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# PERFORMANCE MEASUREMENT OF THE DIABETES CARE

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This paper introduces the *structural indicators*, *process indicators* and *outcome indicators* as the basic concept of data analysis to describe factual evidence of health care in diabetes. As for human nature the health is the most important value in terms of quality of life, the measurement of the health care outcomes and the quality of health care are much more important than the measurement of the health economic implications (financial outcomes or cost savings). Health data analysis can have a prognostic or a predictive power. They can also provide a resource where local and national policymakers can share the best practice was found and made available to doctors, researchers and patients to achieve immediate impact for the public healthcare systems in reducing costs and improving patient care.

*Key words*: Diabetes, advanced data analysis, structural indicators, process indicators, outcome indicators, research study, health care outcomes.

## INTRODUCTION

Key to the success of the increasingly used of data analysis for performance assessment of the diabetes care is based on one of the most important quotes of all time in measurements. It is from *Galileo Galilei* who said: "*Measure what can be measured and make measurable what cannot be measured*". Data analysis is increasingly used in medicine, particularly in chronic diseases because non-communicable conditions (*e.g.* diabetes, cardiovascular diseases, cancers, and chronic respiratory diseases) accounted for nearly two-thirds of deaths worldwide. Chronic diseases are the main causes of poor health, disability, and death, and account for most of health-care expenditures. For example, the complications of diabetes with most disastrous effects on quality of life are blindness, amputations, end stage renal diseases (dialysis), stroke and heart failure. Related research indicates the results of routinely clinical data analysis can help transform the lives of millions patients with diabetes as a way of knowing what the best health care practice is and that is to be followed.

Only a few of data analysis projects are however validated for use in a clinical research setting [1–3]. Such validation implies the use routinely electronic health care records (*e.g.* electronic diabetes registers)[4,5]. By permanent electronic clinical data collection, a common understanding and common set of goals in translating automatic data analysis into action will help to ensure health data evidence makes a positive impact on every chronic disease and address challenges of uncontrolled medical costs.

To collect data about the quality of diabetes care and risk factors for diabetes and for benchmarking the performance of health care systems, have been defined the diabetes indicators. Indicators are holding a collection of parameters and according to the European Diabetes Indicators Projects (EUDIP/EUCID) the diabetes indicators „*Provide a set of indicators* *with a definition of the underlying data collection to monitor diabetes mellitus and his outcome in the Member States/EFTA on a routine, consistent and uniform basis*" [6–8].

## STRUCTURAL INDICATORS

The measurement of diabetes quality can be broken down into three separate types of evaluation indicators: *structural indicators, process indicators and outcome indicators* [6–8]. Measuring quality and outcomes in diabetes care is impossible without the use of indicators. Indicators create bases for clinical data analysis and are defined as "*a measure used to determine, over time, performance of functions, processes, and outcomes*" (US Institutes of Medicine) as described in the Organization for Economic Cooperation and Development (OECD) countries[9, 10] OECD health Technical Papers, No. 15. It is 2004 available at: http://www.oecd.org/els/health-systems/healthtechnicalpapers.htm.

The medical administrative data sources could mainly provide information for structural indicators (aspects of the structure of health care) that refer to those health care programs that are:

- Personnel
- Equipment
- Facilities
- Financing.

However, by examining the results of various studies comparing differences in health care outcome (by evaluating effectiveness, efficiency, and equity of the healthcare systems) it become clear that has been a lot of progress in each of these areas and the structural indicators did not explain a correct and sufficient view of health care. This has led to process indicators, covered with more details in next paragraph, which focuses on the policies, programs and procedures of health care delivery [11–13].

## PROCESS INDICATORS

The scientific rigour development, introduction and application of indicators for continuous improvement in diabetes care to document optimal quality of care has been created through the EUDIP, the "*EU Diabetes Indicator*" project, which has identified diabetes process indicators. These indicators have been proposed to monitor diabetes mellitus and its complications in EU countries in terms of practice guidelines. They are healthcare performance indicators used to review organisations' professional services and to measure physician performance against practice guidelines. Therefore, both the analysis of data and the benchmarking exercise in diabetes need a number of process indicators as in examples given below:

- Proportion of diabetic patients with retinopathy receiving laser treatment.
- Proportion of diabetic patients with foot ulcers treated surgically.
- Proportion of diabetic patients with end-stage renal disease (ESRD) receiving haemodialysis treatment.
- Proportion of T1DM receiving insulin pump therapy.

## OUTCOME INDICATORS

The European Diabetes Indicators Project (EUDIP), a two years (2000–2003) public health project in the field of diabetes, co-financed by DG-SANCO under the Health Monitoring Programme has, defined and piloted "*diabetes risk and diabetes care indicators on the national level in EU Member states*".

### Intermediate outcome

Indicators that reflect changes in biological status (disease-specific measures) such as: HbA1c, BMI, blood pressure, cholesterol, LDL, HDL, albuminuria, triglycerides, creatinine and fundus tested etc. As a main project outcome, the EUDIP published a list of feasible diabetes core indicators. In Table 1 each EUDIP indicator is defined in detail with explicit values and measurement units.

### Practical data analysis

This section is implementation of a pilot observational study aiming to reveals insights about diabetes care outcomes in Black Sea region through basic aspects of diabetes data analyses by using commercial statistics software. Outcomes generated through statistical data analysis were produced aiming to enhance clinical decision-making through evidence-based care outcomes at local and regional levels. Comparative evaluation of risk factors for complications in patients with diabetes in Black Sea region is presented throughout this section. As presentation modes, data are shown both in tables and as frequency histograms (standard benchmark graphs). However, it should be noted that data only be allowed into the public domain in anonymised format. Therefore, the data presented here were stratified anonymously by country (1, 2, 3 and 4).

*Table 1*

Risk factors for complications (in people with diabetes)

| No | Indicator | Description/Values/Measurement units |
|---|---|---|
| 1 | HbA1c | • Percent tested in last 12 months<br>• Percent >7.5% in last 12 months |
| 2 | Lipids | • Percent with lipid profile in last 12 months* Percent of those tested with total cholesterol >5 mmol/l<br>• Percent with LDL>2.6 mmol/l (>3 mmol/l )<br>• Percent with HDL <1.15 mmol/l (<1.0 mmol/l )<br>• Percent with triglycerides >2.3 mmol/l (>2.0 mmol/l) |
| 3 | Microalbuminuria | • Percent tested in last 12 m*<br>• Percent with microalbuminuria in last 12 m |
| 4 | Blood pressure | • Percent tested in last 12 m<br>• Percent with BP >140/90 in last 12 m |
| 5 | Smoking | • Percent of the persons with diabetes who are smoking |
| 6 | Overweight and obesity | • Percent with BMI ≥ 25 kg/m$^2$<br>• Percent with BMI ≥ 30 kg/m$^2$ |
| 7 | Age at diagnosis | • Age at diagnosis by 10 year age bands |
| 8 | Retinopathy | • Percent with fundus inspection in last 12 m<br>• Percent with proliferate retinopathy in last 12 m<br>• Percent who received laser treatment <3 months after diagnosis<br>• Annual incidence of blindness due to diabetic retinopathy/total annual incidence of blindness |
| 9 | Nephropathy | • Percent with serum creatinine tested in last 12 m<br>• Percent with ESRF – serum creatinine ≥ 400 µmol/l (WHO definition) – in last 12 months<br>• Annual incidence of dialysis and or transplantation (renal replacement therapy in patients with diabetes/1,000,000 general population<br>• Prevalence (stock) of dialysis/ transplantation (renal replacement therapy) in patients with diabetes/1,000,000 general population |
| 10 | Mortality | • Annual death rate in patients who have as primary or any cause of death diabetes mellitus/100,000 general population, adjusted for European Standard Population<br>• Annual death rate in the general population from all causes/100,000 general population, adjusted for European Standard Population |

## Data sources

Data were recorded at random from the point of care, coming directly from clinicians (during health care delivery process) from diabetes clinics or hospitals in Georgia, Romania, Russia and Ukraine over period 1997–2000. Therefore, it is important to mention that through this data source, real clinical data were accessible. The DIABCARE Basic Information Sheet (BIS) forms and the computer program DIABCARE Epi Info was used for data recruitment. Overall 3,079 patients' data were prepared to be included in this observational study.

Clinical data analyses for diverse DIABCARE parameters (*e.g.* patient demographics, risk factors, intermediate outcomes) were conducted using commercial statistics software SPSS (SPSS Inc., Chicago, IL, version 9). For us, it was only available and capable software of performing and replicates statistical analysis in the health care studies and research like in Western European countries, although, like many other commercial statistics software, they have high costs and require highly trained personnel.

It is important to note that by measuring the outcomes and quality in comparative evaluations, they are not intended to be treated as data that truly represent the practice or efficacy of the diabetes care services from a number of countries in Black Sea region that submitted data. Nevertheless, the creation of a regional network through data collection exercise, improved the capability of organizations to collaborate for direct comparison of results and to understand the evaluation criteria of quality of diabetes care.

## PATIENTS BASIC CHARACTERISTICS

The baseline characteristics of the patients (age, sex, type of diabetes, diabetes duration, and Body Mass Index – BMI) are summarised in this paragraph. They are presented as directly comparison among recruitment countries for various parameters. The aim of this observational study was to collect and compare data about risk factors for diabetes complications and quality of care indicators in Black Sea region. Data were gathered by using the method for data collection described on previous paragraph. It assured credible data (patients' information registered in directly contact with physicians at the sites of diabetes care). However, for all countries complete national data were not available and indicators results finding therefore came from clinical sample data.

Gender details of included patients are shown in Table 2 and in Figure 1. Detailed characteristics for duration of diabetes of included patients are shown in Table 3 and in Figure 2. Detailed characteristics for type of diabetes and age category are shown in Table 4 and in Figure 3. Body Mass Index details for included patients are shown in Table 5 and in Figure 4. Figures present the patients characteristics as frequency distribution to allow a direct comparison of characteristics among the four countries who submitted data. Important to note that our approach was not to provide an interpretation of the data since this was the task of each national diabetes centre who submitted data (of each individual country). Only interpretation and identification of common factors valid for all countries has been given briefly to help them if need to do more to promote the benefits of data collection and data analysis.

As is shown in Table 2 and Figure 1, most of the included patients for this study were females, 1838 (59.8%) and 1238 (40.2%), were men. Table 3 and Figure 2 show that 627 (20.4%) patients were with type 1 and 2,428 (78.9%) patients were with type 2 diabetes. 24 (0.8%) had unknown type of diabetes.

*Table 2*

Detailed breakdown of number of patients for male and female among four countries

**SEX * COUNTRY Crosstabulation**

Count

| | COUNTRY | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Total |
| SEX | | 3 | | | 3 |
| F | 552 | 628 | 588 | 70 | 1838 |
| M | 386 | 535 | 233 | 84 | 1238 |
| Total | 938 | 1166 | 821 | 154 | 3079 |

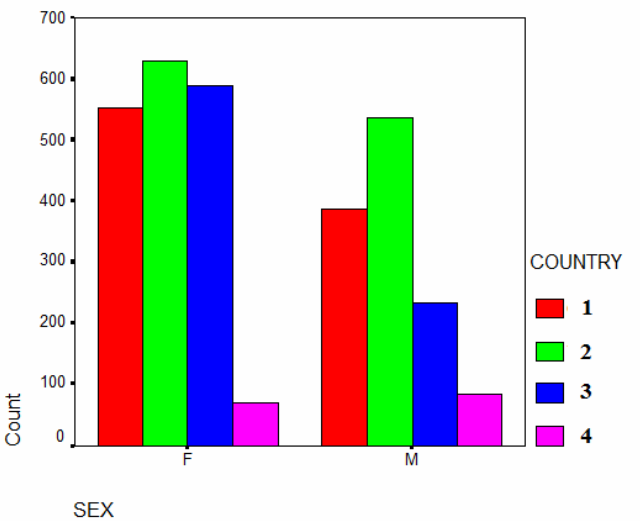


Fig. 1. Direct comparison of number of patients for male and female among four countries.

*Table 3*

Detailed breakdown of number of patients for type of diabetes and age category among four countries

**AGE_CAT * COUNTRY Crosstabulation**

Count

| | | COUNTRY | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| AGE_CAT | Type 1 17-25 | 33 | 62 | 12 | 47 | 154 |
| | Type 1 25+ | 97 | 192 | 44 | 74 | 407 |
| | Type 1 < 17 | 10 | 36 | 3 | 17 | 66 |
| | Type 2 50-70 | 580 | 598 | 528 | 1 | 1707 |
| | Type 2 70+ | 99 | 109 | 170 | 1 | 379 |
| | Type 2 < 50 | 110 | 156 | 63 | 13 | 342 |
| | Unknown | 9 | 13 | 1 | 1 | 24 |
| Total | | 938 | 1166 | 821 | 154 | 3079 |

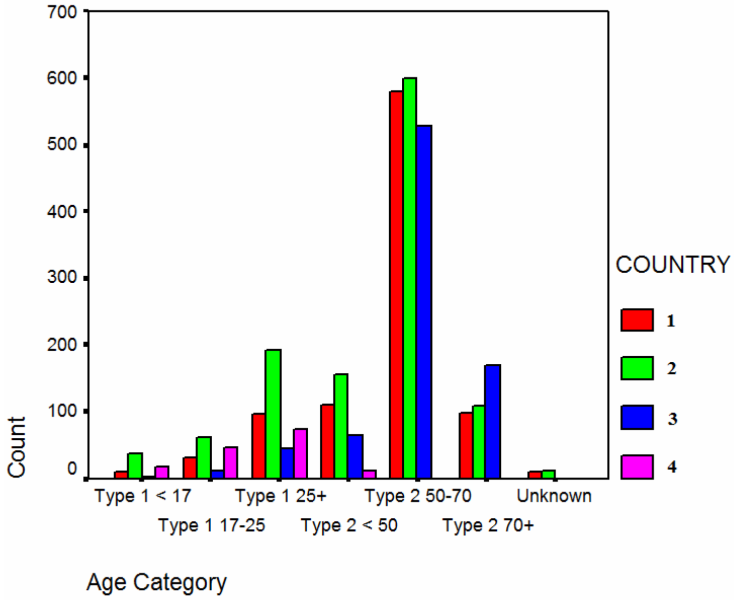


Fig. 2. Comparison of number of patients for type of diabetes and age band among four countries.

*Table 4*

Detailed breakdown of number of patients for duration of diabetes among four countries

**DUR_CAT * COUNTRY Crosstabulation**

Count

| | | COUNTRY | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| DUR_CAT | 0-4 years | 248 | 471 | 279 | 63 | 1061 |
| | 05-9 years | 160 | 204 | 165 | 37 | 566 |
| | 10-14 years | 191 | 206 | 178 | 25 | 600 |
| | 15-19 years | 145 | 134 | 108 | 13 | 400 |
| | 20-24 years | 88 | 61 | 45 | 13 | 207 |
| | 25-29 years | 52 | 37 | 26 | 2 | 117 |
| | 30+ years | 36 | 32 | 19 | | 87 |
| | Unknown | 18 | 21 | 1 | 1 | 41 |
| Total | | 938 | 1166 | 821 | 154 | 3079 |

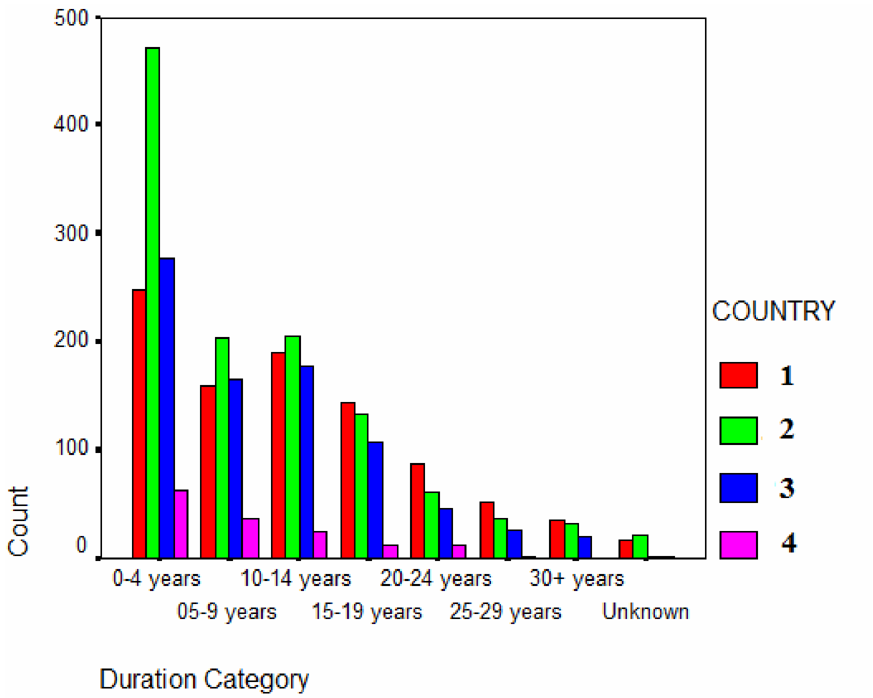


Fig. 3. Direct comparison of number of patients for duration of diabetes among four countries.

*Table 5*

Detailed breakdown of number of patients for BMI category among four countries

Count

| | | COUNTRY | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| BMICAT | BMI 25 - 30 | 392 | 395 | 246 | 31 | 1064 |
| | BMI 30+ | 282 | 229 | 275 | 5 | 791 |
| | BMI < 25 | 213 | 522 | 146 | 113 | 994 |
| | Not Known | 51 | 20 | 154 | 5 | 230 |
| Total | | 938 | 1166 | 821 | 154 | 3079 |

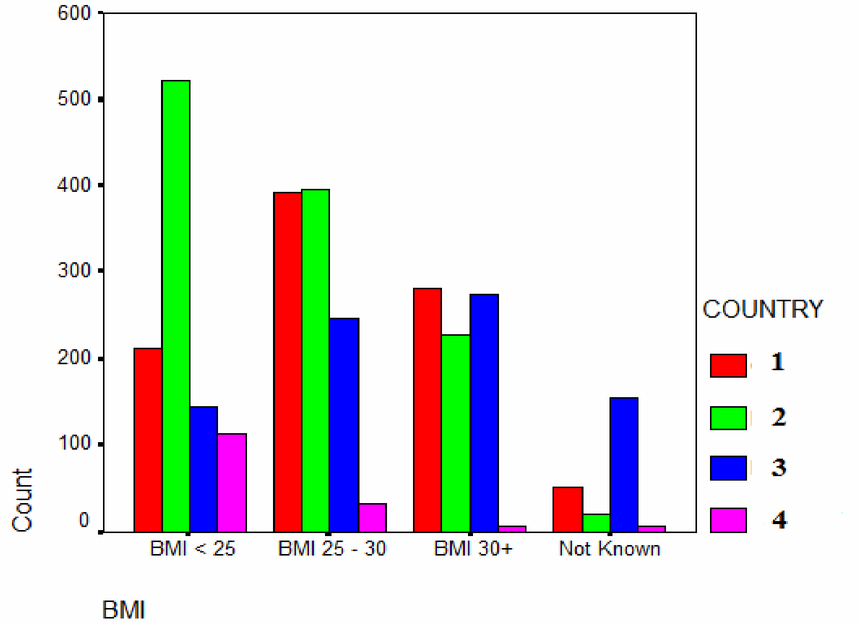


Fig. 4. Direct comparison of the distribution of BMI categories among four countries.

Regarding diabetes duration there was a large range of diabetes duration as is shown in Table 4 (duration category * country cross tabulation) and as a frequency histogram in Figure 3.

As shown in Table 5 and in Figure 4, the distribution of BMI categories among the patients revealed that 32.3% were classified as normal weight (BMI <25 kg/m$^2$), 34.6% as overweight (BMI 25–30 kg/m$^2$), 25.7% as obese (BMI equal and above 30 kg/m$^2$) and 7.5% were not known or not measured.

## RISK FACTORS ASSESSMENT

Risk prediction can be used as prognostic information and also as support for intervention for the benefit of the patient. We aimed to investigate the risk factors levels (*e.g.* HbA1c, smoking, BMI, SBP, LDL, HDL, and Creatinine) and history events (*e.g.* Myocardial Infarction – MI, Stroke, Blindness, Amputation, Renal failure, and Foot ulceration in care-based sample of patients with diabetes in region. The relevant risk factors measurements data finding are presented in the following.

### HbA1c data understanding and analysis findings

*Data understanding:* For diabetes control by monitoring the blood glucose, it is very important for all diabetes patients to know that the HbA1c measures the amount of glucose that binds to hemoglobin over a period of last 3 months. It is relevant predictor criteria as the therapeutic outcome goal in the treatment of diabetes. Therefore, for prevention diabetes complications the target is for maintaining HbA1c < 6.5% [14]. In terms of risk factors for diabetes care assessment, if the Hba1c ≥ 6.5%, diabetes treatment should be intensified. In our data analysis the HbA1c were stratified as "tested" and "Not tested". The values of HbA1c were also classified into three arbitrary categories: HbA1c < 8.0%, HbA1c between 8.0–10% and HbA1c ≥10.0%. Table 6 shows that the percent of patients who had missing an annual HbA1c test was significantly higher than the percent of the patients who had received an HbA1c annual test: 77.6% *versus* 22.4%, 72.0% *versus* 28.0%, 75.6% *versus* 24.4% and 45.6% *versus* 54.4% for the country 1, 2, 3 and 4, respectively.

Also, the frequency histogram clearly illustrates in Figure 5 that were a lack of HbA1c measurement among all BSDU countries, in spite it is a key indicator for assessing the quality of diabetes care. The results (using data from hospitals or from diabetes clinics) show very clearly that over period 1997–2000, the HbA1c test as the main instrument to keep the diabetes under control was sub-optimally used in the Black Sea area. Again, both in tables and in histograms the data presented were stratified anonymously by country (1, 2, 3 and 4).

*Table 6*

Detailed breakdowns of number of patients for HbA1c records among four countries

Count

| | | COUNTRY | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| HbA1c | HbA1c 10+ | 138 | 88 | 91 | 37 | 354 |
| | HbA1c 8-10 | 23 | 107 | 62 | 29 | 221 |
| | HbA1c < 8 | 49 | 131 | 47 | 18 | 245 |
| | Not tested | 728 | 840 | 621 | 70 | 2259 |
| Total | | 938 | 1166 | 821 | 154 | 3079 |

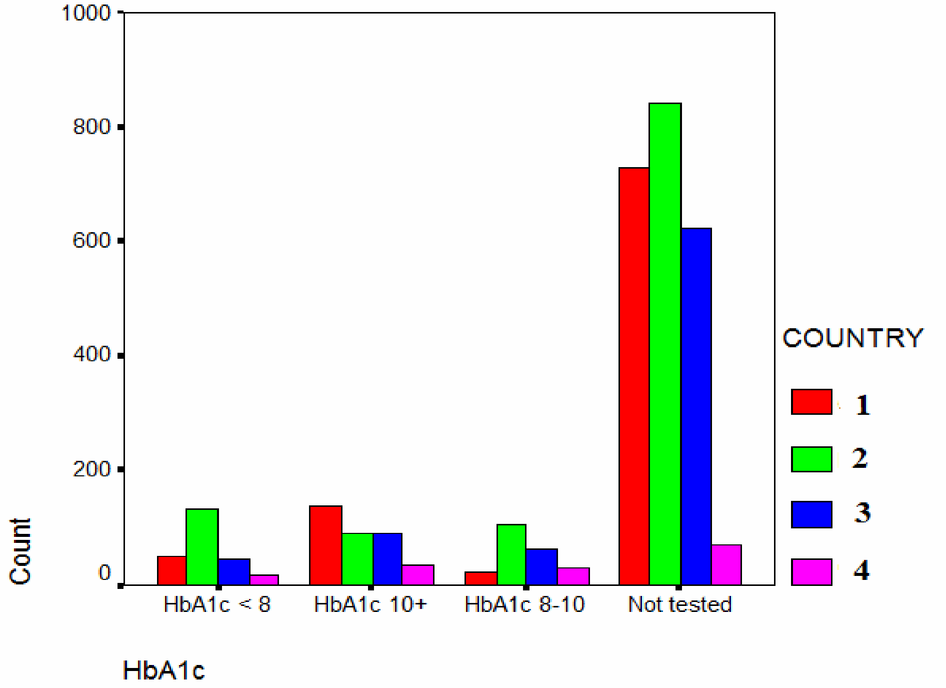


Fig. 5. Direct comparison histogram of HbA1c measurement distribution among the four countries.

## Smoking findings

*Data understanding:* What risk for health can smoking bring to diabetic patients? Smoking and long-term exposure to smoke environment "*secondhand smoke*" can accelerate damage the interior walls of arteries allowing deposits of cholesterol to collect and block blood flow. For this study "Yes/No" type of data was registered. The detailed breakdown of number of patients among countries for smoking status is summarized in Table 7. The frequency distribution for categories of smokers *versus* no smokers status by country were 13.1% *versus* 86.1%, 23.2% *versus* 76.8%, 10.4% *versus* 89.6% and 35.1% *versus* 64.1% for country 1, 2, 3 and 4, respectively. Comparison histogram of frequency distribution for categories of smokers versus no smokers by country is presented in Figure 6. Findings showed that significant differences in the distribution for smoking *versus* non-smoking were reported among all countries. The lowest percent (10.4%) of smokers were reported in country 3 and the highest percent (35.1%) of smokers were reported in country 4. However, country 4 had submitted the lowest number of patients of all records (5.5%) in the Black Sea database used for this analysis.

*Table 7*

Detailed breakdown of number of patients for smoking among four countries

**TOBACCO * COUNTRY Crosstabulation**

Count

| | | COUNTRY | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| TOBACCO | 0 | 809 | 644 | 736 | 98 | 2287 |
| | 1 | 122 | 194 | 85 | 53 | 454 |
| Total | | 931 | 838 | 821 | 151 | 2741 |

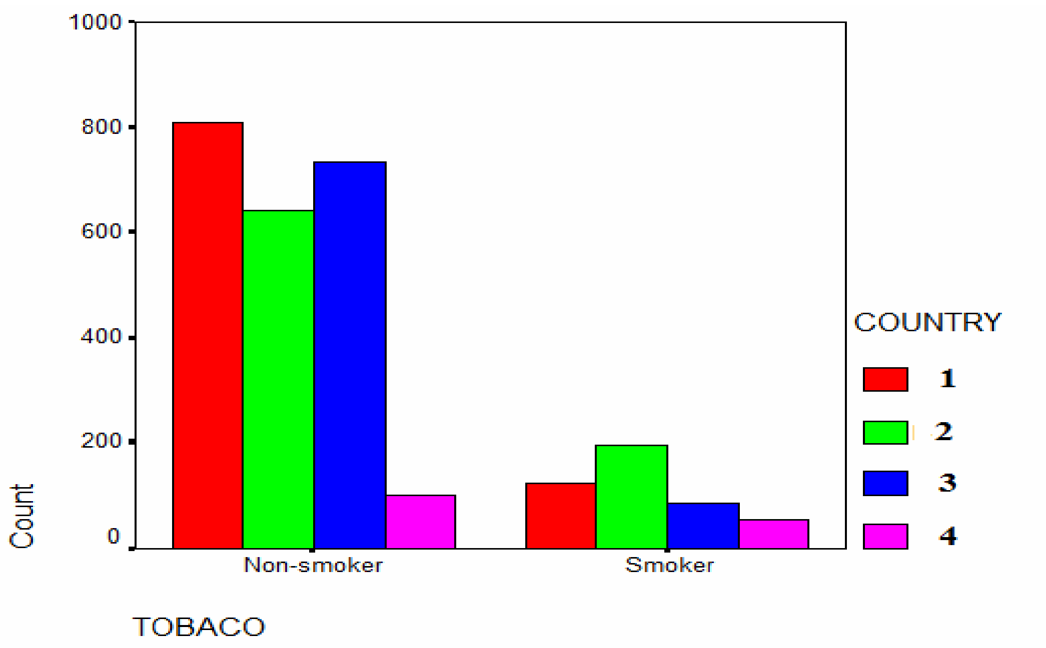


Fig. 6. Direct comparison of number of patients for smoking among four countries.

### Blood pressure data findings

*Data understanding:* What is blood pressure (BP)? It is the force that blood exerts on the walls of arteries. BP is determined by the amount of blood the heart pumps and the amount of resistance to blood flow in the arteries. It is measured in millimeters of mercury (mmHg). What a patient should know about blood pressure related to diabetes care? Over time a high glucose level may cause high blood pressure which damages especially heart and blood vessels by accelerating hardening of the arteries. Table 8 and Figure 7 show the findings of BP analysis. The BP results (Table 8) were classified into three categories as, Normal: "BP < 145/85 mmHg", Abnormal: "BP > 145/85 mmHg" and "BP not tested". The results show that 493 of 938 (52.56%), 685 of 1166 (58.75%), 357 of 821 (43.48%) and 114 of 154 (74.03%) had normal BP (BP < 145/85 mmHg) for countries 1, 2, 3 and 4, respectively whereas 412 of 938 (43.92%), 453 of 1166 (38.86%), 460 of 821 (56.03%) and 36 of 154 (23.38%) had abnormal BP (BP > 145/85 mmHg) for countries 1, 2, 3 and 4, respectively. Direct comparison histogram of number of patients for BP records among four countries is shown in Figure 7. Although this is just a small sample of data, our findings show a discrepancy in country 3, where hypertension is higher prevalent than in the other three countries.

### Creatinine findings

*Data understanding:* Creatinine test is most widely used to assess kidney function. For diabetes care, creatinine is a laboratory investigation result which reveals important information about kidneys is functioning properly. Results of the creatinine blood test are measured in milligrams per deciliter (mg/dL) or micromoles per liter (μmol/L). What are "normal" blood creatinine levels? Normal levels of creatinine in the blood are approximately 0.6 to 1.3 mg/dL (53 to 115 micromoles per liter) in adult males and 0.5 to 1.1 mg/dL (44 to 97 micromoles per liter) in adult females. Creatinine ≥ 10.0 mg/dL (884 micromoles per liter) in adults may indicate severe kidney impairment and the need for a dialysis machine to remove wastes from the blood. Table 9 shows that the percent of patients who had missing an annual creatinine test in comparison with the other three countries is much smaller. The percent distribution for categories of creatinine tested versus non-tested by country (shown in Table 9 and Figure 8) were 9.4% *versus* 90.6%, 56.1% *versus* 43.9%, 91.8% *versus* 8.2% and 53.9% *versus* 46.1% for country 1, 2, 3 and 4, respectively.

*Table 8*

Detailed breakdown of number of patients for BP among four countries

**BPCAT * COUNTRY Crosstabulation**

Count

| | | COUNTRY | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| BPCAT | BP < 145/85 | 493 | 685 | 357 | 114 | 1649 |
| | BP > 145/85 | 412 | 453 | 460 | 36 | 1361 |
| | BP not test | 33 | 28 | 4 | 4 | 69 |
| Total | | 938 | 1166 | 821 | 154 | 3079 |

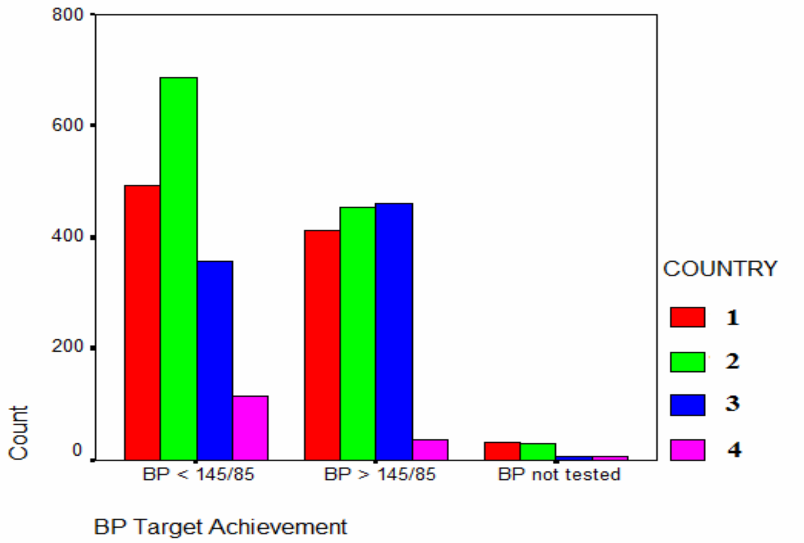


Fig. 7. Direct comparison histogram for the distribution of the number of patients for BP records among the four countries.

*Table 9*

Detailed breakdown of number of patients for Creatinine (micromoles per liter) among four countries

**CREATCAT * COUNTRY Crosstabulation**

Count

| | | COUNTRY | | | | Total |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| CREATCAT | Creat < 200 | 86 | 638 | 749 | 80 | 1553 |
| | Creat > 200 | 2 | 16 | 5 | 3 | 26 |
| | Not Tested | 850 | 512 | 67 | 71 | 1500 |
| Total | | 938 | 1166 | 821 | 154 | 3079 |

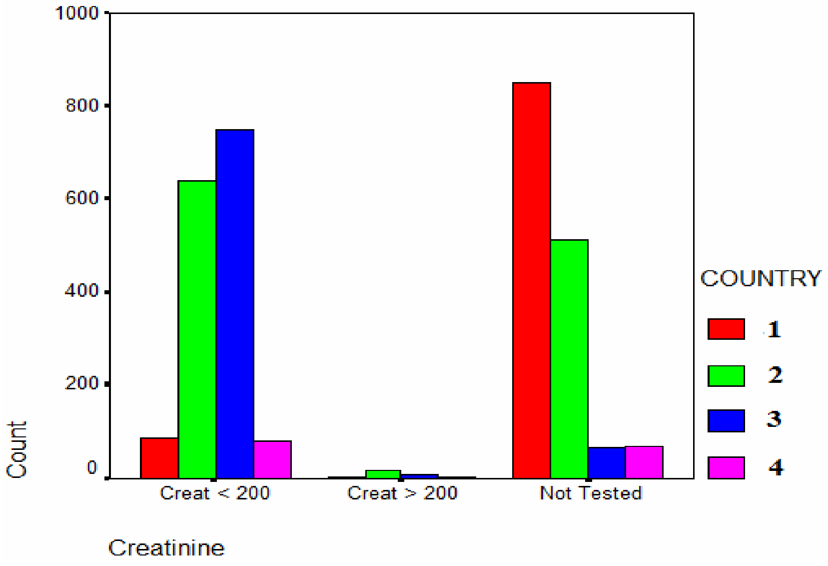


Fig. 8. Direct comparison histogram of number of patients for Creatinine records among four countries.

## Long-term outcomes

Another emerging area of serious interest is long term outcomes. They deal with disease-specific measures to prevent chronic complications in diabetes. Relevant example of long-term outcomes is listed below:

- Foot problems (ulcers, infections, deformities).
- Retina changes.
- Cardiovascular disease.
- Renal changes.
- Neurological changes.
- Peripheral vascular disease.

Identifying process measures of clinical indicators of diabetes care in Europe has been done through few well-known join initiatives to data evidence of health care in diabetes: The Declaration of St. Vincent movement, Black Sea Diab Union (meant to bridge the gap from European countries in data analysis research) [15] and the DIABCARE initiative.

## LAW, ETHICS AND GOVERNANCE ACROSS THE EU

One of the major concerns particularly when using IT technology which involve the use of the Internet for storing and modifying health information, data gathering and data analysis to measuring outcomes and quality of care is the issue of data security and confidentiality about a person's medical history [16-18].

The EU has established a set of regulations that govern the storage and exchange of patients' medical records. To guarantee that only the appropriate personnel have access to patient records, the patient database has to be protected against unauthorized access and should keep access audit trail in accordance with the European Directive of Data Protection and regulations [18,19]. Also HIPAA (USA regulations) is taken into account in the context of new IT health technology.

## EUROPEAN CORE INDICATORS IN DIABETES PROJECT

The "European Core Indicators in Diabetes" (EUCID) project was a two-year project (2005–2007) co-funded by the DG-SANCO under the Public Health Programmes (health information strand), whose goal was "*to make available the national facts of Diabetes Mellitus and it's risk factors from countries in the European Union*". The EUCID project is a follow-up of the EUDIP project and collected diabetes data from 19 countries with the aim of delivering diabetes indicators for 2005 by the end of 2007. The authors of this paper have represented Romania

(Institute of Diabetes, Nutrition and Metabolic Diseases "N. Paulescu" through Telemedicine Centre) as partner in this project.

Data were age-standardized for comparisons performed in the general population when possible, or representative regional population if national was not possible. Very innovative approach was a web application built to facilitate the data entry and to facilitate competition between countries in data entry (a progress chart shows the completeness of the data entry for each individual country).

Fig. 9. Map of Europe containing the collaborating countries of the EUCID project.

According to the Final report European Core Indicators in Diabetes project available here: http://ec.europa.eu/health/ph_projects/2005/action1/docs/action1_2005_frep_11_en.pdf some striking results were:

- Among the least available indicators, incidence of blindness in people with diabetes was provided by only 4 countries, and impaired fasting glucose in general population by 2.
- The standardized prevalence of diabetes varied from 2.6% in Finland to 7.6% in Cyprus.
- Crude incidence of diabetes (0–14 yrs.) from 11 in Spain to 60 per 100,000 in Finland.
- Standardized prevalence of overweight (25–74 yrs.) from 37% in Germany to 60% in Cyprus.
- Standardized mortality rates linked with diabetes from 7 in Luxembourg to 56 per 100,000 in Finland.

Among people with diabetes (>25 yrs.), process indicators ranged:

- For HbA1c testing once a year, from 51% in Ireland to 99% in the Netherlands, France and Belgium.
- For lipid testing, from 45% in Ireland to 99% in the Netherlands.
- For microalbuminuria testing, from 25% in Finland to 97% in the Netherlands.
- For fundus examination, from 12% in Ireland to 84% in the Netherlands.

**Risk factors in people with diabetes varied:**

- HbA1c >7%, 32% in Ireland to 83% in Cyprus.
- Total cholesterol > 5 mmol/l, 14% in Ireland to 68% in Cyprus.
- Microalbuminuria, 9% in Finland to 41% in England.
- Blood pressure > 140/90 mmHg, 17% in France to 46% in Sweden.
- Smoking, 10% in Ireland to 37% in Denmark.

**Complication incidence rates were:**

- Dialysis and transplantation, 4 in Cyprus to 149 per 100,000 diabetes clients in Scotland.
- Stroke, 37 in Cyprus to 2675 in Germany.
- Myocardial infarction, 21 in Cyprus to 2135 in Austria;
- Major amputation, 78 in Scotland to 574 in Spain.

*Conclusions in the final report of the project*: "while European epidemiologic systems can provide diabetes indicators, major indicators as blindness are still missing. Most of the European countries achieve remarkable good testing of people with diabetes. Risk factors and outcomes vary across countries, reflecting a mixture of genetic background, societal and cultural factors, as well as public health politics. The results of EUCID will be used within countries to try to influence these policies" (*Dr. Fred Storms, the project coordinator*).

## CONCLUSIONS

This paper introduced the basic concept of realistic data analysis as factual evidence of health care in diabetes. The common data set, the relevant standard indicators for measuring outcomes and the assessment quality criteria in diabetes care are the basic concepts. The paper deals with the quality assessment criteria and how they are identified to help in data collection [20] and data analysis to asses of the diabetes care based on quality and outcomes indicators. In order to better understanding status of healthcare we need faster moving in data analytics. Applying analytics in cost reduction will positively affect change in healthcare. These changes are signs of healthcare system vitality that drives to better solutions that support better patient outcomes. Therefore, the essence of the positively changes in healthcare is by taking action based on information we find from advanced data analysis. However, a major challenge is applying a realistic and relevant analytics in cost reduction. Issues to address in quality and outcomes measurements of diabetes care are presented. Overall perception for viability assessment of diabetes care rise the main question: how digital and connected health technologies can be used to improve health outcomes? Solution needs resolving IT challenges to the healthcare industry to make existing and future IT standards in healthcare productive, pervasive, practical and persistent[21].

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## REFERENCES

1. The BIRO Consortium. Best Information through Regional Outcomes: a Shared European Diabetes Information System for Policy and Practice. Perugia,

Italy: A public health project supported by the European Commission; 2009.
2. Cristescu V, Ionescu-Tirgoviste C, Pruna S. EUBIROD technology: relationship between obesity and diabetes innewly diagnosed Type 2 patients. PROCEEDINGS-ROMANIAN ACADEMY SERIES B CHEMISTRY LIFE SCIENCES AND GEOSCIENCES, ISSN: 1454-8267, BL Shelfmark: 6791.090000, OCLC Number: 844277785. 2012;14(2): 126-134.
3. Pruna S, Bealle A, Purtill C, *et al*. Screening for diabetic hypertension in newly diagnosed Type 2 diabetes using a new technology that carries out in minutes agregated data analysis. Proc. Rom. Acad., Series B, In Press. 2013; 2:2, ISSN: 1454-8267.
4. Pruna SS, Dixon R, Harris ND. Black Sea TeleDiab: diabetes computer system with communication technology for Black Sea region. IEEE Trans Inf Technol Biomed. Sep 1998; 2(3): 193-196.
5. Pruna S, Georgescu M, Stanciu E, Dixon RM, Harris ND. The Black Sea Tele-Diab System: development-implementation-clinical evaluation. Stud Health Technol Inform. 2000; 77: 656-660.
6. de Beaufort CE, Swift PG, Skinner CT, *et al*. Continuing stability of center differences in pediatric diabetes care: do advances in diabetes treatment improve outcome? The Hvidoere Study Group on Childhood Diabetes. Diabetes Care. Sep 2007; 30(9): 2245-2250.
7. Danne T, Mortensen HB, Hougaard P, *et al*. Persistent differences among centers over 3 years in glycemic control and hypoglycemia in a study of 3,805 children and adolescents with type 1 diabetes from the Hvidøre Study Group. Diabetes Care. Aug 2001; 24(8): 1342-1347.
8. de Beaufort CE, Lange K, Swift PG, *et al.* Metabolic outcomes in young children with type 1 diabetes differ between treatment centers: the Hvidoere Study in Young Children 2009. Pediatr Diabetes. Sep 2013; 14(6): 422-428.
9. Greenfield S, National Center for Health Statistics (U.S.). Outcomes research for effectiveness and quality: the major issues. Hyattsville, MD: National Center for Health Statistics; 1994.
10. Nicolucci A, Greenfield S, Mattke S., Selecting indicators for the quality of diabetes care at the health systems level in OECD countries. Int J Qual Health Care. Sep 2006; 18 Suppl 1: 26-30.
11. Kravitz RL, Greenfield S, Rogers W, *et al.* Differences in the mix of patients among medical specialties and systems of care. Results from the medical outcomes study. JAMA. Mar 1992; 267(12): 1617-1623.
12. Giraldes MoR. [Efficiency *versus* quality in the NHS, in Portugal: methodologies for evaluation]. Acta Med Port. 2008 Sep-Oct 2008; 21(5): 397-410.
13. Mazze RS, Powers MA, Wetzler HP, Ofstead CL. Partners in advancing care and education solutions study: impact on processes and outcomes of diabetes care. Popul Health Manag. Dec 2008; 11(6): 297-305.
14. Kucharska E. [Diabetes type 2--criteria concerning the recognition and prevention, as well as therapeutic targets in the light of research results and guidelines formulated by the American Diabetes Association in 2012]. Przegl Lek. 2013; 70(6): 404-406.
15. Pruna Simion, Herinean Radu, Andreea P. Set up an Internet infrastructure, interconnecting clinicians and scientists in countries of the Black Sea area to promote WHO/EURO care quality programs. Fifth Conference of the European Society for Engineering and Medicine, ESEM 99. Barcelona, 1999: 293-294.
16. Di Iorio CT, Carinci F, Azzopardi J, *et al.* Privacy impact assessment in the design of transnational public health information systems: the BIRO project. J Med Ethics. Dec 2009; 35(12): 753-761.
17. Di Iorio CT, Carinci F, Brillante M, *et al*. Cross-border flow of health information: is 'privacy by design' enough? Privacy performance assessment in EUBIROD. Eur J Public Health. May 2012.
18. Di Iorio CT, Carinci F. Privacy and Health Care Information Systems: Where Is the Balance? eHealth: Legal, Ethical and Governance Challenges: Springer; 2013: 77-105.
19. George C, Whitehouse D, Duquenoy PE. eHealth: Legal, Ethical and Governance Challenges: Springer; 2012.
20. Pruna S, Harris ND, Dixon R, Laxminarayan S. Black Sea Tele Diab: Building an Information System for Management of Diabetes. IEEE EMBS International Conference on Information Technology Applications in Biomedicine. Arlington, VA, USA: IEEE; 2000: 284-289, ISBN: 078036449X.
21. Pruna S., Georgescu M., Stanciu E., Dixon R.M., Harris N.D. The Black Sea Tele-Diab System: development-implementation-clinical evaluation. Paper presented at: Studies in health technology and informatics.; Medical informatics Europe; Medical infobahn for Europe proceedings of MIE2000 and GMDS2000; 2000; Hannover, Germany.