ANALYSIS STUDY ON THE COST-EFFECTIVENESS OF COMMUNITY NURSING SERVICES IN ASSISTED COMMUNITIES FOR THE YEAR 2010 IN SIBIU COUNTY

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I. INTRODUCTION

The burden of disease can be reduced by different interventions. In order to determine the optimal intervention from a series of alternatives, certain factors must be considered, such as the cost-effectiveness of the intervention.

In order to cope with the burden of disease and risk factors, most necessary funds required to finance an adequate health system depend on large array of variables. There is no direct relationship between conventional indicators of the burden of disease and the need for resources: some diseases can be treated in a simple fashion with low costs, whereas others require a very expensive treatment and care. The profile of expenses varies according to the age of the beneficiary and on-coming death [1].

II. PRESENTATION OF THE STUDY

1. Cost-effectiveness analysis is an economic evaluation that compares costs and consequences of two or more alternatives, from which one of the results is expressed in natural units. The index used is the proportion between total actualized costs and effects obtained (C/E) [2].

2. Type of study: Applied scientific research (intervention)

3. Background: Verifying the hypothesis according to which in the year 2010 in Sibiu county community nursing specific interventions were cost-effective, bringing advantages to the economy by the gain in health due to years of life lived extra by the population from towns that benefited from these services (study sample), compared with the population from the other towns (witness study).

4. Object of the study: The cost-effectiveness analysis, considering the health benefit due to community nursing specific interventions, by comparing the burden of disease from assisted communities (study sample) with the levels of the burden of disease from unassisted communities (witness sample).

5. Scope of the study: Adapting community nursing services to specific health problems identified in each zone and community, on the criteria of cost-effectiveness.

6. Methods of research:

For this study were used few methods like:

- method for estimating the years of life lost by premature death, (from the Cost-Effectiveness Analyze model proposed by W.H.O.) on the assisted population (study sample) and on unassisted population (witness sample) by community personnel in the year 2010, comparing the results obtained on the two strands (survival curve), and estimating the health benefit obtained by community nursing: number of extra years lived, the effectiveness of interventions, (back-adjusting method), costs.

RESULTS AND DISCUSSIONS: In the year 2010 in Sibiu county, community nursing specific interventions were cost-effective, bringing economical advantages by the health gain due to the years of life gained by the population of the community that beneficed from this type of services (study sample), compared to the population of the other communities (witness sample).

CONCLUSIONS: Community nursing specific interventions are cost-effective. These interventions can be generalized and can be sustained on the long term with minimum costs, generating important benefits for the entire population. Community nursing specific interventions need to be permanently adapted to the ever changing populations needs by public health management.

Keywords: community nursing, burden of disease, cost-effectiveness of services.
estimating the health benefit obtained by community nursing: number of extra years lived;

- calculating the effectiveness of interventions, (adapting back-adjusting method) [2];

- calculating the cost-effectiveness of community nursing interventions ratio.

III. RESEARCH STAGES

Stage A. Comparative analysis of years of life gained by the population that benefited from community nursing (survival curve)

A.1. Calculating the life tables [3] for the two populations (assisted and unassisted) and respective to gender the following variables [4]:

\[ \begin{align*}
  x &\quad \text{exact age} \\
  n &\quad \text{the size of range between ages} \\
  aP_x &\quad \text{population on January 1\textsuperscript{st} 2008 on years of age} \\
  aD_x &\quad \text{number of deaths at age } x, \text{ in 2008 within population } P_x \\
  aM_x &\quad \text{specific mortality at age } x \text{ for } P_x \\
  a &\quad \text{constant} \\
  aq_x &\quad \text{probability of death at age } x \text{ for } P_x \\
  aP_{x+1} &\quad \text{probability of survival to age } x+1 \text{ for } P_x \\
  l_x &\quad \text{cohort set arbitrarily (value 100000)} \\
  aD_x &\quad \text{number of deaths at age } x \text{ in the cohort } l_x \text{ for the probability of death } q_x \\
  aL_x &\quad \text{number of years lived by survivors from } l_x \text{ between ages } x \text{ and } x+1 \\
  T_x &\quad \text{total number of years lived by the generation studied from } l_x \\
  e_x &\quad \text{life expectancy at age } x
\end{align*} \]

A.2. In order to prove that there are no statistically significant differences between the two populations (assisted and unassisted), namely in the structure of the sex and the 18 age groups, were proceeded to a dispersion analysis by applying the R. Fisher formula [5]:

\[
F = \frac{S_1^2}{S_2} = \frac{1}{n_1 - 1} \sum_{i=1}^{n_1} (X_i - \bar{X}_n)^2 - \frac{1}{n_2 - 1} \sum_{i=1}^{n_2} (Y_i - \bar{Y}_n)^2
\]

Hypothesis:

- \[ H_0 : F \text{ calculated } = \frac{S_1}{S_2} \leq F_{\text{table}} \]
- \[ H_a : F \text{ calculated } = \frac{S_1}{S_2} > F_{\text{table}} \]

Was accepted the null hypothesis \( H_0 \) demonstrating that, in terms of structure by sex and age groups, they are part of the population of Sibiu county, the affirmation stands at a probability of 95% and a risk \( \alpha \) of 0.05. If there are significant differences in health status between the two populations, they are due to the action of favorable external factors, in this case community nursing.

A.3. Information processing

- Calculating the difference between the life expectancy of men and women in the assisted communities and unassisted communities;

- Calculating the percent of survivors from \( aL_x \) of the exact \( x \) and \( x+1 \) age, for the two samples;

- Calculating the difference between the total number of years lived by the assisted cohort and by the unassisted cohort, \( T_x \text{ assisted} - T_x \text{ unassisted} \), respectively.

Data source: The statistical data necessary for the study were taken and centralized from the existing statistical posts from the Sibiu County Statistics Center and The Informatics and Statistics Compartment from Health Department of Sibiu County.

A.4. Comparing results

Placing the data into tables and graphically representing the results: life expectancy and survival curve.

Stage B. Calculating the cost-effectiveness of community nursing services

B.1. Adapting the back-adjusting formula [2]:

Notations:

\[
\lambda_N = \frac{\lambda_C}{1 - (c \times e)} \quad \text{therefore} \quad e = \frac{\lambda_N - \lambda_C}{\lambda_N \times c}
\]

\( \lambda_N = \text{DALY rate for the unassisted for the null situation (witness sample);} \)

\( \lambda_C = \text{DALY rate for the assisted communities for the present situation (study sample);} \)

\( c = \text{percent of the population covered by community nursing in the year 2008.} \)

\( e = \text{effectiveness of community nursing services} \)

Data source: DALY (Disability Adjusted Life Year) rates, representing years of life lost (YLLs) + years of life lived with disability [6], I have obtained from Study concerning the county and local burden of disease for Sibiu county, (cross-sectional study) and comparative analysis of health issues according to their “burden” on the population from communities that benefit from community nursing and unassisted...
communities – Dr. Doina Merla, Doctoral Thesis “Reducing the burden of disease by developing of community nursing”, “Lucian Blaga” University of Sibiu, 2010 [7].

The number of healthy years of life lost by premature death and disability (DALYs) for the two samples of population was:

Study sample 42050 DALYs per total population (270795 persons), a rate of 155.3/100, namely:

- 23501 DALYs men with a rate of 180.2/100
- 18548 DALYs women with a rate of 132.1/100

Witness sample 26938 DALYs per total population (154064 persons), a rate of 174.8/100, namely:

- 15569 DALYs men with a rate of 204.9/100
- 11369 DALYs women with a rate of 145.6/100

B2. Calculating the cost-effectiveness ratio (RCA)

The general formula used to calculate the cost-effectiveness ratio (CER) is [2]:

\[
\text{CER} = \frac{\text{Sum of Costs}}{\text{Sum of Benefic Effects}}
\]

The cost-effectiveness of the services was determined based on the data resulted from stages A and B.

**Statistical collectivity (statistical population)** representing the object of the statistical analysis:

- **Study sample** – the population of Sibiu county that benefited from community nursing = 270795 persons, of which 82791 assisted persons;
- **Witness sample** – the population from Sibiu county that did not benefit from community nursing = 154064 persons.

**Variables analyzed:**

- independent variables: gender, age group, number of population for the two samples, number of deaths, DALY rates, coverage percent, budget for 2008;
- continuous quantitative dependent variables: life expectancy, survivors, differences in years of life lived, cost-effectiveness of services.

**Statistical series**

- bivariate: the string of values corresponding to the difference between the two populations;

**Instruments used:**

- Microsoft Office Excel for the registering, complex grouping and data processing. Simple statistic tables, grouping tables and correlation tables were obtained, and formulae mathematical and statistical functions were applied for the calculus of analytical and synthetic statistic indicators;
- Exercise for applying the calculation method for the adjusted table of mortality Brass Growth Balance, and Excel template with illustrations of the application;
- Standard set of values Lx, for the life table;
- Microsoft Office Word for the editing of the study, presenting information and results, graphical representation of the material resulted from the research, analysis and synthesis;

**IV. RESULTS**

In the year 2010, a number of 82791 persons from Sibiu county (studied sample) beneficiated from community nursing, representing 19.54% of the total population of Sibiu county and 30.57% of the total population from assisted communities; considering these conditions, the standard was of 2500 persons/community nurse and 500-750 persons of roma ethnicity/sanitary mediator.

Supplying criteria for economical evaluation of community nursing and verifying the hypothesis according to which, in Sibiu county, community nursing specific interventions were cost-effective, bringing economical advantages by the health gain due to the years of life gained by the population of the community that beneficiated from this type of services (study sample), compared to the population of the other communities (witnss sample), conducted to the following results:

- The difference between the life expectancies at birth for the two samples is obviously favorable to the male population from the studied sample, the largest difference being for these groups of age: 15-19 years = 1.98 years, 10-14 years = 1.93 years and 20-24 years = 1.83 years.
- The difference between total number of years lived by the assisted male cohort and the unassisted male cohort: assisted Tx - unassisted Tx, namely 714735-6995885=151750 years of life gained by male population from the researched sample. (Table no 1, Graph no 1)
- Also, the difference between the life expectancies at birth for the two samples is favorable to the female population from the studied sample, the largest difference being for these groups of age: 35-39 years = 1.06 years, 15-19 years = 1.03 years and 45-49 years = 1.00 years.
- The difference between the total number of years lived by the assisted women cohort and the unassisted women cohort – assisted Tx – unassisted Tx, namely 7825011-7758635=66376 years of life gained by the female population of the researched sample. (Table no 2, Graph no 2)
- A gain of 218126 years of life gained by the assisted population compared to the unassisted population was recorded, more of the gained years being lived by men (151750) compared to the number of years gained by women (66376).
- The allocated budget from the Ministry of Health to Sibiu county for the VI National Program – Community Nursing and Actions for Health was of 1049000 lei;
Table 1 - Life table for men, with and without community nursing, Sibiu county for the year 2008

<table>
<thead>
<tr>
<th>Age group</th>
<th>Men from the researched sample</th>
<th>Men from the witness sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>$l_x$</td>
<td>$d_x$</td>
</tr>
<tr>
<td>0-1</td>
<td>100000</td>
<td>891</td>
</tr>
<tr>
<td>1-4</td>
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<tr>
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</table>

Notations:
- $x$ – the exact age of the men in the two cohorts
- $l_x$ – cohort arbitrarily set (value 100000)
- $d_x$ – number of man deaths at age $x$ in the cohort $l_x$ for the probability of death $q_x$
- $T_x$ – total number of years lived by the generation studied from $l_x$.

Graph 1 - Percent of surviving males from $l_x$ between the exact age of $x$ and $x+1$ for the two samples (survival curve), Sibiu county

- The average cost/assisted person/the year 2008 was of 12.67 lei.
- The cost per 1 year of life gained was of 4.81 lei.

V. CONCLUSIONS

Community nursing specific interventions are cost-effective.

The interventions of community nursing are supplied on the basic level of the health system and their main objective is promoting health (education for health, prevention and maintaining health) offering considerable economical advantages by health gain, reducing inequalities and costs for secondary healthcare level (hospitalization). These interventions can be generalized and can be sustained on the long term with minimum costs, generating important benefits for the entire population.

Community nursing specific interventions need to be permanently adapted to the ever changing populations needs by public health management.
Table 2 - Life table for women with and without community nursing services, Sibiu county

<table>
<thead>
<tr>
<th>Age group</th>
<th>Women from the researched sample</th>
<th>Women from the witness sample</th>
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</tr>
<tr>
<td>85+</td>
<td>34465</td>
<td>34465</td>
</tr>
</tbody>
</table>

Notations:

x – the exact age of the women in the two cohorts
lx – cohort arbitrarily set (value 100000)
ndx – number of women deaths at age x in the cohort lx for the probability of death qx
Tx – total number of years lived by the generation studied from lx

Graph 2 - Percent of surviving women from lx between the exact age of x and x+1 according to the two samples (survival curve), Sibiu county

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