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ECONOMIC EVALUATION OF A GERIATRIC DAY HOSPITAL: COST-BENEFIT ANALYSIS BASED ON FUNCTIONAL AUTONOMY CHANGES

A Report Prepared for
the Health Transition Fund, Health Canada

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National Evaluation of the Cost-Effectiveness of Home Care

and

Gerontology and Geriatrics Research Center
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PREFACE

The National Evaluation of the Cost-Effectiveness of Home Care is an integrated program of research with 15 studies being conducted across Canada. There is an overall strategy for the program of research to make it as useful to administrators and decision makers as possible. The program of research is designed to determine whether or not home care is a cost-effective alternative to institutional care, that is, care in long term care facilities and acute care hospitals. However, the program of research is also designed to provide an educational function to inform decision makers and the public about home care and to provide advice about issues related to implementing new and cost-effective home care initiatives. Thus, the overall strategy has the following components:

- Conduct studies to determine whether or not home care is a cost-effective alternative to institutional care, and if so, under what conditions it is cost-effective.

- Conduct studies to inform decision makers about the nature and scope of home care services across Canada. These studies provide a baseline of information about home care clients, costs, and utilization. This baseline is important because there is currently no national database on home care in Canada.

- Conduct studies to explore opportunities for potential savings in the hospital sector by substituting home care services. At present there are relatively few areas noted in the literature where home care has been shown to be a cost-effective alternative to hospital care.

- Conduct studies to provide decision makers with information about some of the issues they may face if they try to implement new initiatives to enhance the cost-effectiveness of the health care system.

This study, Substudy 10, *Economic Evaluation of a Geriatric Day Hospital: Cost-Benefit Analysis Based on Functional Autonomy Changes*, examines the question of whether a geriatric day hospital can provide benefits beyond the costs involved in running such a program. Such benefits are measured by changes to an elderly person's functional autonomy.

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EXECUTIVE SUMMARY

Rationale for the Study

Given the costs and uncertain effectiveness of a geriatric day hospital (GDH), there is a need for additional economic evaluations. The goal of Substudy 10 of the National Evaluation of the Cost-Effectiveness of Home Care project was to investigate whether the benefit related to a geriatric day hospital (GDH) program exceeded the costs using a cost-benefit analysis based on functional autonomy changes.

Key Findings

Substudy 10 demonstrated that in our convenience sample composed of elderly people living at home and presenting an average functional autonomy score of 17.9 on the SMAF scale and admitted to a GDH program, the benefit outweighed costs by 114% ($1 dollar invested = $2.14 of benefit; 95%CI: $1.72-2.56). This estimate relies only on functional autonomy changes and must be viewed as the lower limit of the global benefit of the GDH program. Other studies should be done to duplicate our results to compare the benefit related to a GDH with the benefit related to no or a different intervention.

Implications

The results of this study give policy makers more information on the economical aspects of a GDH program for their decisions about budget allocation for the health care of the elderly. From the societal point of view, this report suggests that it is efficient to allocate resources to GDH programs for elderly who have a decrease of functional autonomy.

Methodology/Data Collection

The sample was composed of 151 patients admitted to the GDH program at the Sherbrooke University Geriatrics Institute (SUGI) in the Province of Quebec, Canada. Data from a previous longitudinal study tracking autonomy changes in 607 elderly people over 75 years of age living at home were used to create a comparison group. Clinical data collection. After admission to (T_0) and at discharge (T_1) from the GDH program, functional autonomy was assessed by a trained nurse using the Système de Mesure de l'Autonomie Fonctionnelle (SMAF). Based on financial reports, costs associated with resources consumed by the GDH program were established. Benefit in dollars per day was estimated through regression equations based on functional autonomy changes T_1-T_0 related to the GDH program. A scenario for spreading the benefit per day was proposed: the median time from survival analysis to institutionalization or death from the comparison group.

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INTRODUCTION

The aging population is at the root of an important factor contributing to the cost of health care in the industrialized world. The elderly represent 18% of the Swedish population and 12% of Canada's [1]. In addition, the aging of people with disabilities increases home care and institutionalization needs and generates major expenses in health care services. In 1991, elderly people accounted for 41% of public health care expenses in the Province of Quebec although they represented only 11% of the total population [2]. This reality is a challenge for current public health care systems.

Given the economic constraints facing health care systems, Geriatric Day Hospitals (GDH) constitute a partial answer to the escalating demand for institutional care and services. GDHs have the potential to decrease institutional care and may be seen as a way to reduce health care costs. GDHs provide a setting where care and services for the elderly with disabilities related to poor physical health or psychosocial impairments can be treated on an ambulatory basis. Their programs typically include patient need assessments, comprehensive patient care coordinated by a multidisciplinary team, extensive retraining to improve functional autonomy, and opportunities for social interactions with staff and other elderly persons [3].

Despite the popularity of GDH programs throughout North America over the last decade [4], little is known about their effectiveness. Study results are often contradictory. In one study, GDHs had no significant effect on mortality, use of emergency or hospital services, placement, or changes in selected measures of health status [5]. In another study, no difference was found on functional status or the quality of life of older patients as compared with otherwise excellent geriatric outpatient care [6]. However, positive effects were found on autonomy in activities of daily living and on depression [7], on low rates for re-attendance at day hospitals (within three months of day hospital discharge) and chronic attendance (more than three months) [8], as well as on patients' perceptions of the benefits from services and professional support [9].

Costs related to GDHs were investigated in six randomized trials (Table 1). A review of the four studies carried out before 1985 indicates that GDHs appear to be more expensive when the control group has a relatively low hospitalization and institutionalization rate, and when the day hospital does not operate close to full capacity [3]. The fifth study done in 1992 showed that GDHs were not an efficient alternative to therapeutic, rehabilitation and diagnostic services given in usual facilities [10]. On the other hand, a more recent study (1995) carried out in Hong Kong revealed that the costs of day hospital treatment were found to be cheaper than an equivalent period of in-patient rehabilitation or out-patient therapy [11]. However, the cost estimation was crude and these results should be interpreted with caution.

Table 1: Review of randomized studies on day hospital cost and effectiveness

Authors	Population	Group	Follow-up	Results	Remarks
Woodford-Williams et al. 1982	500 previously hospitalized patients	Intervention: Day hospital Control: Not specified	1 year	Functional status: Trend favoring treatment group Cost: Not assessed specifically	. Poor validity . Results difficult to interpret
Weissert et al. 1980	552 referrals from hospitals and community services	Intervention: Day hospital Control: Community care	1 year	Functional status: No difference in physical function, institutionalization or death Cost: Intervention group = $6,501 Control group = $3,809	. Strength: intend-to-treat analysis
Tucker et al. 1984	120 consecutive patients referred to day hospital	Intervention: Day hospital Control: Hospital admission or outpatient management	5 months	Functional status: Small effect on activities of daily living and depression Cost: Intervention group = $3,052 Control group = $2,083	. High participation rate
Cummings et al. 1985	96 elderly persons meeting the criteria for intensive inpatient rehabilitation	Intervention: Family training and day hospital Control: In-hospital rehabilitation	3 month post-discharge	Functional status: No effect on activities of daily living and physical functioning Cost: Intervention group = 27% higher ($17,931) Control group = $14,082	. Took into account opportunity cost (what economic burden they might have had, had they not taken care of the disabled family member)
Eagle et al. 1992	113 elderly persons eligible for day hospital	Intervention: Day hospital Control: Usual care prior to advent of DH	1 year	Functional status: No effect on functional status and health-related quality of life Cost: GDH increased the costs to the Ontario Ministry of Health and society	. Excellent validity . Very detailed cost estimation
Hui et al. 1995	200 elderly persons	Intervention: Day hospital	1 year	GDH costs: Cost per patient is estimated at $27,274 including transportation based on 28.8 weeks Comparison: No direct estimate Inpatient: $40,768; Outpatient: $29,016	. Assumption that 45 days at GHD was equivalent to a 10-wk inpatient period; .Very crude estimate

In view of these contradictory results, it is difficult to make a judgment regarding the efficiency of GDH programs based on their costs. Moreover, these conclusions may not be applicable to GDHs because of new economic constraints in Canada and other countries.

Given their costs and uncertain effectiveness, GDHs need additional economic evaluations. The most common methods used in health economics are cost-minimization, cost-effectiveness, cost-utility and cost-benefit analyses. Cost-minimization analysis implies that we compare two programs or services assuming that they have common and identical effects but presumably at different costs. The efficiency evaluation is then a search for the lowest cost alternative [12]. One example would be a comparison of home versus hospital treatment for psychiatric patients [13].

However, when two programs have a common effect but differ in their success in achieving this outcome and have different costs, a cost-effectiveness analysis is indicated as the economic evaluation. Prolongation of life is calculated for each program and comparison is based on cost per unit of effect (i.e. cost per life-year saved). The decision rule underlying cost-effectiveness analysis is that the number of life-years gained should be maximized within a given budget [12].

When effect differs between programs, a cost-effectiveness analysis comparison is impossible. In this situation, a common denominator is indicated to facilitate comparison. This analysis is based on translating effects such as disability days avoided or life-years gained into their benefit expressed in dollars. Consequently, when the costs and effects of programs are measured in dollars, a cost-benefit analysis is preferred. The results might be stated either in the form of a ratio of dollar costs to dollar benefits, or as a simple sum representing the net benefit of one program over another. The decision rule is that the program should be implemented if the benefit exceeds costs [12].

In some circumstances, it is impossible to obtain the common denominator expressed in dollars. In these cases, researchers try to put a value on the effect of the programs. This analysis is called cost-utility. Utility refers to the perception by individuals or society of the value of a specific improvement in health status related to a program. For example, for two people equally disabled by an arm amputation, the utility of a rehabilitation program may be different if the first is a building worker and the second is a teacher. The common denominator usually used is healthy days or quality-adjusted life-years. They are expressed by adjusting the length of time affected through the health outcome by the utility value on a scale of 0 to 1 (QUALYs). The decision rule is to maximize the number of QUALYs gained for a given budget [12]. This method has experienced some problems with the quality of life measurement and the construction of valid utility indexes [14], particularly in the elderly population [15].

This brief review shows that there are many possible issues in the economic evaluation of a GDH. If the research question is “Do the benefits related to a GDH exceed the costs?”, a cost-benefit analysis should be the indicated approach. However, practical problems associated with measuring and valuing benefits in monetary terms often lead analysts to avoid doing cost-benefit analyses of rehabilitation programs. Recently, this problem was partially resolved by ground-breaking methods allowing managers to quantify the benefits of improving functional autonomy. The data generated by a study on the costs of caring for the elderly in different living environments made it possible to quantify the costs associated with functional autonomy changes from level X to level Y, taking into account the health services required in three specific living environments (home-dwelling, intermediate facilities and nursing homes) [16].

In the new context of the feasibility of quantifying benefits of improving functional autonomy, the objective of this study was to answer the question “Do the benefits related to GDHs exceed their costs?” using a cost-benefit analysis, where the benefits are estimated through functional autonomy changes and the competing alternative is the do-nothing approach.

METHODOLOGY

Design

Since it is unethical to use an experimental design, this study was based on a quasi-experimental design with an historical cohort as comparison group.

Setting

This cost-benefit analysis is based on the results of a study evaluating the GHD program at the Sherbrooke University Geriatrics Institute (SUGI) in the Province of Quebec, Canada [17]. The SUGI provides care for the elderly through five programs: 1) specialized geriatric out-patient clinics; 2) long term care (patient capacity: 411); 3) short term active geriatric care (patient capacity: 40); 4) functional rehabilitation (patient capacity: 24); and 5) geriatric day hospital (patient capacity per day: 28). This GDH was opened in 1982 with the objective of helping the elderly to stay at home with a good quality of life. It serves a community of 25,000 elderly people. Using a holistic approach, a multidisciplinary team tries to maximize the potential of elderly individuals affected by a functional autonomy decline. The program offers a wide spectrum of care delivered by a multidisciplinary team composed of physicians, nurses, occupational therapists, physical therapists, speech therapists, neuropsychologists, gerontopsychiatrists, dietitians and social workers.

Sample

The population under study was composed of all elderly people admitted to the GDH program between April 1, 1998 and March 31, 1999. The inclusion criteria in the study were: 1) being admitted to the GDH program; 2) having received at least two different services; 3) having had at least four visits; 4) having been discussed at least once at a multidisciplinary meeting; and 5) having agreed to participate in the study.

Comparison group

The comparison group was drafted from a previous longitudinal study [18] tracking autonomy changes in elderly people. The study used a representative sample of community-dwelling individuals over 75 years of age (N=607), living in Sherbrooke (Quebec, Canada), a town of 75,000 inhabitants. The mean SMAF score was 8.9 (sd: 8.7) at the beginning of the study and 20% of the elderly need assistance on a regulary basis. The annual occurrence of functional decline was 27%, including death and institutionalization. This sample was used to identify two estimates required in the present study: the natural decline of functional autonomy over time and median time to institutionalization or death. This comparison group was created by matching the elderly people from this previous study with GDH patients on gender, age categories (75-79 and 80+) and SMAF scores at the beginning of follow-up (T_0).

Functional autonomy measure

The clinical measure used to estimate the benefits of the GDH program in term of functional autonomy changes was the standardized instrument "Système de mesure de l'autonomie fonctionnelle" (SMAF) [19]. The SMAF is a 29-item scale measuring functional ability in five areas: activities of daily living (7 items), mobility (6 items), communication (3 items), mental functions (5 items) and instrumental activities of daily living (IADL) (8 items). Each item is scored on a 4 or 5-point scale from 0 (independent) and 0.5 (with difficulties) to 3 (dependent) for a maximum total score of 87. The SMAF must be administered by a trained health professional who scores the individual after questioning the subject and relatives, observing or testing the subject. Its reliability and validity have been tested in numerous studies [19-22].

Clinical data collection procedure

After being admitted to the GDH program, patients were scheduled for an initial assessment (T_0). Demographic data were collected and functional autonomy was assessed by a trained nurse using the SMAF. At discharge, the nurse reassessed the patient using the SMAF (T_1). Assessments of other clinical outcomes (cognitive function problems - 3MS, walking/balance problems - Tinetti, etc.) were also conducted at T_0 and T_1.

Cost estimation related to the GDH program

<u>Sources of information for cost estimation</u>

Four information sources were used for cost estimation. First, the Monthly Financial (MF) report completed by the director at the end of each month gives information by activity center regarding the cost of salaries, employee benefits and furniture. This report is used to track the budget of all activity centers. Second, compilation of the 12 MF reports constitutes the Annual Financial report (AS-471). This report is recognized by the Ministry of Health of the Province of Quebec as the accounting system for all health establishments. It presents subcategories of costs by activity center. Examples of these subcategories are salaries, employee benefits and furniture associated with maintaining the facility. Third, the Cost Allocation by Program (CAP) report gives the distribution of total costs for each of the five SUGI care programs and the research center [23]. This report is constructed from the AS-471 where different distribution keys are used to assign an activity center cost to each SUGI program. Fourth, a Daily Statistics (DS) report completed by health professionals reporting minutes of patient care was used in some specific situations, such as the actual time spent caring for a GDH patient.

<u>Type of costs estimated</u>

Direct costs associated with resources consumed by the GDH program were estimated in this study. They were divided into two categories: general costs and specialized costs. General costs include four subcategories: costs related to the GDH unit (administration, staff and furniture), support services, administrative support and services related to patient care (laboratories, radiodiagnostic, etc.). Specialized costs relate to specialized health professionals caring for specific patients. Items included in each category are described in Table 2.

Moreover, indirect costs related to the GDH program are also taken into account. Indirect costs are those charged to the elderly at each GDH visit. They are related to transportation and lunch ($5.00/visit).

Method of estimating direct costs associated with resources consumed by the GDH program

For the general costs category, the cost per visit ($/visit) to the GDH program was calculated. In this method, the four subcategories of general costs were added and then divided by the total number of visits to the GDH program for the time period under study (6315 visits). For the GDH unit, costs were established by identifying those related to administration, staff (physicians, nurses, recreologist) and furniture. For support services, costs related to the facility and security service were estimated by the proportion of square meters of the GDH in relation to the total area of the SUGI. Housekeeping was estimated based on real hours assigned to the GDH. Transportation and food were estimated by the number of services delivered. Administrative support was attributed taking into account the proportion of direct costs or paid hours of the GDH program related to all units of the SUGI. All costs for laboratories, electrophysiology and radio-diagnostic/radio-oncology related to GDH patients' investigations were added and included in costs related to patient care.

Two different estimation methods were used for specialized costs. For staff caring for specific patients, the average salary per hour ($/hour) for each category of health professional was calculated using the MF report.

Table 2: Categories and subcategories of direct costs associated with resources consumed by the GDH program

	General costs: 4 subcategories ($/visit)			Specialized costs ($ for patient X)
GDH unit	**Support services**	**Administrative support**	**Services related to patient care**	**Personnel**
GDH administration [a]	Operation of the facility	General management [g]	Laboratories [c]	Caring for specific patient [i]
Physicians [b]	Independent human resources [d]	Patient care management [g]	Electrophysiology [c]	Occupational Therapist
Nurses [a]	Furniture [d]	Human and material resources management [g]	Radiodiagnostic and radio-oncology [c]	Social Worker
Leisure activities [c]	Maintenance and repair of the facility	Professional services management [g]		Speech Therapist
Furniture [a]	Chief of service [d]	Hospital services management [h]		Neuro-psychologist
	Personnel [d]	Computer support [g]		Nutritionist
	Furniture [d]	Receptionist, archives and telecommunications [g]		Physiotherapist
	Housekeeping [e]	Training [g]		Caring sporadically for patient [j]
	Patient transportation [f]			Medical specialists
	Security service [d]			
	Food services [f]			

[a] estimated from AF report
[b] estimated from % of time at GDH and annual salary
[c] estimated from CAP report
[d] estimated from AF report – based on the proportion of square meters of GDH unit related to total area of SUGI (4.95%)
[e] estimated from AF report – based on real hours assigned to GDH and mean $/hour
[f] estimated from AF report – based on direct costs related to number of services delivered
[g] estimated from CAP report – based on proportion of GDH unit costs related to SUGI total costs
[h] estimated from CAP report – based on proportion of hours paid in GDH unit related to those of SUGI
[i] estimated from MF report (mean $/hour) and DS report (time caring for specific patient)
[j] estimated from provincial health system

For the group of staff caring sporadically for some patients, the costs for patient X were estimated using real costs for consultations charged to the provincial health system multiplied by the number of consultations done. Specialized costs were also established for each patient individually.

The total cost for patient X was established by adding direct costs (general and specialized costs) and indirect costs (Equation 1).

Equation 1:

Total cost for patient X		= Direct costs + Indirect costs
		= (General costs + Specialized costs) + Indirect costs
		= {[(GDH + SS + AS + SC) × # of visits] + Σ Staff caring for patient X} + Indirect costs
Where	GDH	= Geriatric Day Hospital unit
	SS	= Support services
	AS	= Administrative services
	SC	= Services related to patient care

Benefit estimation related to the GDH program

Method of estimating the benefit related to the GDH program

The benefit estimation method is based on a previous study [16]. The objectives of that study were: 1) to determine the level of disabilities and resources involved in the care of elderly people living at home or in institutional settings; 2) to estimate the costs (public, private, voluntary) of these resources; 3) to compare the costs according to the level of disability; and 4) to predict the costs associated with disabilities. Using a cross-sectional survey, a representative sample of elderly subjects living at home (n=300), in intermediate facilities (n=271) and nursing homes (n=774) from metropolitan, urban and rural areas in the Province of Quebec was investigated. The cost estimation included not only the costs associated with care but also those related to support services, infrastructure and administrative services, thus enabling fair comparisons to be made between home and institutional settings. An actual replacement cost was used to establish the value of the care given by the family and volunteers so that the total societal costs were considered not just the public and private expenses. Results showed relationships between disability score (SMAF), nursing time and cost (expressed in 1995 Canadian $/day) in relation to home care (with or without public services), intermediate facilities (family-type or pavilions), and nursing homes (public or private) for metropolitan, urban and rural areas (Figure 1).

The regression equations predicting costs from the total SMAF score for each setting are presented in Table 3.

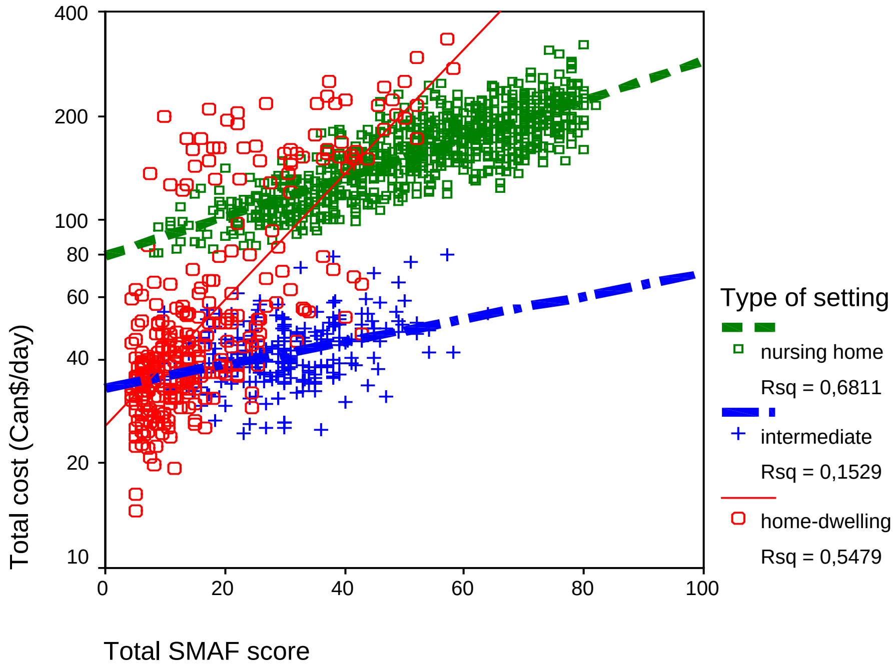

Figure 1: **Costs related to SMAF score by living environment** [16]

Table 3: Regression equations for predicting daily cost (in 1995 Canadian dollars) from the disability (SMAF) scores

Settings	Equation for metropolitan area Log (cost) =	Correction factor for urban area	Correction factor for rural area	95% confidence interval of the estimate	% of the variance of the cost explained (R^2)[1]
Home-dwelling	3.368 + 0.042 SMAF	0.88	0.77	± 1.39	57.2
Intermediate facilities	3.560 + 0.007 SMAF	0.96	0.88	± 1.12	21.7
Nursing homes	4.388 + 0.013 SMAF	1.04	0.96	± 1.05	70.0

[1] adjusted for the geographical area

Since most of the patients referred to the GDH program lived at home or in group homes and since the Sherbrooke area is considered urban, the equation used in this study predicting cost from the total SMAF score is as follows:

Equation 2: Costs associated with a level of functional autonomy (in 1995 Canadian $/day)
Log (Cost) = [3.368 + 0.042 SMAF] * 0.88

Based on equation 2, the benefit of the GDH program was calculated on the difference in the costs associated with functional autonomy at discharge (SMAF T_1) and at admission to the program (SMAF T_0). Moreover, this difference related to functional autonomy changes (SMAF T_1 – SMAF T_0) has to be adjusted to take into account the natural decline in functional autonomy during the time interval of the GDH program. Using the natural decline over time measured with the SMAF observed in the estimation sample, it is possible to document the functional autonomy decline for a period of one year. Knowing the average duration of the GDH program and the average SMAF decrease for one year, it is subsequently possible to adjust the SMAF T_1 – SMAF T_0 of each GDH patient to take into account the natural decline in functional autonomy during the time period of the GDH program (SMAF $T_{1\ adjusted}$ – SMAF T_0). Equation 3 gives the benefit in 1995 Canadian dollars per day related to autonomy changes for patient X, adjusted for the natural decline during his/her length of stay in the GDH program.

Equation 3: Benefit of the GDH program (in 1995 Canadian $/day)

Log (Benefit GDH) = [3.368 + 0.042 SMAF $T_{1\ adjusted}$]* 0.88 – [3.368 + 0.042 SMAF T_0]* 0.88

where $T_{1\ adjusted}$ = SMAF score at discharge from the GDH program adjusted for the natural decline in functional autonomy during the time period of the GDH program and T_0 = SMAF score at admission to the program.

In order to take into account the differential timing of costs between the collection of data related to the benefit estimation (1995) and the estimation of costs in this study (1998), the total benefit is multiplied by 5.59% [24].

Knowing the benefit in dollars per day related to the GDH program, the next step was to determine the period over which this benefit is spread. In other words, what is the time window in which we can assume the patient and society benefit from the functional autonomy changes related to the GDH program?

Spreading of benefit

To answer this question, we propose a model showing 1) a natural decline in functional autonomy over time, and 2) the effect of the GDH program on functional autonomy (Figure 2). Two assumptions are tied with the model proposed: 1) the functional autonomy decline over time is linear for elderly living at home; and 2) the initial score does not affected the slope of functional autonomy decline. This last hypothesis was verified in a previous study [20]. The natural decline in functional autonomy is demonstrated by the increase in the SMAF score as showed by the positive slope of the line representing functional autonomy decline over time. However, incidents may happen which cause functional autonomy to drop rapidly. To counteract this decrease in functional autonomy, admission of the elderly person to a GDH program may be an option. During the GDH program, an increase in functional autonomy should be observed. After the end of the program, functional autonomy resumes its natural tendency to decline in the same way than before the incident. GDH effect is represented by the discrepancy between the two functional autonomy lines after discharge.

In the model proposed to estimate the spreading of the benefit, we assume that the patient benefits from the change in functional autonomy from the discharge of GDH program until institutionalization or death. To estimate this time interval, survival analysis of the comparison group to institutionalization or death is used. The median survival time in years is identified as the spreading time of the benefit.

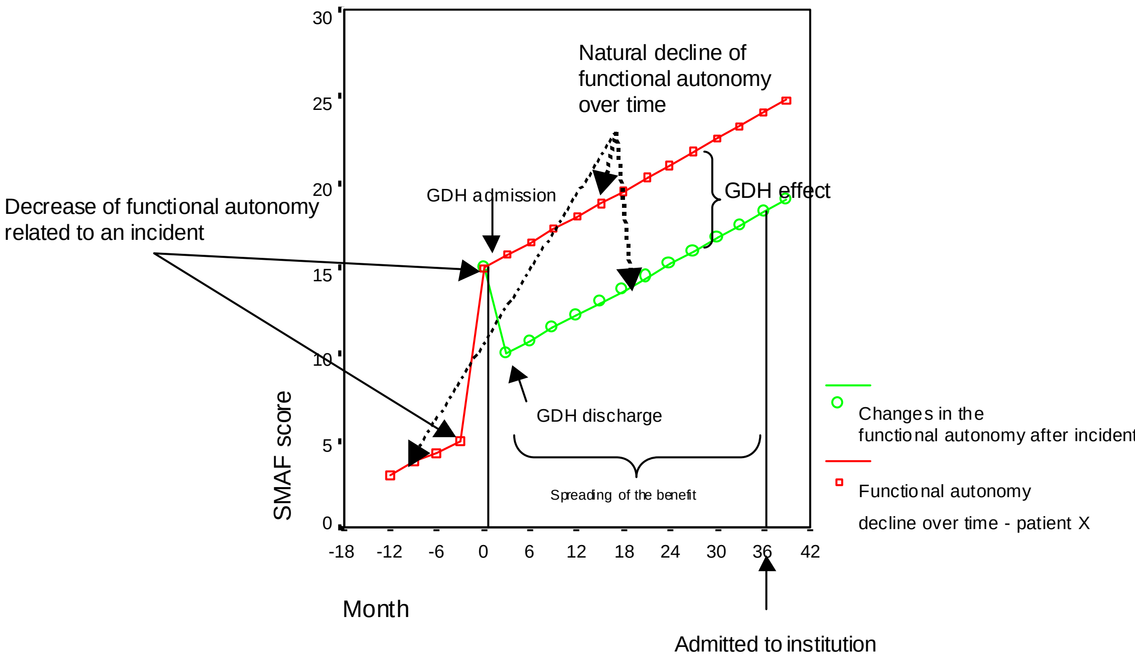

Figure 2: Natural decline of functional autonomy

and effect of GDH program on functional autonomy

DATA ANALYSIS

Descriptive statistics for the GDH sample and the comparison group are presented first. A t-test for independent samples was performed to investigate differences for age and SMAF at T_0. General and specialized costs were calculated and added to give the total cost. The benefits in dollars per day per patient, spreading of the benefit in days, total benefit for the sample and benefit by diagnosis category are presented. Mean, standard deviation (sd), median and semi-interquartile interval (semi-IQ) are presented to describe total costs and total benefit. Cost-benefit is expressed by the difference between costs and benefit, and by the cost/benefit ratio. An 95% confidence interval (95%CI) was estimated for this ratio using the Taylor linearization technique for variance estimation [25]. Because the data are not normally distributed, the Wilcoxon rank test was used to test differences between cost and benefit for the whole sample and for diagnosis categories.

RESULTS

Samples

Complete data were collected for 151 of the 171 patients included in the study at T_0. Comparison of participants and non-participants indicates that those who were not available at discharge evaluation presented more cognitive function problems at admission [3MS → participants: 88.1 (10.7); non-participants: 80.7 (15.2); p=0.02], more disabilities [SMAF → participants: 17.9 (10.5) vs. 26.1 (15.2); p=0.02] and more walking/balance problems [Tinetti → participants: 26.1 (9.8) vs. 19.3 (11.3); p=0.01].

These 151 participants were matched with elderly people from a previous study to create the comparison group. This comparison group was slightly older (p=0.001) and less disabled (p=0.001) than the GDH sample (Table 4). The effect of the GDH program on functional autonomy is shown by the SMAF score improvement (-3.1) from T_0 to T_1 for the GDH sample. The natural decline in functional autonomy observed in the comparison sample for a one year period is represented by an increase of 2.9 points on the SMAF score.

Table 4: Descriptive statistics for GDH and comparison group

	GDH sample			Comparison group		
	Men n = 53 Mean (sd)	Women n = 98 Mean (sd)	Total n = 151 Mean (sd)	Men n = 53 Mean (sd)	Women n = 98 Mean (sd)	Total n = 151 Mean (sd)
Age	75.0 (6.2)	77.8 (7.0)	76.8 (6.8)[1]	78.1 (2.9)	80.0 (4.5)	79.3 (4.2)[1]
SMAF T_0	18.4 (9.8)	17.7 (10.9)	17.9 (10.5)[2]	14.4 (6.5)	16.8 (7.0)	15.9 (6.9)[2]
SMAF T_1	15.7 (9.5)	14.4 (11.2)	14.8 (10.6)	15.6 (9.7)	20.6 (12.9)	18.8 (12.1)
SMAF T_1 – SMAF T_0	-2.7 (4.6)[3]	-3.3 (5.8)	-3.1 (5.4)	1.2 (6.3)	3.8 (10.7)	2.9 (9.5)

[1] p=0.001
[2] p=0.001
[3] a negative sign indicates an improvement

For participants, the diagnosis categories are shown in Table 5. Their average length of stay in the GDH program was 15.6 (sd: 7.7) weeks (Figure 3). The average number of visits per patient was 28.9 (sd: 5.2).

Table 5: **Principal diagnosis categories for GDH patients**

Diagnosis	Frequency	Percentage (%)
Locomotor impairment	58	38.4
Stroke	29	19.2
Walking problems and falls	23	15.2
Neurological diseases	11	7.3
Medical pathologies	7	4.6
Cognitive function alterations	6	4.0
Amputation	5	3.3
Psychopathology	4	2.6
Other	8	5.3
Total	**151**	**100**

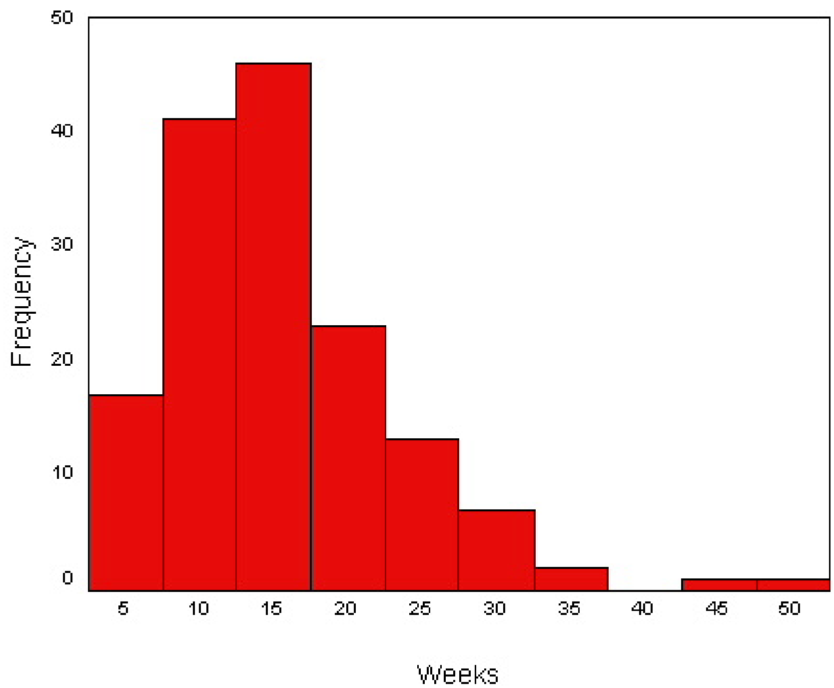

Figure 3: Histogram of length of stay in the GDH program

Direct costs

A description of general costs of the GDH program is presented in Table 6. Summing the four subcategories of general costs ($1,127,332) gives a cost/visit of $179.33.

Table 6: General costs of GDH program

Unit or services	$/year	$/visit [1]
GDH unit		
GDH administration	52,594	8.33
Physicians	141,584	22.42
Nurses	237,671	37.64
Leisure activities	101,688	16.10
Furniture	7,446	1.18
Total	**$540,983**	**$85.67**
Support services related to GDH		
Operating the facility		
. Independent human resources	1,153	0.18
. Furniture	32,962	5.22
Maintenance and repair of the facility		
. Chief of service	4,768	0.76
. Personnel	41,184	7.32
. Furniture	29,688	4.70
. Housekeeping	8,393	1.33
. Patient transportation	39,568	6.17
. Security service	12,353	1.96
. Food services	12,840	2.03
Total	**$182,909**	**$29.76**
Administrative services related to GDH		
General management	23,504	3.72
Patient care management	46,425	7.35
Human and material resources management	43,517	6.89
Professional services management	13,257	2.10
Hospital services management	26,680	4.25
Computer support	21,832	3.46
Receptionist, archives and telecommunications	172,005	27.24
Training	5,821	0.92
Total	**$353,221**	**$55.93**
Services related to patient care		
Laboratories	27,705	4.39
Radiodiagnostic and radio-oncology	21,624	3.42
Electrophysiology	980	0.16
Total	**$50,309**	**$7.97**
GENERAL COSTS Total	**$1,127,332**	**$179.33**

[1] Costs divided by 6,315 visits to GDH program for the year under study

Specialized costs are listed in Table 7. The total for the two subcategories is $218,372.

Table 7: **Specialized costs: personnel caring for patients in GDH program**

Personnel caring for specific patients	Cost by category ($) Mean $/hour × # of hours
. Physical Therapist	92,189
. Occupational Therapist	76,503
. Speech Therapist	16,776
. Social Worker	15,269
. Neuropsychologist	11,773
. Nutritionist	1,754
Total	**$214,264**
Personnel caring for patients sporadically	
$/consultation × # of consultations	
. Medical specialists	**$4,108**
SPECIALIZED COSTS Total	**$218,372**

Total costs

Table 8 shows the total costs (direct + indirect costs) for the GDH sample. Using Equation 1, the total costs were established at $1,021,681 for the 4,358 visits of the 151 patients. The mean cost per subject is $6,6766 (sd: $3,584) and the median was $6,090 (semi-IQ: $6,215). Figure 4 shows the distribution of total costs per patient.

Table 8: **Total costs of GDH sample**

Total costs =	**Direct costs**		**+ Indirect costs**
	(General costs + Specialized costs)		+ $5.00 / visit
Patient X =	= [(GDH + SS + AS + SC) × # of visits] + Σ Staff caring for patient X = [($85.67 + $ 9.76 + $55.93 + $7.97) × # of visits] + Σ Staff caring for patient X = [($179.33 × # of visits] + Σ Staff caring for patient X		+ ($5.00 × # of visits)
	# of visits for the 151 patients in GDH sample = 4,358		
For the 151 subjects =	[($179.33 × # of visits] $179.33 x 4,358 visits	+ Σ Staff caring for patient X	+ $5.00 × 4,358 visits
=	$781,520	+ $218,371	+ $21,790
=	$1,021,681		

GDH = Geriatric Day Hospital unit
SS = Support services
AS = Administrative services
SC = Services related to patient care

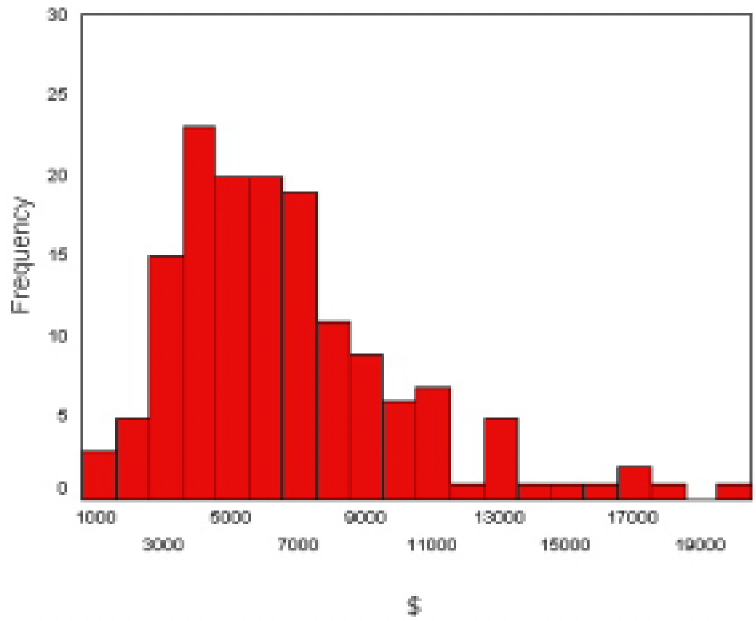

Figure 4: Histogram for total costs per patient

Benefit estimation

Benefit per day

The benefit per day ($/day) is related to the SMAF T_1–SMAF T_0. Knowing from the comparison group that the natural decline in functional autonomy is represented by an increase of 2.9 SMAF-years and from the actual study that the average duration of the GDH program is 15.6 weeks, it is now possible to adjust the SMAF T_1–SMAF T_0 for the natural decline during the GDH program: 2.9 SMAF-years / (15.6/52 weeks) = 0.9 SMAF-years. To take this adjustment into account, 0.9 is subtracted from SMAF T_1 (SMAF $T_{1adjusted}$). Figure 5 shows the distribution of SMAF $T_{1adjusted}$–SMAF T_0 per patient.

Using Equation 3, the $/day related to the functional autonomy change of SMAF $T_{1adjusted}$–SMAF T_0 was calculated for each patient. These benefits were adjusted in 1998 dollars and Figure 6 shows the distribution of 1998$/day per patient.

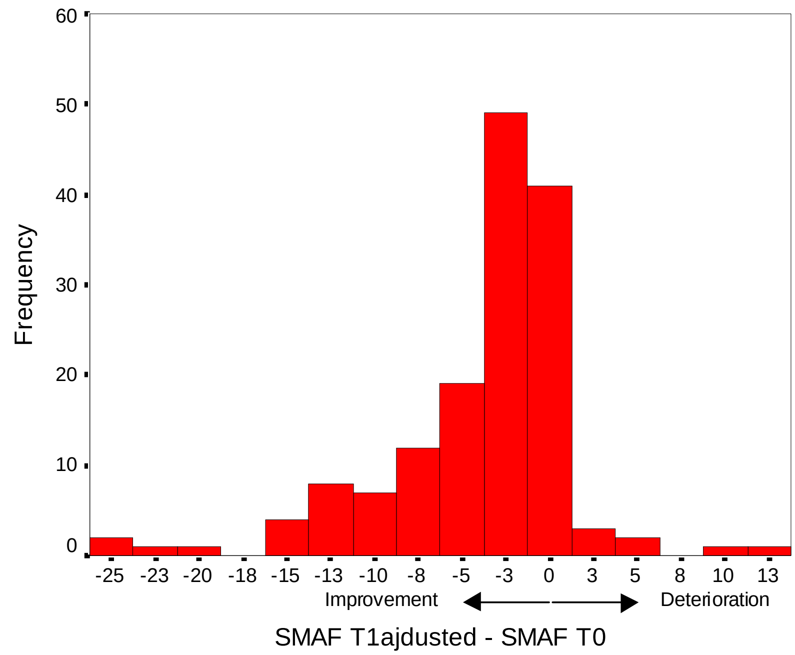

Figure 5: Histogram of SMAF $T_{1adjusted}$–SMAF T_0 per patient

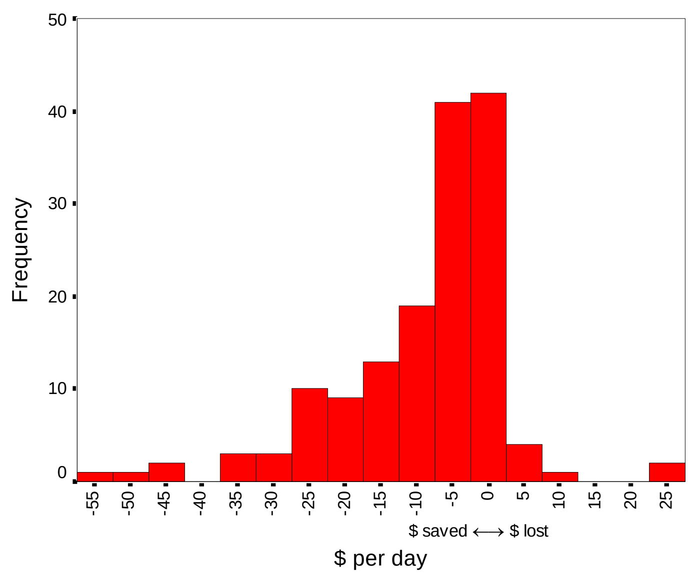

Figure 6: **Histogram of benefit/day per patient (in 1998 $) based on $ SMAF $T_{1adjusted}$– $ SMAF T_0**

Spreading of the benefit

Spreading of the benefit was estimated for the proposed model, which is based on the results of the survival analysis of the elderly individuals in the longitudinal study. The median time to institutionalization or death is 51 months or 1,551 days (Figure 7). This time interval was used as the spreading period for each GDH patient.

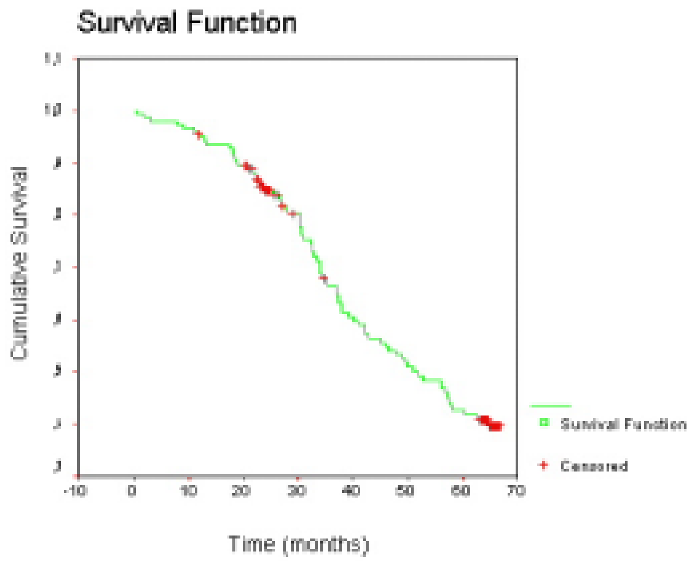

Figure 7: Survival analysis curves to institutionalization or death for the longitudinal study elderly individuals

Benefit per patient and total benefit

The benefit per patient was calculated using the 1998$/day figure for the difference in costs associated with SMAF $T_{1adjusted}$–SMAF T_0 multiplied by the number of days of the spreading period of benefit (1,551 days). Figure 8 shows the distribution of benefit per patient. Total benefit for the whole sample was established by summing the benefit per patient of the 151 patients: the total is $2,183,077. The mean is $14,457 (sd: $18,978) and the median is $7,775 (semi-IQ: $12,659).

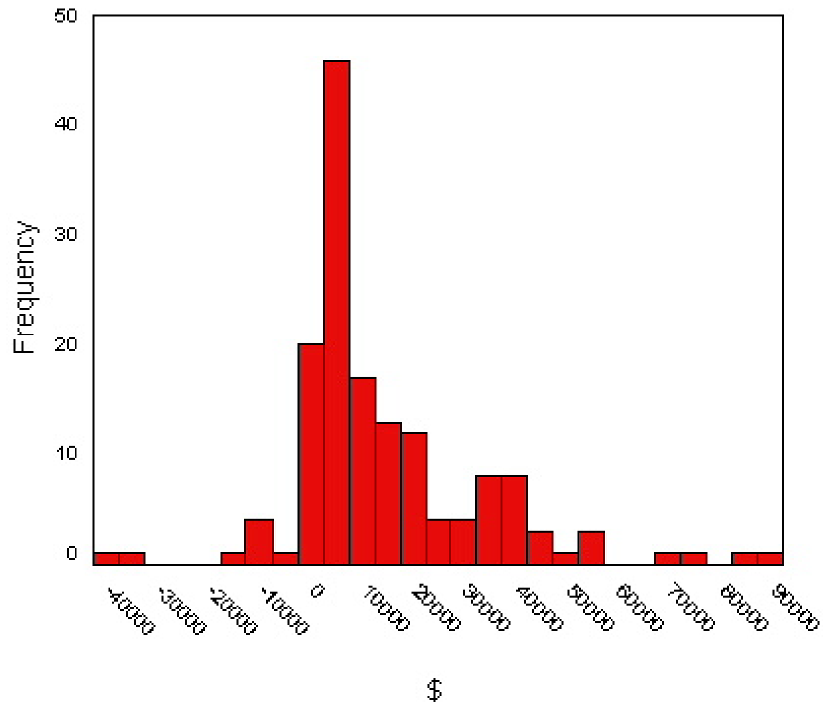

Figure 8: Histogram of benefit per patient

Relation between costs and benefit

The mean cost-benefit per patient based on survival median time to institutionalization or death is \$7,836 (sd: \$18,016) and the median is \$2,335 (semi-IQ: \$7,357) (benefit > costs: p<0.001) (Figure 9).

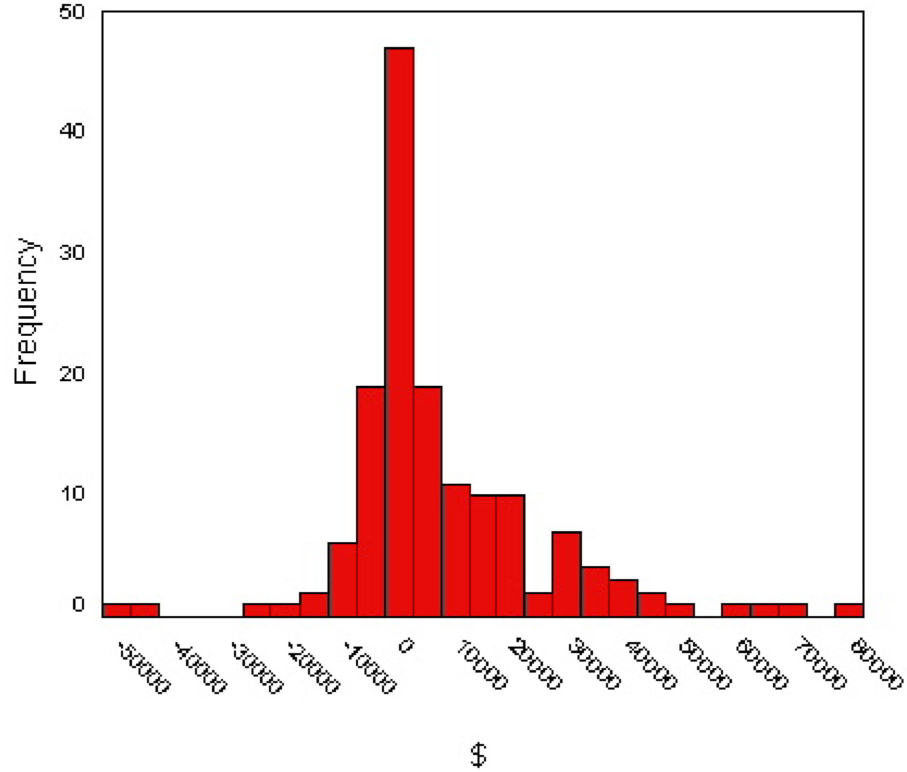

Figure 9: Distribution of cost-benefit per patient

Table 9 shows the cost-benefit analysis for the whole sample. The results show that for each dollar invested in the GDH program, the benefit for the health system is \$2.14 (95%CI: \$1.72-\$2.56).

Table 9: **Cost-benefit analysis**

Scenario for spreading of benefit	**Total costs** (in \$ 1998)	**Total benefit** (adjusted in \$ 1998)*	**Difference**	**Cost/benefit** (95%CI)
Survival median time to institutionalization or death	\$1,021,681	\$2,183,076	\$1,161,395	\$1 invested = \$2.14 benefit (\$1.72-2.56)

* Allowance for differential timing of costs : 1998 \$ = 1995 \$ in x 5.59%

Cost-benefit by principal diagnosis categories

Figure 10 shows the mean cost and mean benefit per diagnosis category. For two groups of patients, benefits are statistically higher than costs (stroke/neurological diseases: $p<0.001$; locomotor problems/amputation: $p=0.004$). Other differences are not significant.

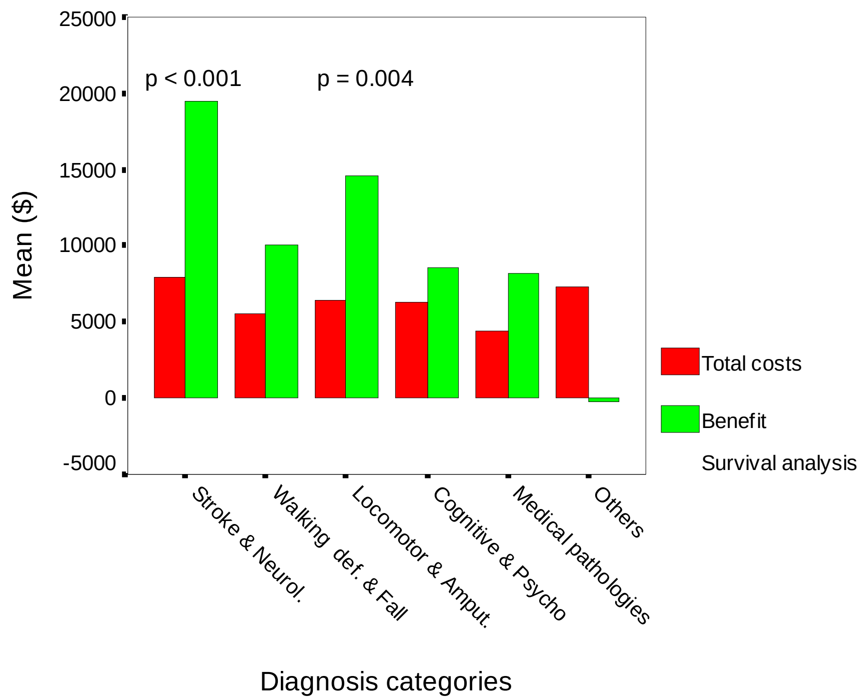

Figure 10: Comparison of costs and benefit by diagnosis category

Cost-benefit by grouping diagnosis categories

Secondary analyses were conducted to verify the hypothesis of dilution of cost-benefit when all diagnosis categories are taken together (Table 10). The sample was split into two subgroups. The first analysis included only patients where the main goal of the GDH program was to increase functional autonomy status, such as those with 1) stroke/neurological diseases, 2) locomotor problems/amputation, and 3) walking problems/falls (n = 126). The cost-benefit stands at $2.35 (95%CI: $1.89-$2.81). In the second subgroup including only patients where the goal of the GDH program was not oriented principally toward a gain in functional autonomy, such as 1) medical pathologies, 2) cognitive function alterations and psychopathologies, and 3) other patients (n = 25), the cost-benefit of the GDH program drops to $0.95 (95%CI: $0.12-$1.78) for each dollar invested, i.e. a loss of $0.05.

Table 10: **Cost-benefit analysis by diagnosis subcategory**

Scenario of spreading the benefit	**Total costs** (in $ 1998)	**Total benefit** (adjusted in $ 1998)*	**Difference**	**Cost-benefit** (95%CI)
Diagnosis categories where the goal of GDH <u>is</u> to increase functional autonomy: Stroke/neurological – locomotor problems/amputation – Walking problems/falls (n=126)				
Survival median time to institutionalization or death	$865,387	$2,035,327	$1,169,940	$1 invested = $2.35 benefit ($1.89-$2.81)
Diagnosis categories where the goal of GDH <u>is not specifically</u> to increase functional autonomy: Medical pathologies – Cognitive function alterations/Psychopathologies – Other (n=25)				
Survival median time to institutionalization or death	$156,294	$147,750	-$5,544	$1 invested = $0.95 benefit ($0.12-$1.78)

* Allowance for differential timing of costs : 1998 $ = 1995 $ x 5.59%

<u>Costs, benefit and cost-benefit related to length of stay</u>

Figure 11 shows the relationship between length of stay and costs: as expected, a very strong relation was found (r = 0.98). The relationship between length of stay and benefit is shown in Figure 12. However, this relation was weak (r = 0.35).

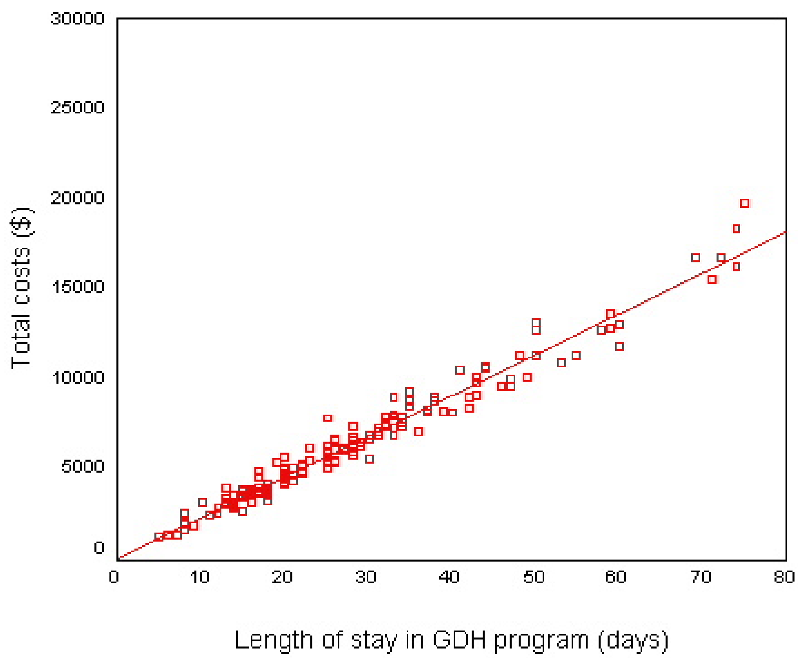

Figure 11: Relationship between length of stay and costs

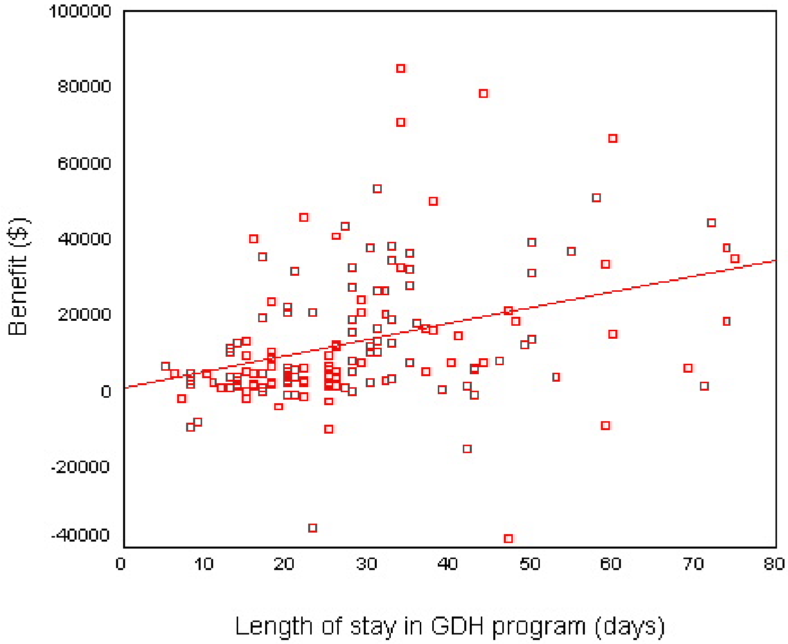

Figure 12: Relationship between length of stay and benefit

Figure 13 shows the mean cost and mean benefit per length of stay categories (0 to 25 days, 26 to 50 and 51+). Three tendencies emerged for both scenarios: 1) benefits are statistically higher than costs for length of stay between 26 and 50 days (p<0.001); and 2) there is no statistically significant difference (benefit > costs) for a length of stay over 50 days; 3) there is no statistically significant difference (costs > benefit) when the length of stay is under 25 days.

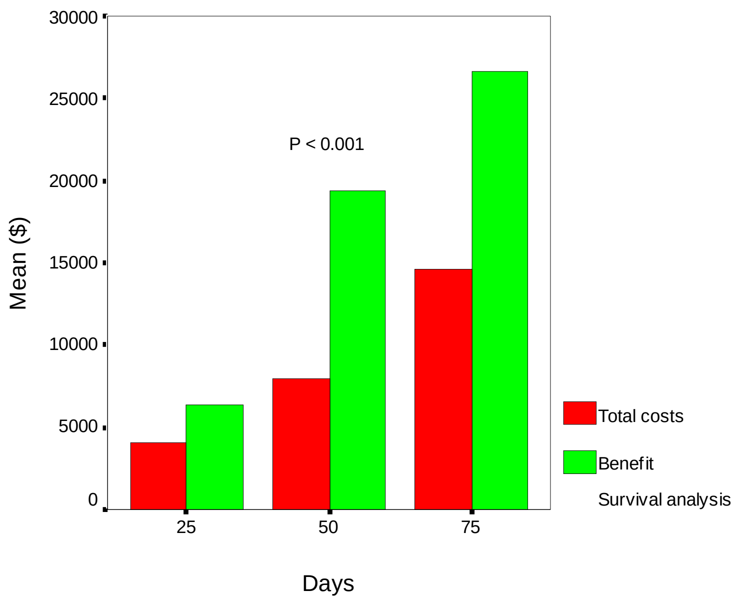

Figure 13: Comparison of costs and benefit by length of stay

DISCUSSION

The objective of this study was to investigate whether the benefit related to a GDH program exceeded the costs using a cost-benefit analysis. Knowing the benefit for each dollar invested in a GDH program, policy makers will be able to make more informed decisions about budget allocation for the health care of the elderly.

Based on financial reports, general and specialized costs were established. Benefit was estimated through regression equations based on functional autonomy changes related to the GDH program. Our results show that the benefit exceeds costs: $2.14 (95%CI:$1.72-$2.56). Because our study is the first to use a cost-benefit analysis of a GDH, it is impossible to compare our results to those from previous studies.

Can we trust these results? To answer this question, some issues must be discussed in relation to the validity of the method used for cost and benefit estimates. First, the validity of the financial reports is investigated. The MF and AS-471 used to estimate general costs are widely recognized in the health system of the Province of Quebec. The CAP report presents costs for different SUGI programs. It is based on the AS-471 where different keys are used to allocate cost of services by program. As argued by the authors of the report, it may present some error sources related to the key distributions, but these errors are minimized. Finally, the method used to estimate the costs of health personnel caring for specific patients appears very precise since health professionals must file statistics about the time spent with each patient on a daily basis. This system is well established and although it is based on self-report, its validity is widely recognized in the health system of the Province of Quebec. However, the average salary per hour used in this study only applies to the SUGI because it depends on the number of years of experience of the health professionals in the unit and on collective agreements used in the Province of Quebec. Hence, if another unit has fewer or more senior health professionals, or if the unit is located in another country, the average salary per hour could be different. Cost estimation for specialist consultations is also very precise because it uses the billing system used in the Province of Quebec. As a whole, the validity of the reports used for cost estimation does not seem to be an issue.

The validity of the benefit estimation also seems to be good. Our study was conducted in the same country as the Hébert et al. (2000) study, meaning that the specific structures of health care services and costs are identical. Moreover, to counteract the different timing of cost estimations between the Hébert et al. (2000) study and the present study, the benefit estimations used in this study were adjusted in 1998 dollars.

Seeing that validity does not seem to be an issue in this study, a general discussion highlights some interesting points from secondary analyses. For example, the analysis of costs-benefits related to the grouping diagnosis categories shows that patient with the greatest benefit present a diagnosis of locomotor problems/amputation or stroke/neurological diseases. Since benefits are estimated through functional autonomy changes, this result is not surprising since admission of these categories of patients to the GDH program aims to increase functional autonomy status. On the other hand, grouping categories such as walking problems/falls, medical pathologies, cognitive function alterations and psychopathologies and other categories show a smaller or no benefit. With the exception of walking problems/falls groups where the expectation was an increase in functional autonomy, this result was not surprising because these categories of patients are going to the GDH program for purposes other than functional autonomy increase. Since the benefit estimation method is based on functional autonomy change, it is not surprising that these patients showed less or no benefit. This sub-analysis supports the hypothesis of dilution of the benefit when we take the whole sample of heterogeneous GDH patients and use functional autonomy as the method of benefit estimation.

Another major point emerged from this sub-analysis. This study showing that the benefit exceeds costs must be considered as the lower limit of potential benefits from a GDH program. This study only estimates the benefit related to functional autonomy changes. Other important aspects such as improvement in cognitive function, socialization, well-being, etc., cannot be estimated in terms of dollar benefits. Thus the benefit estimated in our study is only a portion of the global potential benefit of the GDH program. In this context, when we establish the cost-benefit at $2.14 (95%CI: $1.72-$2.56) for each dollar invested, we must interpret this result as the lower limit of the possible benefit of the GDH program.

Other aspects of the results may be interesting for health policy makers regarding the optimal length of stay for GDH patients. As expected, there is a strong positive relationship between length of stay and total costs. However, this is not the case for the benefit: the relationship between length of stay and benefit is very weak. A tendency emerged from these two points: increasing the length of stay increases the costs but not necessarily the benefit. How can we choose the optimal length of stay where costs are minimized and benefit maximized? From the analysis of the length of stay by categories (less than 25, 26-50, and over 51 days), it seems that the benefit exceeds costs ($p<0.001$) only when the length of stay is between 26 and 50 days. Under 25 days, costs may exceed the benefit, suggesting that there is not enough time to attain optimal benefit for a patient. Also, a length of stay longer than 50 days may be questionable because the difference between the benefit and costs is not significant. These results can be used as a cue about decisions for the most effective length of stay for GDH patients. For example, if the priority is the efficiency of the GDH program from an administration point of view, it could be argued that caring for a GDH patient less than 25 or over 50 days might be questionable. In this case, the multidisciplinary team should re-examine the objectives of the treatment plan for these patients.

Caution must be exercised in the interpretation of the results if we want to answer the question “Which patients should be included in or excluded from a GDH program based on the magnitude of the anticipated benefit?” It would be erroneous to exclude patients who show a small benefit from the GDH program based on our study since we measured benefit only on the basis of functional autonomy changes. Patients with a small benefit estimated by functional autonomy changes may show large benefits in regard to other aspects of their health. Therefore, the present study cannot determine which patients should be excluded. However, there is strong evidence to include patients admitted to a

GDH to increase functional autonomy. However, the fact that patients with walking problems/falls groups showed a non-significant difference between benefit and costs cannot be explained. Indeed, the expectation for this group of patients was an increase in functional autonomy, and consequently, benefit should exceed costs with the benefit estimation used in our study.

Two weaknesses of this study must be highlighted. First, the absence of a true control group means it is impossible to compare benefits related to the GDH with those related to a different or no intervention. Other studies using our methodology need to be done to determine this important aspect of the efficiency of the GDH program. Second, a cohort bias characterizes this study. The results show that functional autonomy status was worse in the 20 non-participants at the beginning of the study [SMAF: 26.1(15.5) compared to 17.9 (10.5)]. Hence the cohort under study is biased in favour of a better functional autonomy level. What is the effect of this bias? This difference leads to the assumption of greater potential to increase functional autonomy among the participants. To answer this question, a sensitivity analysis was conducted to establish the impact of the 20 non-participants on the cost-benefit analysis. For 9 non-participants who were not available at T_1 for reasons such as not located at follow-up, left the GDH program or died, we hypothesized that non-participation does not seem related to functional autonomy change. However, we assume that non-participation of the 11 others may be related to functional autonomy deterioration (transfer to active rehabilitation or hospitalization). The SMAF at T_0 was known for all non-participants and the SMAF at T_1 was extrapolated as follows: 1) for those where non-participation did not seem related to functional autonomy change, SMAF T_1 = SMAF T_0 - 4 (average change in SMAF T_1 during GDH program of the 151 patients); and 2) for those where exclusion seemed related to functional autonomy deterioration, SMAF T_1 = SMAF T_0 + 11.6 (the largest SMAF T_1 increase during the GDH program for the 151 patients). The result of the sensitivity analysis based on the worse case scenario showed that benefit exceed costs, but the difference is no longer statistically significant. However this extreme scenario for 11 of the 20 patients may not represent the reality.

CONCLUSION

Based on our results, we can answer the question “Do the benefits related to the GDH program exceed the costs?” In our convenience sample composed of elderly people living at home and presenting an average functional autonomy score of 17.9 on the SMAF scale and admitted to the SUGI-GDH program, the benefit outweighed costs by 118% ($1 dollar invested = $2.14 of benefit). This estimate relies only on functional autonomy changes and must be viewed as the lower limit of the global benefit of the GDH program. Other studies should be done to duplicate our results to compare the benefit related to a GDH with the benefit related to no or a different intervention.

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