

GNU Health: 10 Years of Freedom in Healthcare



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GNUHealthCon 2018
Nov 21-23, Las Palmas de Gran Canaria

Luis Falcón Martín
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GNU Health : Freedom and Equity in Health

GNU Health is, first and foremost, a Social Project

...with really cool technology



About GNU Solidario

“Delivering Health and Education with Free Software”



GNU Solidario first project :Santiago del Estero, **Argentina, 2006**

GNU Health

The Free Health and Hospital Information System. (health.gnu.org)

GNUHealthCon - IWEEE

International Workshop on E-Health in Emerging Economies.



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GNU Health : Functionality



Person and Community

- Person, families
- Domiciliary Units, Health Institutions,
- Socioeconomics, lifestyle...

Patient

- Medical history, Evaluations, appointments
- Genetics & family history
- Prescriptions...

Health Institution Management

- Finances, Billing
- Stock Management , pharmacies
- Hospitalizations, Inpatient, EMS, LIMS...

Health Authorities / MoH

- Reporting, epidemiology
- Health campaigns
- Federation, distributed health networks...



GNU Health is Free/Libre Software

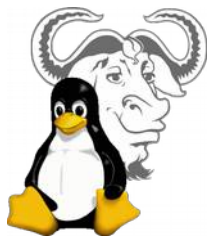
Freedom to run , adapt, improve and redistribute

Official GNU Package, from the Free Software Foundation

Open Documentation

Relies on free technology

International community



From rainforest clinics



<http://health.gnu.org>



To the Largest Public Hospital in Asia



All India Institute of Medical Sciences
chooses GNU Health.



All India Institute of Medical Sciences, AIIMS

Largest public health hospital in Asia



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National Public Health Systems



GNU Health & World Health Organization



MDG6 : Malaria, TB, HIV
Essential list of medicines
Neglected Tropical Diseases
Immunization schedules

ICD-10 ICPM

MDG4 : Reduce Child mortality

Pediatric growth charts



The Academia



United Nations University, Kuala Lumpur, Malasia



University of Entre Rios, Argentina

HST.936: Global Health Informatics to Improve Quality of Care

The 2015 iteration of our course will focus on **Public Health Emergencies and Humanitarian Crises**.

Classes begin: February 6, 2015
Fridays 9am - 11am ET (GMT -5)
Room: 09-057



Harvard / MIT, Boston, United States



Insolàfrica



UNIVERSIDAD DE CIENCIAS MÉDICAS
Matanzas

Univ. Matanzas, Cuba



Univ. Palermo, Italy



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GNU Health Alliance of Academic and Research Institutions



GNUHealth

ALLIANCE
OF ACADEMIC AND RESEARCH INSTITUTIONS



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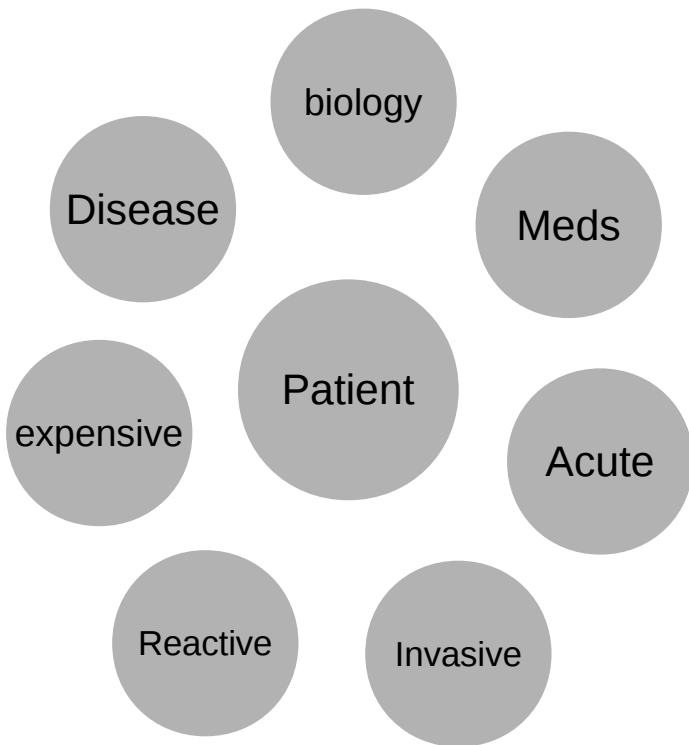
Nature + Nurture

Precision Medicine
=
Personalized Medicine



GNU Health : Nature and Nurture

Current System of Disease
(reductionist)



"GNU" System of Health
People before patients



health.gnu.org



Genes load the gun, environment pulls the trigger



Genetically identical !

Epigenetics

"Before, genes predetermined outcomes.

*Now everything we do—
everything we eat or smoke
—can affect our **gene**
expression and that of future
generations.*

Dr Randy Jirtle
("agouti sisters")



"Epidemics of Unjustice"

Tuberculosis : $\frac{1}{3}$ of the world infected . **Who gets sick ?**

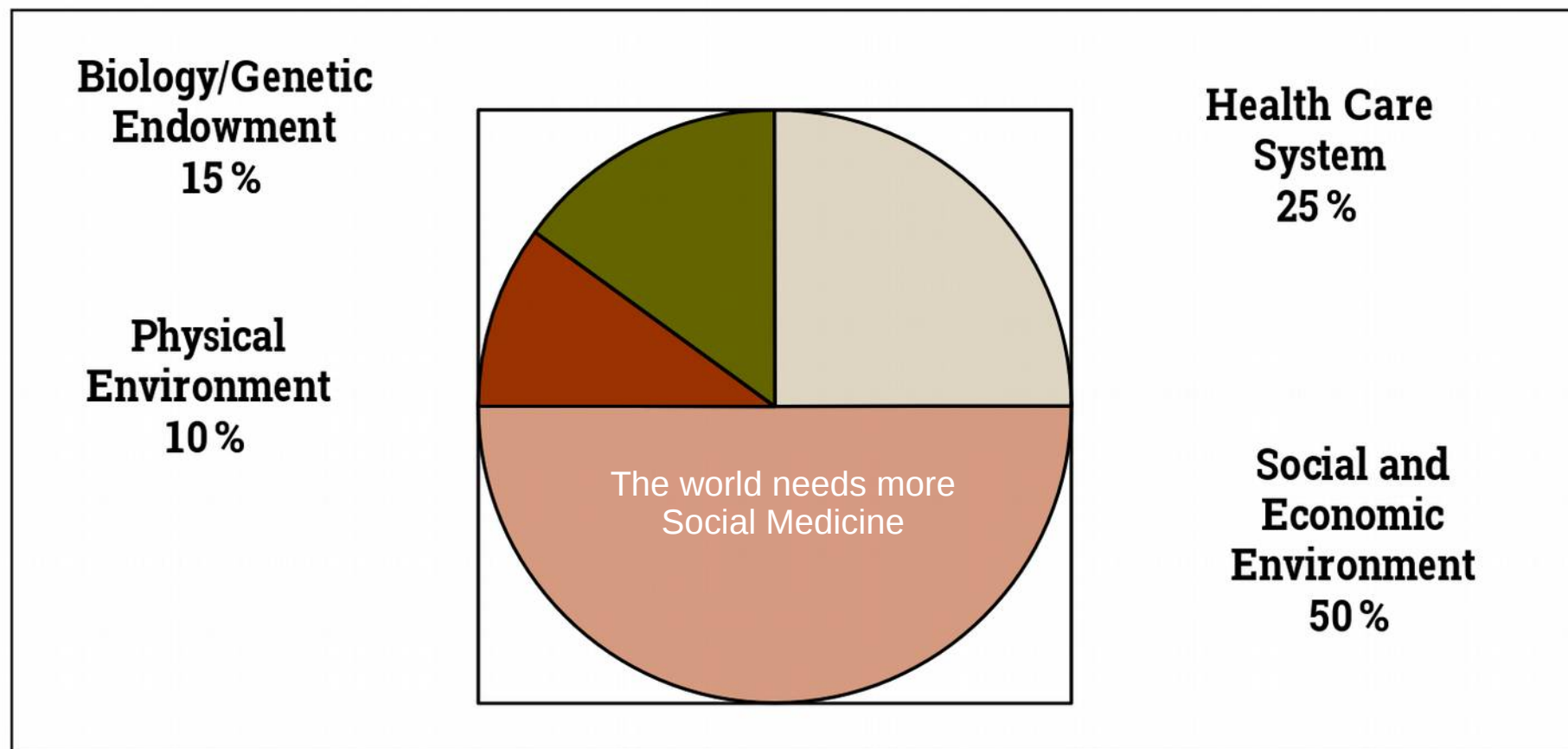


"(Claude) Bernard avait raison. Le germe n'est rien, c'est le terrain qui est tout."
Louis Pasteur

"Epidemics of Unjustice" Dr. José Caminero



Impact of Determinants of Health



Source: Canadian Institute for Advanced Research, Health Canada, Population and Public Health Branch AB/NWT 2002.



Medical and Family History

GNU Health - localhost - Administrator - GNU SOLIDARIO HOSPITAL [ksh]

Connection User Options Favorites Window Help

Obstetric Histories Patient

Patient 1/1

Main Info

Ana Betz

Critical Information

Z88.0 : Personal history of allergy to penicillin
 Z88.0 : Personal history of allergy to penicillin
 E10 : Type 1 diabetes mellitus
 A90 : Dengue fever [classical dengue]
 A40 : Streptococcal sepsis

Disabilities / Barriers:

General Info Functioning and Disability OB/GYN S

Main Misc

GP: Cordara, Cameron Family

Conditions

Condition	Status
Z88.0 : Personal history of allergy to penicillin	unchanged
E10 : Type 1 diabetes mellitus	chronic
A90 : Dengue fever [classical dengue]	acute
A40 : Streptococcal sepsis	

Notepad

DoB: 08/28/1980 PUID: 55567890 Blood Type: A Hospitalized: Hb: Active:

PAT ANA Connected

Name : Betz, Ana
 DoB : 1985-10-04
 Blood Type : A +

Female Critical Info : T1D

Field 1	Field 2	Field 3	Field 4	Field 5
...
...



Some data generating commands

Main GNU Health Commands

Command	Description
CMD	GNU Health Commands
PPL	Demographics
PAT	Patients
SYSINFO	Technical information for client and server
LAB	Lab Test Results
FEDQ	Federation objects queue
MED	Patient Medicaments
APP	Appointments
SES	Socioeconomics and Family Functionality Assessment
DU	Domiciliary Units
HP	Health Professionals
RX	Prescription Orders
EVL	Patient Evaluations
ECG	Electrocardiograms
RCRI	Revised Cardiac Risk Index

Main GNU Health Commands

Command	Description
DX	Health Conditions
POL	Pages of Life
GEN	Personal Genetic Info
NEO	Newborn / Neonatal Information
OBS	Obstetric histories
SRV	Patient Health Services
SUR	Surgeries
MI	Medical Imaging Results
INV	Invoices
PRD	Products
CMD	GNU Health Commands
GDIS	Disease Genes
VAR	Natural variants
VARP	Natural variant phenotypes
PDIS	Protein related diseases



GNU Health & Molecular basis of Health and Disease

The image displays two windows from the GNU Health application. The left window, titled 'Variant Phenotypes', shows a table with columns for 'Gene & Protein', 'Variant', and 'Phenotype'. The right window, titled 'VMD 1.9.4a12 OpenGL Display', shows a 3D molecular model of a protein structure with various atoms represented by colored spheres.

Gene & Protein	Variant	Phenotype
BRCA1 (P38398):breast cancer 1, early onset	VAR_007778 : p.Thr1025Ile	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_007781 : p.Val1047Ala	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_007782 : p.Pro1150Ser	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_007796 : p.Ala1708Glu	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_007799 : p.Met1775Arg	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_020679 : p.Glu10Lys	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_020680 : p.Glu23Lys	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_020683 : p.Asp749Tyr	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_020690 : p.Ser1187Ile	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_020691 : p.Gln1200His	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_020692 : p.Arg1204Ile	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_020693 : p.Lys1207Asn	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_020695 : p.Ser1217Tyr	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_063212 : p.Met1775Lys	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_075666 : p.Arg1699Trp	DI-02602:Breast cancer
BRIP1 (Q9BX63):BRCA1 interacting protein C-t	VAR_020896 : p.Pro47Ala	DI-02602:Breast cancer
BRIP1 (Q9BX63):BRCA1 interacting protein C-t	VAR_020900 : p.Met299Ile	DI-02602:Breast cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_007757 : p.Cys61Gly	DI-01655:Ovarian cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_020702 : p.Cys1697Arg	DI-01655:Ovarian cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_075666 : p.Arg1699Trp	DI-01655:Ovarian cancer
BRCA1 (P38398):breast cancer 1, early onset	VAR_020679 : p.Glu10Lys	DI-01559:Breast-ovarian cancer, familial, 1
BRCA1 (P38398):breast cancer 1, early onset	VAR_020680 : p.Glu23Lys	DI-01559:Breast-ovarian cancer, familial, 1
BRCA1 (P38398):breast cancer 1, early onset	VAR_020690 : p.Ser1187Ile	DI-01559:Breast-ovarian cancer, familial, 1
BRCA1 (P38398):breast cancer 1, early onset	VAR_020691 : p.Gln1200His	DI-01559:Breast-ovarian cancer, familial, 1
BRCA1 (P38398):breast cancer 1, early onset	VAR_020695 : p.Ser1217Tyr	DI-01559:Breast-ovarian cancer, familial, 1
BRCA1 (P38398):breast cancer 1, early onset	VAR_020696 : p.Phe1226Leu	DI-01559:Breast-ovarian cancer, familial, 1
BRCA1 (P38398):breast cancer 1, early onset	VAR_020697 : p.Arg1243Gly	DI-01559:Breast-ovarian cancer, familial, 1
BRIP1 (Q9BX63):BRCA1 interacting protein C-t	VAR_023700 : p.Gln255His	DI-01603:Fanconi anemia complementation gr
BRIP1 (Q9BX63):BRCA1 interacting protein C-t	VAR_023702 : p.Ala349Pro	DI-01603:Fanconi anemia complementation gr
BRIP1 (Q9BX63):BRCA1 interacting protein C-t	VAR_023703 : p.Trp647Cys	DI-01603:Fanconi anemia complementation gr
BRIP1 (Q9BX63):BRCA1 interacting protein C-t	VAR_023704 : p.Arg707Cys	DI-01603:Fanconi anemia complementation gr

```
File Edit View Bookmarks Settings Help
Info) Angles: 0 Dihedrals: 0 Impropers: 0 Cross-terms: 0
Info) Bondtypes: 0 Angletypes: 0 Dihedraltypes: 0 ImproperType
Info) Residues: 224
Info) Waters: 3
Info) Segments: 1
Info) Fragments: 5 Protein: 2 Nucleic: 0
0
```



GNU Health Genetics



Personal genetic information & family history

Disease genes

Over 29,000 Natural Variants & their phenotypes

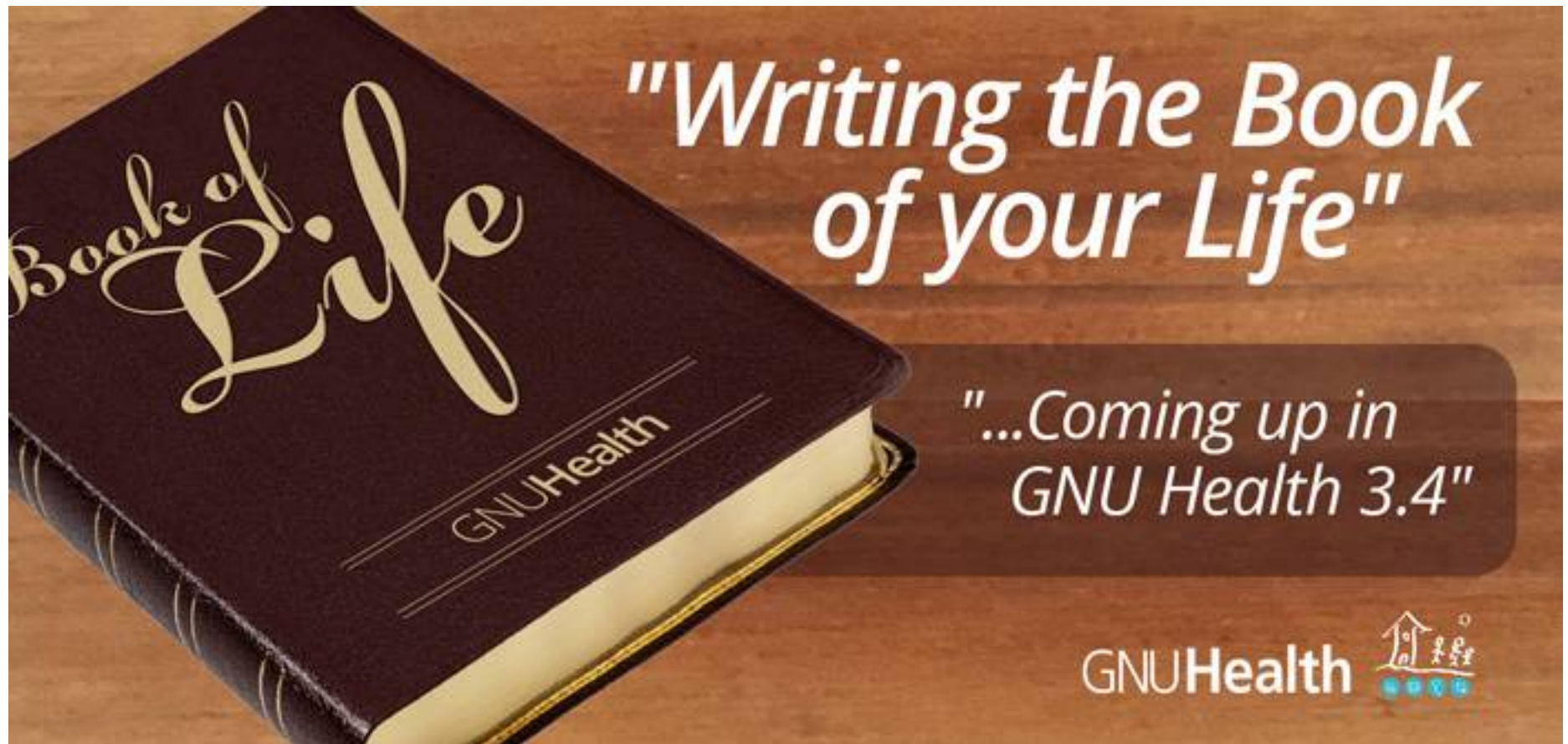
Protein related diseases from Uniprot

Linked to protein code, MIM code, Acronyms and descriptions

Integrated to the person “Book of Life”



Book of Life



GNU Health Integrative Medicine: Nature + Nurture

“GNU” System of Health
Holistic, proactive, transdisciplinary



Our life is much more than cold medical records



Book of Life

Made of “Pages of Life”

Each page represents a relevant event in on a person life

Types of pages: ***Demographical, Medical, Biographical and Social***

With their own categories, for instance :

- * **Social** : Exclusion, Stress, lifestyle, family, violence, food, ...
- * **Medical** : Health condition, encounter, genetics, lab, surgery,...

Linked to HMIS processes (evaluations, health conditions, genetics...)

Easy to write and read by health professionals and patients

Easy to process by machines (industry and health coding standards)

Integrates and contextualizes the information



Sample entry related to Genetics



BRCA1

Federation Account : ESPGNU777ORG

Gene : BRCA1 (breast cancer 1, early onset)

Locus : 17q21

Protein code : P38398 . **URI :** <https://www.uniprot.org/uniprot/P38398>

Natural variant : VAR_007757 // **p.Cys61Gly**

Phenotypes: DI-02602: **Breast Cancer** . MIM Code : 114480

DI-01655: **Ovarian Cancer** . MIM Code: 167000

Onset age : -

Family history: **Mother :** C50.1 Malignant neoplasm central portion of the breast

Grandfather (maternal): Q87.4Marfan Syndrome

Medical History: **Type 1 Diabetes (7y) / allergic to β -lactams // appendectomy (13y)**

Lifestyle: Ex-smoker //...

GNU Health - localhost - Administrator - GNU SOLIDARIO HOSPITAL [EUR]

Connection User Options Favorites Window Help

Patients Pages of life Gene variant 2 / 33

Gene variant

Gene and Protein: BRCA1 (P38398) :breast cancer 1, early onset **Protein Variant:** VAR_007757

Change: p.Cys61Gly

Phenotypes

Gene & Protein	Phenotype
BRCA1 (P38398) :breast cancer 1, early onset	DI-02602:Breast cancer
BRCA1 (P38398) :breast cancer 1, early onset	DI-01655:Ovarian cancer

var Connected



Human readable, machine readable



BRCA1

Browser address bar: <https://federation.gnuhealth.org:8443/pols/ESGNU777ORG/9b04958d-c4cc-4c05-b8bf-93f7232194a8>

JSON Raw Data Headers

Save Copy Collapse All Expand All Filter JSON

```
{
  "_id": "9b04958d-c4cc-4c05-b8bf-93f7232194a8",
  "age": "",
  "author": "Dr. Cameron Cordara",
  "book": "ESPGNU777ORG",
  "creation_info": {
    "node": "SPAIN-LASPALMAS-GNUSOLIDARIO-GRAL_HOSPITAL",
    "timestamp": "2018-11-13 16:52:50.309425",
    "user": "ITPYT999HON",
    "gene": "BRCA1 (P38398) :breast cancer 1, early onset",
    "medical_context": "genetics"
  },
  "modification_info": {
    "node": "SPAIN-LASPALMAS-GNUSOLIDARIO-GRAL_HOSPITAL",
    "timestamp": "2018-11-13 16:57:03.072608",
    "user": "ITPYT999HON"
  },
  "natural_variant": "p.Cys61Gly",
  "node": "GNU SOLIDARIO HOSPITAL",
  "page_type": "medical",
  "relevance": "important",
  "summary": "Susceptibility :Mother : C50.1 Malignant neoplasm central portion of the breast"
```



Tackling current challenges in Precision Medicine

Most systems and databases work in **isolation**

Study both **genetic** and **environmental** factors

- * Socioeconomic determinants of Health
- * Medical history
- * Genetic information
- * Family history



Some natural variants are clearly pathogenic, but ...

There are **many natural variants of unknown clinical significance** .

The more *“Pages of Life”* we collect globally, the better prediction about the risk on a particular gene / protein variant.



Federation Community Hub



Community public server in Munich

Demo and test environment

Main Federation components:

- * **HMIS node and PostgreSQL**
- * **Thalamus** message server
- * **MongoDB** backend
- * **openSUSE** Leap OS

The GNU Health Federation Community Hub allows developers, **health practioners and research institutions** from all over the world to learn, test and develop their nodes to integrate them in the Federated network.



One World, One Health

Welcome to the GNU Health Federation



Let's build the largest, community-based federated health network



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Challenges to discuss

Privacy : **Proprietary Software** & operating systems are **black boxes**

Who owns your data? **Who has access to** your medical information ?

Too much technology and sophistication of medicine are **displacing** the Human Factor and Medical Humanism

Health is not a business, but a
NON-NEGOTIABLE Human Right

Need **universal** Public Healthcare

