

#### A European model for the Automatic Production of Standardized Performance Indicators: the BIRO statistical engine

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# The problem

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  - Performance reports have become common practice to benchmark and leverage quality, equity and efficiency in health systems
  - The methodology applied is frequently advanced and results are not easy to interpret for policy makers.
  - New tools to facilitate the uptake of performance results are increasingly sought at all levels
  - International comparisons are hampered by the lack of standardized data and the absence of procedures/software to constantly and automatically check the quality and management of the existing data sources







### Theory: Conceptual Model Practice: Multidimensional sets of Indicators



#### BIR D



# Quality of Care in Diabetes

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[IDF Diabetes Atlas, Fourth Edition, 2009]

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**2004-2008:** >1,500 publications on quality of care

- Multicentric data in a single country
- Analysis on a single centre
- Only N=3 studies comparing quality across countries

#### 1999-2003: sample of 50% papers:

N=5 internazional studies

#### OECD "Health Care Quality Indicators Project" N=9 diabetes indicators originally identified

- N=2 computed:
  - Annual eye examination, Amputation rates











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#### [IDF Diabetes Atlas, Fourth Edition, 2009]



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"So, why is it that there is a large number of studies of diabetes care within countries, many based on multiple sites, yet so few international comparisons? The simple answer is lack of consistently applied standards that would enable international comparisons. Standard systems and definitions, applied to comparable populations result in data that can be collected and compared relatively easily. The more unified systems are, the easier these comparisons become."









#### Data Sources of Performance Indicators

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#### Linked Administrative Data



**Clinical Databases** 



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Epidemiological Studies









# Unified model: cathedral or bazaar?





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# Mixed models





L'Aquila – Piazza Duomo







#### **Best Information** through Regional Outcomes (BIRO) 🦉 🔍 📧 🛞 Tisp 🧹 💯 🕍 $(\mathbf{O})$

- BIRO project (2005-2009): DG-SANCO co-funded project in diabetes
- Aim: to provide European health systems with an ad hoc, evidence and population-based diabetes information system
- EUBIROD project (2008-2011) builds upon BIRO
- Aim: "to implement a sustainable European Diabetes Register through the coordination of existing national/regional frameworks and the systematic use of the BIRO system in 20 European countries







#### Coordination rather than unification: a pragmatic model



# **BIRO** Diabetes Core EU Dataset

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#### N=48

1. ID Patient

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- 2. ID Centre
- 3. Type of Diabetes
- 4. Sex
- 5. Date of Birth
- 6. Date of Diagnosis
- 7. Episode Date
- 8. Smoking Status
- 9. N.Cigarettes (x day)
- 10. Alcohol Intake (g/x day)
- 11. Weight
- 12. Height
- 13. BMI
- **14. Systolic Blood Pressure**
- **15. Dyastolic Blood Pressure**
- 16. HbA1c
- 17. Creatinine
- 18. Microalbumin
- **19. Total Cholesterol**
- 20. HDL
- 21. Tryglicerides
- 22. Eye Examination
- 23. Retinopathy Status
- 24. Maculopathy Status

- 25. Foot Examination
- 26. Foot Pulses
- 27. Foot vibration
- 28. End Stage Renal Failure
- 29. Renal Dyalisis
- 30. Renal Transplant
- 31. Stroke
- **32. Foot Ulceration**
- **33. Acute Myocardial Infarction**
- 34. Laser
- **35. Hypertension**
- 36. Blindness
- 37. Amputation
- 38. Antihypertensive Medication
- 39. Hypoglicemic Drug Therapy
- 40. Oral Drug Therapy
- 41. Pump Therapy
- 42. Nasal Therapy
- 43. Average Injections (x day)
- 44. Self monitoring
- 45. Diabetes Specific Education
- 46. Lipid Lowering Therapy
- 47. Anti-platelet Therapy
- 48. Patient enrollment in DMP for diabetes







# Local "Mapping" of Diabetes Data

Heip   Fields mapping configuration   Configure mapping between BIRO fields and local fields   BIRO Data of BiRD Dedd   Setup   BIRO Database   Pater ID   Achol ataba   BIRO Database Engine   Bird Eld engine   Bird Eld engine   Bird Coatabase   Database Engine   Bird Coatabase   Coatabase Engine   Bird Coatabase   Bird Coatabase   Coatabase Engine   Bird Coatabase   Database Engine   Bird Coatabase   Coatabase   Coatabase   Database Engine   Bird Coatabase   Coatabase   Bird Coatabase   Coatabase   Bird Coatabase   Coatabase   Coatabase   Bird Coatabase   Coatabase   Bird Coatabase   Coatabase   Bird Coatabase   Coatabase   Bird Coatabase	<u>\$</u>		BIROBox		
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Setup   Setup   Setup   Setup   BRO Database   Acbol status   BRO Database Engine   Bro Database Engine   Bro Database Engine   Bro Database Ingine   Bro Database Engine   Bro Database Engine   Bro Database Engine   Data Transmission   Communication Software   Ford Sensation   Ford Sensation   Ford Sensation   Ford Sensation   Post Engine   Bro Database   Data Transmission   Colobal Connection   Web Portal	RIRORox 🛞	Patient ID	Type of blabetes		
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Communication Software Foot Pulses   Foot Sensation   Foot Ulcer   HbA1c   HbL   HbL   Height   Hypertension   Hypertension   Hypertension   Hypertension   Hypertension   Hicoaburnin   Maculaphy   Microaburnin   Mycoardial Infarction   Nasal Therapy   Nasal Therapy		Foot Examination			
Global Report   Central Engine   Hbl.   Height   Hypertension   Hypertensive Medication   Hypertensive Medication   Hypoglicaemic Drug Therapy   Laser   LDL   Lipid Therapy   Microalburnin   Myocardial Infarction   Nasal Therapy   Nasal Therapy	Communication Software	Foot Pulses			
Global Report   Central Engine   Hbl1c   Height   Hypertension   Hypertensive Medication   Hypoglicaemic Drug Therapy   Laser   Lipid Therapy   Maculopathy   Microalbumin   Mocardial Infarction   Nasal Therapy   Out Therapy		Foot Sensation			
Global Report   Central Engine   HDL   Height   Hypertension   Hypertension   Hypertension   Hypertension   Hypertension   Laser   Laser   Lipid Therapy   Maculopathy   Microalburnin   Myocardial Infarction   Nasal Therapy   Out Therarow		Foot Ulcer			
Central Engine   Height   Hypertension   Hypertension   Hypertension   Hypoglicaemic Drug Therapy   Laser   LD   Lipid Therapy   Maculopathy   Microalbumin   Myocardial Infarction   Nasal Therapy   Cisal Therapy	Global Report 🛛 🔊				
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Web Portal     Lipid Therapy       Maculopathy     Maculopathy       Microalbumin     Myocardial Infarction       Nasal Therapy     Cral Therapy		LDL			
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		Oral Therapy	_		





# The complete BIRO model www.biro-project.eu



# Fundamental BIRO definitions

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#### Region

a network sharing a common homogeneous framework for the collection of health information (e.g. group of professionals/centres, local health authority, single provinces, regions, states, or group of states)

#### Statistical Object

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An element of a distributed information system carrying essential data in the form of embedded, partial aggregate components, required to compute a summary measure or relevant parameter for the whole population from multiple sites









Demographic Characteristics (N=2) Clinical Characteristics (N=18) Health System (N=21) Population (N=3)

Standardized / Risk Adjusted (N=28)

- Epidemiological (N=2)
- Process (N=16)
- Intermediate Outcomes (N=7)
- Terminal Outcomes (N=3)









### Structure of the Report









# **Tabular Outputs**







# **Graphical Outputs**



In the SUB DATA SOURCE output, BOXPLOTS are used to compare distributions across centres for continuous response variables



Boxplots: 2.2.1.2 3 - BMI by data source (Type of Diabetes = Type 2)







### Standardization (AHRQ Quality Indicators)

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Risk adjustment model (in each region)

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$$Y(\%) = \beta_0 + \beta_1 (\text{females}) + \beta_2 (\text{age\_class1}) + ... \beta_k (\text{age\_class4})$$

$$\downarrow \qquad \qquad \downarrow \qquad \qquad \downarrow \qquad \qquad \downarrow \qquad \qquad \downarrow$$
Source unit

 $Y_i \text{ expected} = \beta_0 + \beta_1 (\text{females}) + \beta_2 (\text{age}_class1) + ... \beta_k (\text{age}_class4)$ 

 $\Sigma$ Pred<sub>i</sub> x 100 = Expected Rate

Standardized Rate= (observed rate/expected rate)\*population rate







#### Logistic regression for risk adjustment: why using individual data?

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	Box 3.4.2. Output Logistic Model on all observations	Box 3.4.3. Output Logistic Model on aggregate data		
Ormulate	The LOGISTIC Procedure Model Information	The LOGISTIC Procedure Model Information		
Sample	Data Set     WORK_MODEL_       Response Variable     HI_HBA       Number of Response Levels     2       Number of Observations     17102       Model     binary log it       Optimization Technique     Fisher's scoring       Response Profile     1	Data Set Response Variable     WORK.IN_SEDIS HI_HBA     Combinations of Combinations of Levels       Number of Response Levels     2     Levels     Of Covariates       Number of Observations     16     Levels     Of Covariates       Weight Variable     17102     binary logit     Dinary logit       Optimization Tech nique     Fisher's scoring     Fisher's scoring     Description		
	Ordered Value HI_HBA Total Frequency 1 1 4856 2 0 12246 Probability modeled is HI_HBA=1. Analysis of Maximum Likelihood Estimates	Response Profile         Ordered Value       HI_HBA       Total Weight       Total Frequency         1       1       8       4856.000         2       0       8       12246.000         Probability modeled is HI_HBA=1.       1       1		
	Standard Parameter         Wald DF         Estimate         Error         Chi- Square         Pr > ChiSq           Intercept         1         -0.6862         0.1028         44.5243         <.0001	Analysis of Maximum Likelihood Estimates         Standard       Wald       Chi       Pr >         Parameter       DF       Estimate       Error       Square       ChiSq         Intercept       1       -0.6862       0.1026       44.5243       <0001         GENDER       1       0.2297       0.0343       44.7555       <0001		

#### Box 3.4.2 Output Logistic Model on all observations

#### Box 3.4.4. Observed/expected rates by centre using logistic regression

#### Centre Den. Num. %Observed % Expected 95% Lower 95% Upper 7699 2189 27.5 1 28.4 28.5 29.5 2 Э 42.4 28.**0** 26.1 29.8 2360 1000 26.8 28.4 26.9 29.9 3422 916 222 25.8 4 1239 17.9 28.3 30.8 5 529 22.2 26.6 30.2 2382 28.4



#### www.eubirod.eu



Same results !

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### **Standardization outputs**



#### BIROX: Ubuntu Linux Virtualized distribution









#### The BIRO Statistical Engine: Automated Local & Global Report Delivery

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🕞 🖉 🖓 🛤	-Statistical Engine Conf	iguration	
<b>5</b> K.	BIRO Database	foligno	▼ Refresh
Best Information through Regional Outcomes	Centre ID	2=Umbria Dataset, Italy	
BIROBox (*)	Start year		2008
Setup	Duration (years)		1
	Reference date	12-31	
BIRO Database 🛞	Sub data sources	🗌 enable sub data sources reportir	ıg
Database Engine		, Statist	iical engine status
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		BIRO_se(dirse="/home/fabrizio/Desktop/testr dirout="/home/fabrizio/Desktop/testrun-2.0. driverClass="org.postgresql.Driver", classPath="/home/fabrizio/Desktop/testrun-2 dentifier.quote=""", pathdb="jdbc:postgresq dbname="foligno", dirdatastore=""", centre_id vearnow=2010, refanadate=12-31", logfile "ilepopdiab="", activitytable=0, compiletex=1	run-2.0.7/_se_", .7/workingDirectory/_se_", dbformat="postgres", 2.0.7/BIROCommonLibraries/postgresql=8.4-701.jdbc4.jar", l://localhost/foligno", user="postgres", password="postgres", ="2", startdate="2008-01-01", enddate="2008-12-31", = "statisticalEngine.log", cex= 1, wide=1, filepop="", .)







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# **Report Delivery**

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  - Outputs are produced in html and pdf formats, together with a very large number of component files that can be conveniently reused in customized web portals

BIR.*	
Reference date: 31/12/08	
Parameter: 5.3.1 % subjects with most recent HbA1c > 9.0 pct (poor control)	
HbA1c Type of Diabetes	reports1.pdf-Adobe Reader
Valid Value (%) NV/NA (%)	EUROD premini. I report pdf I proti 1 pdf X
Valid Value 8797 ( 93.9) 0 ( 0.0) 8797( 93.9)	🚔 💩 +   🕵   👆 😨 (205 of 229)   🗮 🚼 (min) +
NV/NA 575 ( 6.1) 0 ( 0.0) 575( 6.1)	Bookmarks 7
9372 ( 100.0 ) 0 ( 0.0 ) 9372 (100.0)	
Table 5.3.1.1 - Missing Data: HbA1c * Type of Diabetes	🖉 🔠 Demographic 🛛 📮
Type of Diabetes           Type 1 (%)         Type 2 (%) $(9 + )$ 76 (12.2)         618 (7.6)         694(7.9) $(0 - 9)$ 545 (87.8)         7558 (92.4)         8103 (92.1) $621 (7.1)$ 8176 (92.9)         8797 (100.0)           Table 5.3.1.2 - HbA1c * Type of Diabetes         9	Chical ch
CMH Chi-Square         p.value         df           16.7553         0         1	
Gender           Valid Value (%) [VV/NA (%)           Valid Value         8797 (93.9)         0 (0.0)         8797 (93.9)           NV/NA         575 (6.1)         0 (0.0)         575 (6.1)           9372 (100.0)         0 (0.0)         9372 (100.0)           Table 5.3.1.3 - Missing Data: HbA1c * Gender	
Gender         Gender           Male (%)         Female (%)           (9 + )         331 ( 6.9)         363 ( 9.0)           (0 - 9)         4438 ( 93.1)         3665 ( 91.0)         8103( 92.1)	Forest plot: 5.3.2 Percentage of patients with most recent HbAic level greater than 7,5 pct
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Health & Consumers



# Statistical Objects Data

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i	5_3_3_type_dm_d1_3a.csv	334 bytes CSV document	Sat 23 Oct 2010 09:19:35 AM CEST		
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### **Execution Time**



Centre	N Patients	N episodes	Elapsed Time
1	2 842	9 097	10' 46"
2	3,202	8,316	9' 23"
3	1,115	1,948	8' 26"
4	1,268	1,456	8' 17"
5	994	1,329	8' 02"
6	318	438	8' 19"
Overall (Statistical Engine)	9,739	22,584	24' 52"
Overall (Central Engine)	9,739	22,584	15' 30"







# Conclusions

• The BIRO statistical engine may represent a useful model to collect and analyze standardized data for the routine production of multidimensional sets of performance indicators

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- The current version, implemented for the case of diabetes registers, is provided with extensive specifications and is completely open source.
- To make it generally and directly applicable to different sets of performance indicators, the software must be properly reshaped to allow for the inclusion of "user plugins".
- Plugins must specify parameters for the basic steps required for performance reporting: mapping local values to a common standard, applying definitions and algorithms to the target indicators, standardization formulas for risk adjustment







#### Perspectives Connecting BIRO and HEIDI

isp

NEPI

Bar chart Line chart Map chart Table chart Total population, shown between 1975 and 2006 (31 years) The inhabitants of a given area on 1 January of the year in question (or, in some cases, on 31 December of the previous year). The population is based on data from the most recent census adjusted by the components of population change produced since the last census, or based on population registers 100000000 EU27 Ŧ  $\checkmark$ Minimum 90000000  $\checkmark$ Average  $\checkmark$ Maximur  $\checkmark$ Austria 80000000  $\checkmark$ Belgium  $\checkmark$ Bulgaria 70000000  $\checkmark$ Cyprus  $\checkmark$ Czech Republi 60000000  $\checkmark$ Germany  $\checkmark$ Denmark 50000000  $\checkmark$ Estonia  $\checkmark$ Spain  $\checkmark$ Finland 40000000  $\checkmark$ France  $\checkmark$ Greece 30000000  $\checkmark$ Hungary  $\checkmark$ Ireland 20000000  $\checkmark$ Italy  $\checkmark$ Lithuania 10000000  $\checkmark$ Luxembourg  $\checkmark$ Latvia  $\checkmark$ Malta  $\checkmark$ 1985 1987 1991 2003 Netherlands 1981 1983 1989 1993 1995 1007 1999 2001 2005 Years Select None ESTAT (demo pian) EUHI ID: DSEFI001010 ECHI ID: 10101 Last update: 2010-07-23T04:37:51 Generated on: 12/11/2010 1:31 Source: Full Screen Figure 3.2. Population size per Member State in 1975, 2006 and forecasts for 2050 About HEIDI wiki Privacy policy

HEIDI wiki: "Health in Europe: Information and Data Interface"

...

BIRO .csv data outputs

=>

HEIDI SDMX data format





Havelhöhe

Generate HTML Tag





"Performance measurement is not something done to you by someone else but something done together, in partnership, to improve our ability at every level – local, state, regional, and national – to achieve our common goals".

former USA Assistant Secretary for Health, Philip R. Lee



