the hip" is so and so ...

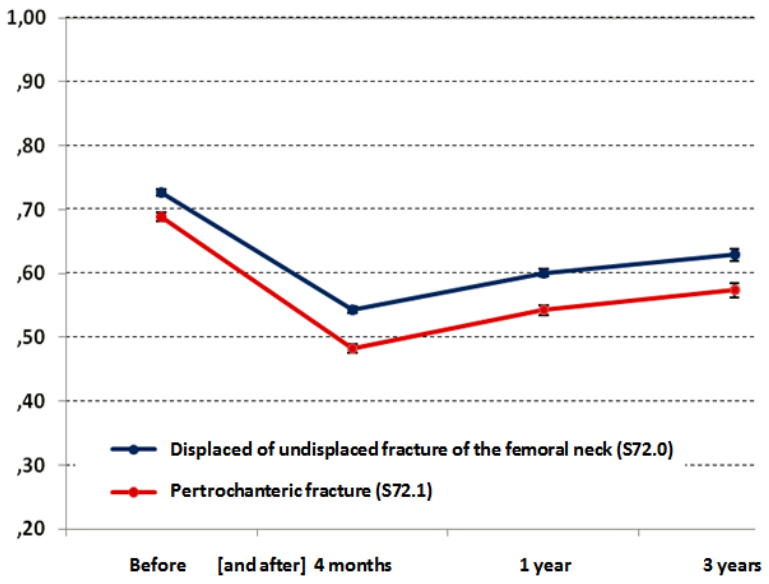
(which codes are used?)

Should we not say the following:

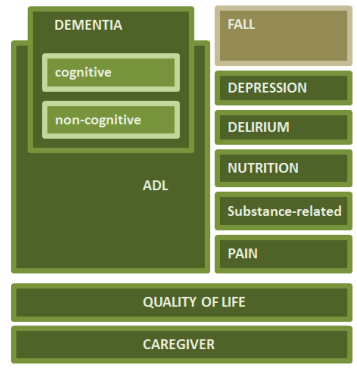
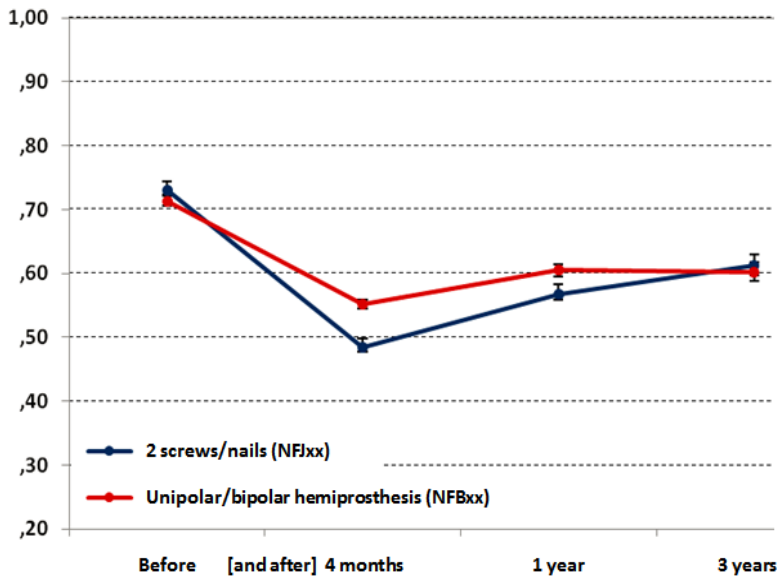
The condition (ICF) of the person having a "hip which is so and so" (ICD) is so and so ...

(which codes are used?)

Quality of life (EQ-5D, 95% KI) before/after hip fracture

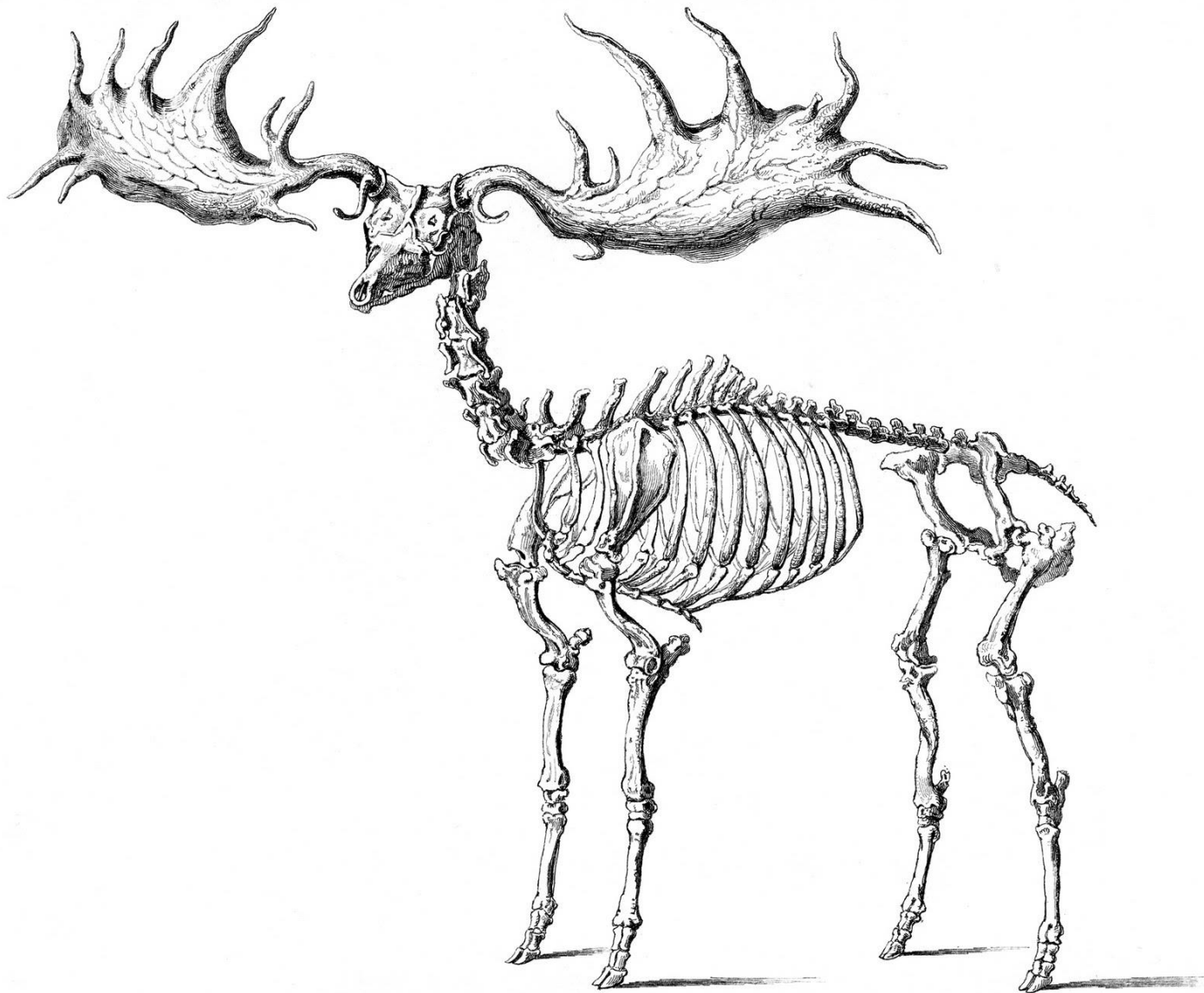


Quality of life (EQ-5D, 95% KI) before/after dislocated fracture of the femoral neck

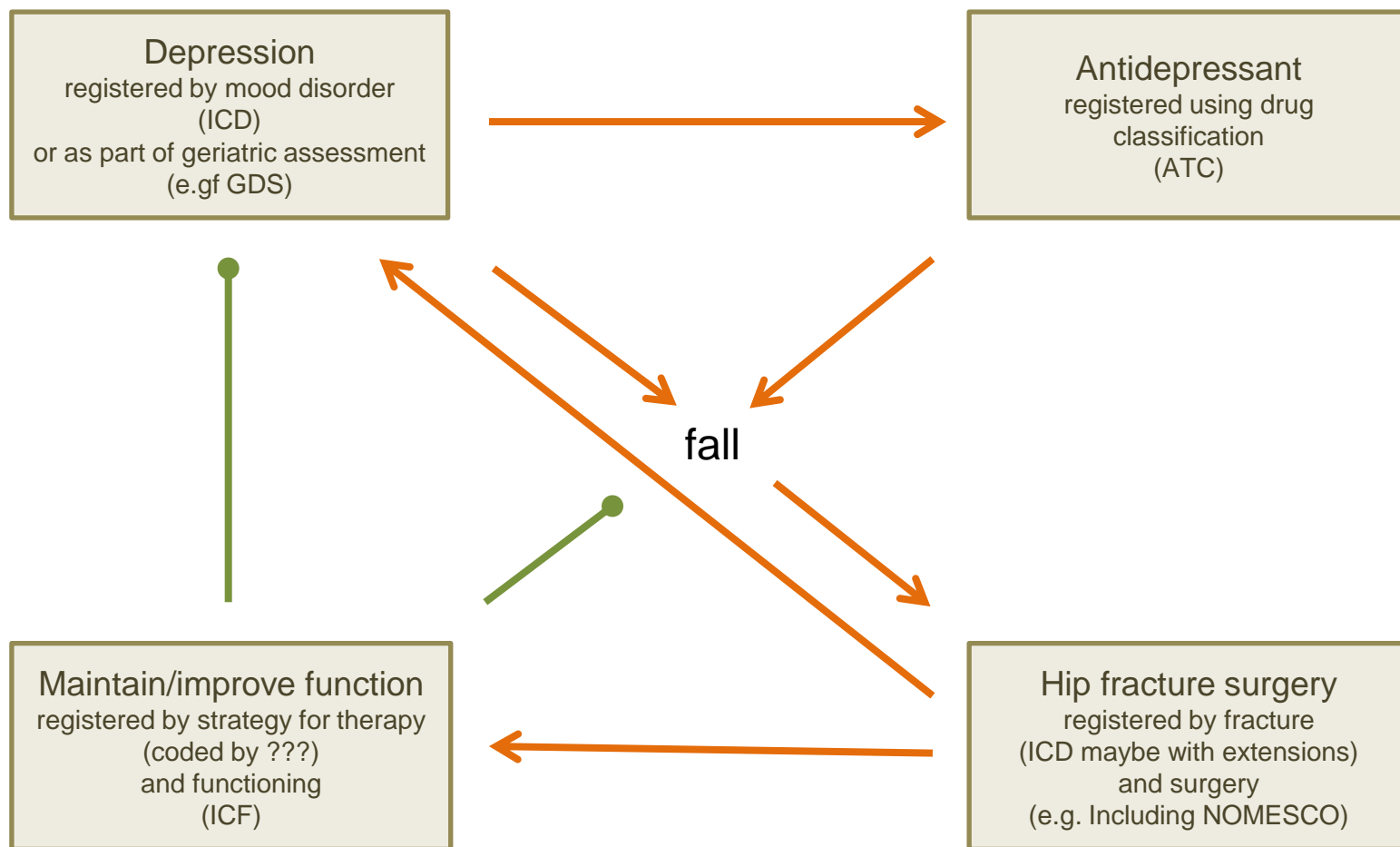


ICD ICF
ATC NOMESCO

They did talk to me about nutrition, but I never followed their recommendations.



Do the arrows make any sense? What do or should the arrows mean? Are there missing arrows?
Is the intuition about these arrows the same across all professionals and stakeholders?
Do the implicit causalities represented by these arrows reflect the way some studies are designed?
Is it really sufficient always just to count *How many?* and then to create *evidence* by comparing means?



Given the order, whatever it is, it means we have to be careful about addition.

If item A "comes before" item B, then for numbers a and b attached to these items, we have to be careful about

$$a + b$$

$$b + a$$

Is addition really the correct operation ?

If not, and we we another operation Ω , then $a \Omega b$ may not be the same as $b \Omega a$!

As logicians say, it's non-commutative.

Non-commutative and, **ncAND**

severe depression **ncAND** moderate memory loss ... remains at severe something ???

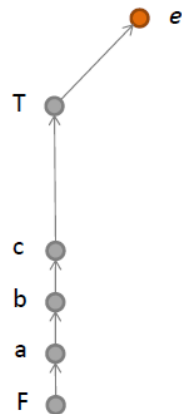
moderate memory loss **ncAND** severe depression ... remains at moderate something ???

The 'not specified' in ICF's generic scale is also interesting.

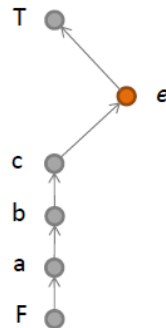
In arithmetics, $2 + \text{'unspecified'} = \text{'unspecified'}$, but MILD **ncAND** 'unspecified' wouldn't necessarily have to be 'unspecified'.

Unknown as unital e with 5-valued set $\{F, a, b, c, T\}$ of **truth values**,
corresponding to the ICF valuations,
including the unknown as 'not specified' (problem qualifier code 8)

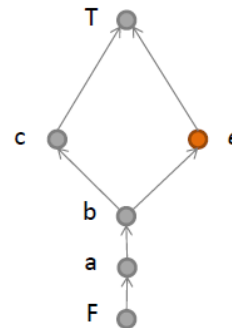
F - a - b - c - T - e



F - a - b - c - e - T



F - a - b - {c | e} - T



$$(3 + 3 + 3 + 3 + 3)/5 = 3$$

"Mean value 3. No variance."

But suppose we have

$$3 = 1+1+1+0+0+0+0$$

$$3 = 0+0+0+0+1+1+1$$

$$3 = 1+0+0+1+0+0+1$$

$$3 = 0+0+1+1+1+0+0$$

$$3 = 0+1+0+1+0+1+0$$

Isn't there then quite a bit of "variability", but another kind as the one statistics uses?

Furthermore, because of order, we may need another algebraic or logical operation.

Is "3 out of 7" really a number?!

Isn't it a logical quantification?

And the generic scale in ICF is logical.

Many-valuedness and logical constructions can model all of this.

Medical information structures can logically be modelled more precisely as compared to statistics.

See e.g.

P. Eklund, M.A. Galán, R. Helgesson, J. Kortelainen, Fuzzy terms, *Fuzzy Sets and Systems* 256 (2014), 211-235.

P. Eklund, The logic and ontology of assessment of conditions in older people, In: *Human-Centric Decision-Making Models for Social Sciences* (Eds. P. Guo, W. Pedrycz), *Studies in Computational Intelligence* (Springer), 502 (2014), 391-400.

P. Eklund, U. Höhle, J. Kortelainen, A Survey on the categorical term construction with applications, *Fuzzy Sets and Systems*, Available online 13 July 2015.

Obviously, it is harder to understand than just simple arithmetics and hypothesis based statistics. However, that should be no justification not to use it.

- GDS-4 :**
- 1. Are you basically satisfied with your life? (NO/yes)*
 - 2. Do you feel that your life is empty? (no/YES)*
 - 3. Are you afraid that something bad is going to happen to you? (no/YES)*
 - 4. Do you feel happy most of the time? (NO/yes)*

When do we observe a 'no' and when do we observe a 'yes'?

What is the quality of that observation?

What is the "quality" or "trustworthiness" of the observer !?!

Should we and/or can we make a distinction between the observer and the observation?

Medically we might say "**no, we should not**". Only the observation, the value, is important.

Logically we say "**yes, we can**". Lack of "trustworthiness" in observation and observer can be accumulated to provide an overall trustworthiness of the final assessment like "GDS-4 = 2/4".

'John' is a 85, with ADL problems and symptoms of depression.
'Patrick' is a home care social worker. 'Cindy' is a general practitioner.

In home care: Patrick making a house call in John's home:

Patrick: *Let me help you with that rollator.*

John: *Yes .. Auhh! .. My knee always reminds me.*

Patrick: *Life treats you ..*

John: *No longer in the best of ways.*

Patrick: *Okey, there you go. Can you move?*

John: *I'll try ..*

In primary care: John visiting Cindy at the health care centre to update his medications:

Cindy: *Okey, these are now your new pills. Be sure always to take them on time.*

John: *Thank you.*

Cindy: *Anything else we can do for you?*

John: *No, thank you, I'm fine.*

Cindy: *Otherwise life treating you well?*

John: *Yes, yes, ... everything is ok.*

GDS-4	1	2	3	4
<i>True</i>	x			x
<i>Probable</i>			x	
<i>Possible</i>		x		o
<i>False</i>	o	o	o	

x Patrick
o Cincy

$$GDS4_{Patrick}^1(John) = True$$

$$GDS4_{Cindy}^4(John) = Possible$$

Which one of the observers, $GDS4_{Patrick}$ or $GDS4_{Cindy}$ is more "trustworthy" in producing the overall observation

$$GDS4_{Observer}(older_person)$$

and how should we logically accumulate the many-valued 'local' truth to 'global' truth?

MORE EXAMPLES ...

Tranquilizers/Sedatives

What does that mean? When we say "YES" to "Tranquilizers/sedatives?", e.g. in Downton's Fall Risk Index, what does that "YES" mean?

It could mean

"Yes, the patient was half a year ago prescribed a drug in the therapeutic group "N05C hypnotics and sedatives".

or

"Yes, the patient has been using a long-acting drug for insomnia, a "N05CD benzodiazepine derivative", more precisely, a "N05CD02 nitrazepam".

or something else.

What if one study says "sedative" is "benzodiazepine derivative", and another involving a larger selection of sedatives, **how do we compare these studies?**

We don't. Unless studies are more specific about typing their information.

F00 (Alzheimer dementia)
S72 (femur fracture)

If we have 1 F00, how certain is that 1?

If we have 1 S72, how certain is that 1? Is it more certain than the 1 on 1 F00?

If we have 25 out 100 Alzheimer dementia cases, how certain is '25'?

$$100 = \overbrace{1 + 1 + \dots + 1}^{25} + \overbrace{0 + 0 + \dots + 0}^{75}$$

If 1 F00 is 90% certain, then 25 F00 is only 7% ($0,9^{25}$) certain ?!?!?

That is, assuming that 1 not F00 is 100% certain.

Yet another fundamental difference between logic and statistics

If we know 2 and 3, appreciating that we know both 2 and 3, and we also want the sum $2 + 3 = 5$, what should we store for future use?

2 +3 or 5?

If we store 5, we will ignore it came from 2 and 3, since 5 could have come from 1 and 4 as well. If we store $2 + 3$, we can still retrieve both 2 and 3, and, when can computer 5 from 2 and 3. So why do we store just 5?

Every time we add information, we hide information!
Summation hides individual in population!

9 orientation + 4 registration and recall + ... = 22 MMSE ?

This is fine, but the left-hand side is more informative.

3 GDS-4 + 22 MMSE + 4 Hackinski + hypertension treatment + ... = **X** ?

There are those who desperately want to compute X.

Using only arithmetics (and mean) as fundamental operations, means that **statistics is untyped** (because a random variable is untyped!), but also very remote from logical constructions.

'Not applicable' in ICF's generic scale is added because it intuitively means "types of data are not comparable in some sense".

'Evidence' in evidence-based medicine is not a logical notion.

Numbers stating that a null hypothesis has been rejected cannot be enough for use in a rule base implementing a guideline.

The 'language' of hypothesis testing is statistics.

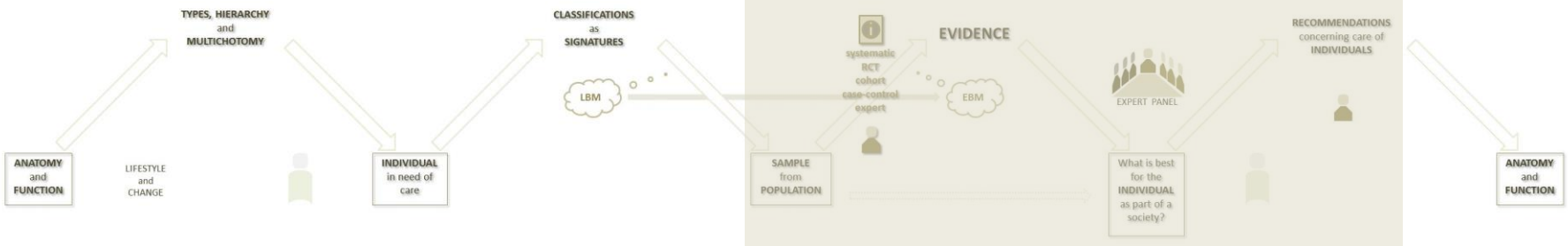
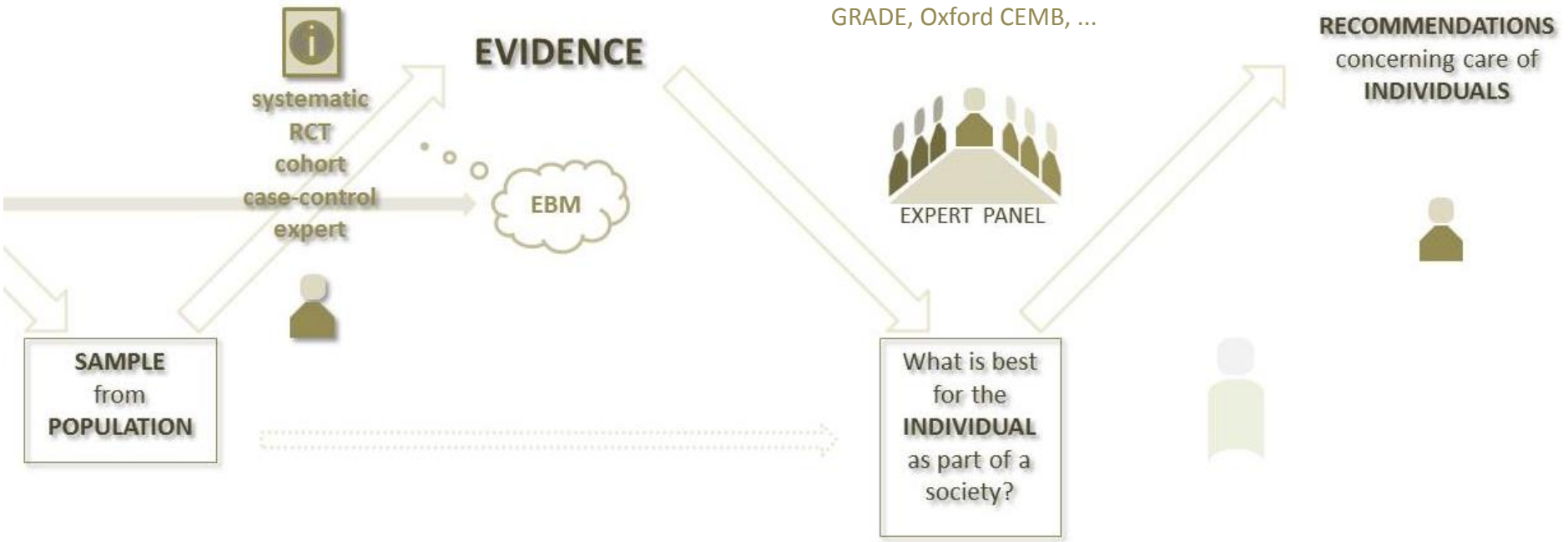
The 'language' of guidelines and recommendations is logic.

Statistical "evidence" must be converted to many-valued logical truth. Otherwise guidelines have no logical meaning.

Further, **information** and **process** must be intertwined (but 'process' is outside the scope of this presentation).

We need logic-based medicine.

Without it we will never be able to create EU or EUGMS databases for AHA analytics purposes.



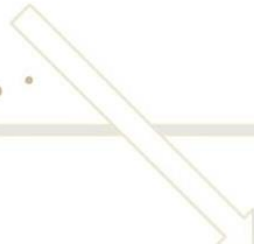
TYPES, HIERARCHY
and
MULTICHOTOMY



INDIVIDUAL
in need of
care



CLASSIFICATIONS
as
SIGNATURES



SAMPLE
from
POPULATION

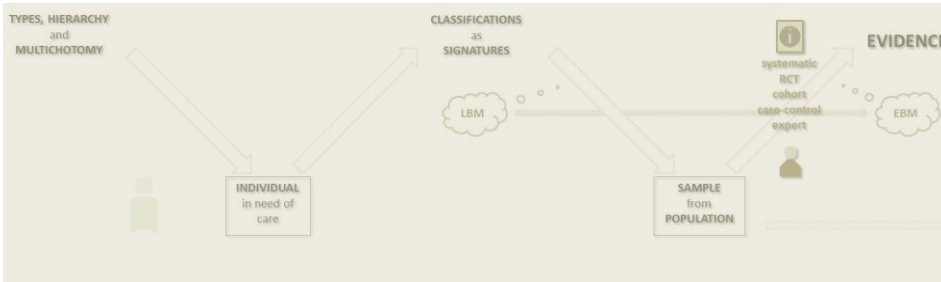


EVIDENCE



ANATOMY
and
FUNCTION

LIFESTYLE
and
CHANGE



TYPES, HIERARCHY
and
MULTICHOTOMY

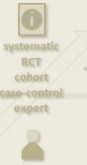


INDIVIDUAL
in need of
care

CLASSIFICATIONS
as
SIGNATURES



SAMPLE
from
POPULATION



EVIDENCE



What is best
for the
INDIVIDUAL
as part of a
society?



RECOMMENDATIONS
concerning care of
INDIVIDUALS

ANATOMY
and
FUNCTION

harmonize existing national and regional guidelines

Variety of detail and lack of common language across national fall prevention programmes

No harmonization even if fall and fall injury risk is equally understood.

Granularity is very different across and even within guidelines.

Some countries have national/regional databases, others not.

Some countries are nationally active with broad and detailed guidelines.

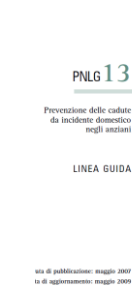
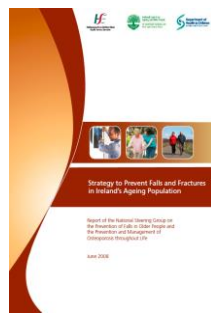
Sometimes detailed guidelines are more intervention oriented.

Other countries produce national guidelines but with less ambition and detail.

In some countries, some regions may be even more active as compared to national ambitions.

Outside Europe, Australia is particularly active fall prevention.

Common to all guidelines is that **classifications and nomenclatures are missing**, and they provide basically **no support for potential structuring of national databases** to support fall prevention.



Sturzprophylaxe bei älteren Menschen in ihrer persönlichen Wohnumgebung

Katrin Balzer, Martina Bremer, Susanne Schramm, Dagmar Lühmann,
Heiner Raspe

Das vorliegende Studienmaterial gibt Hinweise darauf, dass ein **Absetzen psychotroper Medikamente** bei älteren, in der eigenen Häuslichkeit lebenden Personen die Anzahl der Stürze verringern könnte, ebenso die Überprüfung der Medikation bei Bewohnern von Pflegeeinrichtungen. Die Aussagen sind jedoch unter Vorbehalt zu sehen, da die **methodische Qualität der Studien nicht überprüfbar** und damit das Verzerrungspotenzial auf die Ergebnisse nicht abschließend einschätzbar ist. In der Arbeit von Zermansky et al.³⁶⁴ wird eine Intervention eingesetzt, die mit dem Versorgungskontext in deutschen Pflegeheimen derzeit nicht kompatibel ist. Angesichts der Höhe der beobachteten Effekte und der klinischen Plausibilität der Maßnahme besteht hier sicher Forschungsbedarf, der einerseits klinisch relevante Endpunkte (vor allem sturzassoziierte Verletzungen) fokussieren und andererseits den Kontext des **deutschen Versorgungssystems berücksichtigen sollte**.

Strategy to Prevent Falls and Fractures in Ireland's Ageing Population

Report of the National Steering Group on the Prevention of Falls in Older People and the Prevention and Management of Osteoporosis throughout Life

June 2008

Intrinsic:

Muscle weakness
History of falls
Gait and balance deficits
Visual deficit
Arthritis
Depression
Cognitive impairment
Age >80 years
Urinary incontinence
Orthostatic or postprandial hypotension
Dizziness
Fear of Falling
Limited activity (Institutional setting)
Hearing (Institutional setting)

Environmental:

Environmental hazards
Home hazards

Extrinsic:

Use of assistive devices
Impaired ADL (activities of daily living)
High level of activity (Community setting)
Medication:

- Polypharmacy
- Psychotropic drugs
- Class 1a antiarrhythmic medications
- Digoxin
- Diuretics

The logo for the National Program for Guidelines (PNLG) features the acronym 'PNLG' in a bold, serif font. To the right of the text is a stylized green arrow pointing to the right, with a curved tail.

Programma nazionale
per le linee guida

DOCUMENTO 13
maggio 2007

Prevenzione delle cadute da incidente domestico negli anziani

Raccomandazioni

III/A

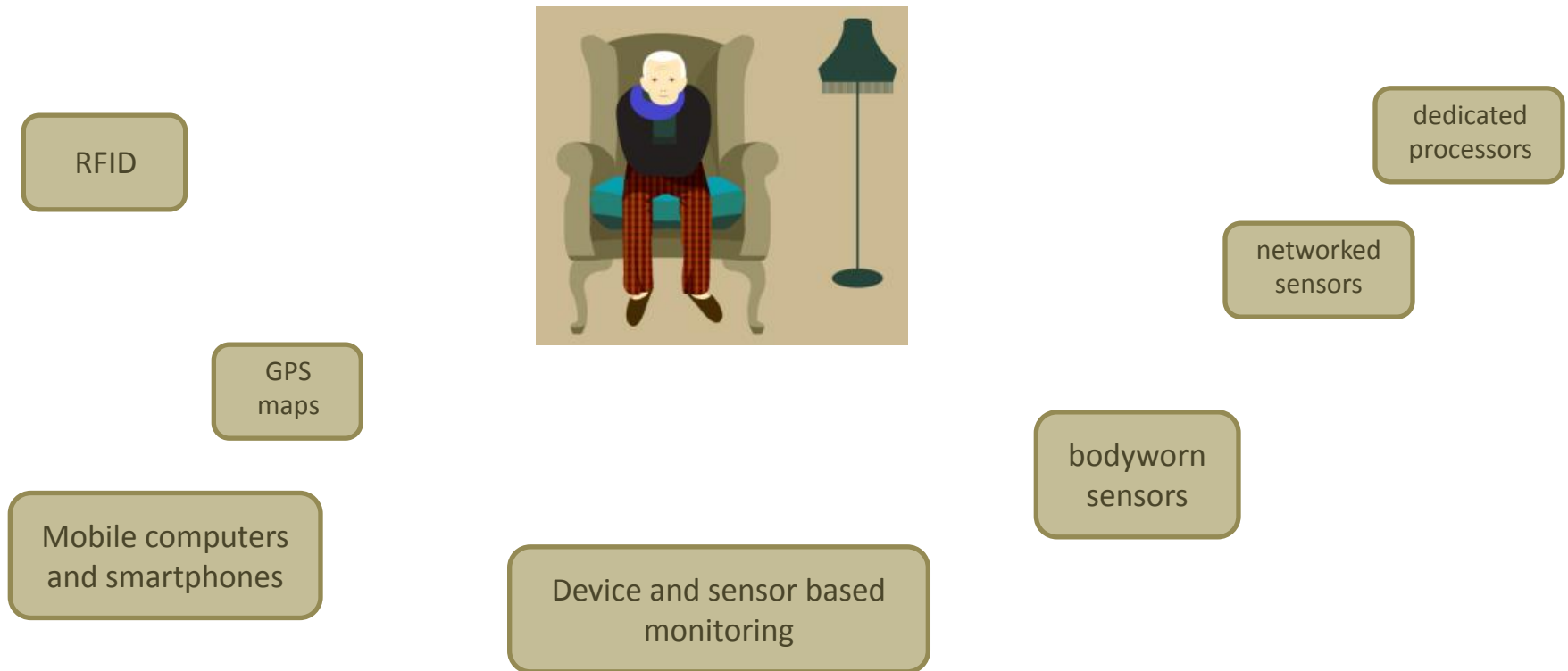
Interrogare gli anziani sulle terapie assunte e tenere sotto rigido controllo i farmaci somministrati.

III/A

Rivedere periodicamente le prescrizioni farmacologiche, con particolare attenzione all'assunzione di farmaci quali benzodiazepine, antidepressivi o all'assunzione simultanea di tre farmaci. Ove possibile, rimodulare tali prescrizioni al fine di ridurre l'esposizione al rischio.

device and electronic approaches

Engineers will continue to promote this approach forever.
It will provide some support but it is not in itself a global solution.



personalized prevention guideline

Efficacy is personalized, and information modelling requires logic.
Effectiveness is for populations, and “proofs” are only statistical.

Who will/should build the EU Personalized Fall Prevention Guideline?

EUGMS!, I hope. I will be happy to help you with all the formal and mathematical logic you may need.

Efficacy involves "idealism and control". Efficacy studies involve a more precise description of the targets, i.e., where the 'population' is specified by the 'individuals', not the other way around, where the 'individuals', given rather quite unspecified exclusion/inclusion criteria, are very loosely bound to that population. Efficacy studies are said to involve highly controlled conditions, but these "conditions" are seldom strict and highly controlled from information structure and classification utility point of view. Efficacious interventions must not just be effective in clinical practice, but they need to be effective for the individual. This is the very foundation of successful PHC.

Effectiveness studies are seen successful and as delivering "evidence" if they can demonstrate to have reached certain statistical thresholds given hypothesis testing given populations. Individuals can seldom be recovered in such populations, and an individual qualifies more or less as a "member" of that population. However, an intervention based on a effectiveness study is usually targeted to a individual as member of the population rather than as an individual with specific individual characteristics.