LITERATURE REVIEW IN HOME CARE

Bushra Bashir, Michelle Chabrol, Christophe Caux

▶ To cite this version:

9th International Conference of Modeling, Optimization and Simulation - MOSIM'12
June 06-08, 2012 – Bordeaux - France
"Performance, interoperability and safety for sustainable development"

LITERATURE REVIEW IN HOME CARE

B. BASHIR, M. CHABROL

LIMOS CNRS UMR 6158/Université Blaise Pascal
Campus des Cézeaux-BP 10125

63173 Aubière, France

bashir@isima.fr, chabrol@isima.fr

C. CAUX.

LIMOS CNRS UMR 6158/Université Blaise Pascal
Campus des Cézeaux-BP 10125

63173 Aubière, France

christophe.caux@ifma.fr

ABSTRACT: *Home Care replaces the traditional hospitalization or helps in the early discharge of a patient. The objective of Home Care is to assign health professionals to patients at minimum cost, while satisfying various constraints and maintaining the quality of care. In this paper, we analyze the various types of problems that we have to face within this type of care structure. A systematic literature search was performed in a number of international databases. This review presents the existing problems treated in the home care context and also points out some problems which could not get much attention of the researchers.*

KEYWORDS: *Home health Care, Literature Review, Identification of various problems.*

1 INTRODUCTION

Home Care is a generic term which includes all forms of structures (i.e. public, private or community) that receive patients requiring long and regular care. This care is provided outside the hospital by a team of medical professionals, allied health, rehabilitation, social workers and / or volunteers relied on various services and facilities as a resource.

Last twenty years the number of beds in hospitals and private clinics has only decreased (i.e. from 6.8 beds / 1,000 inhabitants in 1980, 3.8 beds / 1000 inhabitants in 2005, a 40% reduction in France). The aging population has created an increase in the number of people with chronic degenerative diseases that result in functional disabilities and handicaps. Patients who undergo a treatment for chronic progressive or palliative care, they want a support that removes them as little as possible from their family environment for reasons of personal comfort. Moreover, these new needs do not require the care that mobilizes a high-level technical apparatus and thus making heavy load on the hospital. It is for these reasons that the structures of comprehensive care for patients have developed in recent years outside hospital walls in local structures and in various places of living (i.e. school, business area etc.) or their homes. So there is need to adapt the patient's home environment for taking medical, paramedical, social and psychological care comparable to that can be offered at hospital. In the treatment of kidney deficiencies, the realization of dialysis at home will require the care equipment not complicated, but the establishing of an environment for surveillance and monitoring.

Home Care structures (HC) had a total of 5857 beds installed in 2005 (7780 allowed) in the hospital sector and part of the "emergency plan" was expected to reach 15,000 by 2010 in France.

Objective

The purpose of this paper is to do a detailed state of art of the problems issues as well as scientific knowledge in this domain following the three strategic, tactical and operational levels. This will allow us to better identify the variation of the objectives of the home care structure. The problems of high value are selected. The study will allow diagnostics and modeling of existing good practices. The bibliographic knowledge will find the potential contributions of engineering, science, information technology and communication. An initial search of the literature revealed that the study of problem of Home Care is in its infancy. We have found a limited number of publications in engineering sciences and medical sciences that concern the operational management of Home Care facilities. In this paper, we have analyzed the various types of problems that that can arise within this type of care structure. A systematic literature search was performed in a number of international databases. This review presents the existing problems treated in the home care context and also points out some problems which could not get much attention of the researchers.

This paper is organized as follows. Section 2 provides the associated issues and assumptions. Section 3 presents the set of constraints which needs to take into account. In section 4 we identify the various problems relevant to the new development of the home care structure while Section 5 provides a detailed literature review relevant to Home Care Problem, their application and a cost comparison study of traditional hospitalization and home care. Last, concluding remarks and some unexplored research directions are given in Section 6.

2 ISSUES AND ASSUMPTIONS ASSOCIATED

We are interest to work in the research problems related to coordination and network of the home care structures

regarding cost control and quality of care:
Coordination - The new structures outside the walls of the hospital put in place to treat patients whose care needs are difficult and comprehensive in terms of treatment plan (i.e. medical, paramedical, support psychological, social support, ...) require the implementation of a coordination extremely fine structures involved in this support and various professionals involved with the objective of monitoring and care quality (as perceived by the patient and professionals) to ensure efficiency (Minimizing delays, cancellations, redundancy) and to control costs.
The network – These new structures should provide at minimum the same quality of care as in a traditional hospital, through a permanent care provided by a dense network of actors. This raises the question of coordination; a term implies a hierarchy and a single decision-maker. Outside actors monitoring of care, support "distributed" are all decision makers (as well as the patient), with their own objectives. So it is a network of actors that it is required to control, manage and drive across the network complexity to give more than the sum of its nodes.

Our aim is therefore to analyze the problems related to the coordination in home care structures, models of production management of care and internal logistics operational level, in all their "complex network" involving multiple "Decision Makers" and many "resources" and through the set of constraints given below.

3   CONSTRAINTS

For example the constraints on the inter-active coordination of structures are:

- constraints related to decision makers and caregivers due to their own objectives;
- human resource constraints, constraints related to patient choice, lack of availability of these patients (i.e. time of passage, finite number of day care activities, ...) ;
- constraints related to the "range" operations management i.e. relationship dependence between the activities, timing of activities, excluding activities;
- constraints of resource availability supports (i.e. equipment, drugs, sterile medical devices), forced expiration of certain resources (i.e. preparation of chemotherapy), with in all cases this system strongly marked by its various human dimensions, the need to take account of uncertainty and incompleteness on variables, which increase the complexity of the network related to the decision makers and Resources.

4   METHODOLOGY/ TOOLS

We are interested in the history of the Home Care. We then studied the various works that have addressed this issue both in the publications of engineering in the medical world. After conducting a literature review of various works related hospitalization at home, we try to analyze home care structures to study how they work and identify various points at which we could make improvements.

Identification of Various types of Problems in Home Care:

For the efficient organization of Home Care in terms of human and material resource management, we need to analyze the various types of problems that we have to face within this type of care structure. The problems which we identified are given in the following:

i.   Guide and information exchange among different actors of Care
ii. Dimensioning the resources
iii. Modeling of system
iv. Resource Allocation
v.   Management of Human and Material resources
vi. Defining the criteria of quality to meet the necessity to guarantee a satisfactory service
vii. Coordination of HC with other health care network
viii. Districting problem (i.e. the problem of partitioning a territory into districts)
ix. Allocation of resources to districts
x.   Cost saving study (cost comparison of Home Care)
xi. Routing Problem for health Care Personnel and Medicines
xii. Planning and Scheduling of nurses and doctors
xiii. Assignment of human resource to patients
xiv. Taking into account of uncertainties and emergencies
xv. Workload balance among health care personnel and satisfaction of their preferences
xvi. Efficient use of Technological support in the Home Care service delivery

Many problems faced by Operational Research in industry can be applied to problems in home care. In fact, the two fields treat the same problems and thus, the industrial problems can be adapted to home care logistic by adjusting the different parameters to the given situation.

5   LITERATURE REVIEW IN HOME CARE

Due to the important growth of the Home Care in the last decade, this type of hospitalisation has interested a number of researchers. In this section, we survey the studies in Home Care literature. The main issues are delivery problem, scheduling and assignment problem, home care modeling, resource dimensioning problem, districting problem, home care in developing world and cost comparison of home care and hospitalization.

5.1   Home Care Modeling

Crétien van Campen, Isolde B. Woittiez, (2003) estimate the volume and composition of referrals to home care on the basis of applicant characteristics. The rela-

tionships between the background and care needs of applicant groups on the one hand and the referral of home care packages on the other hand, are studied by means of a multinomial logit model. The model is estimated on the basis of more than 7000 requests for home care in the northern part of the Netherlands. In the modeling of Home Care, emphasis has been placed on the differentiation of clients and products. They find for instance that elderly chronically ill applicants have a greater chance of being referred for domestic help only, while applicants with psychosocial disorders are more liable to be offered packages that include social support.

Patients discharged from hospital have a greater chance of a referral to domestic help only when they are slightly disabled, and are more likely to be offered packages including physical care when they are more disabled. The model has a range of policy applications in assessing the impact of changes in the health care system on the volume and structure of the demand for home care services. Examples are presented of the consequences of the ageing population and earlier discharge from hospitals on demand for home care packages.

This (Bibbi Thomé *et al*., 2003) study is a review of the empirical literature for the description of home care as a phenomenon and as a concept, especially with regard to who the care recipients are, what actions and assessments are performed and what effects are achieved for the care recipient in terms of functional health status and quality of life (QoL).

Clémentz C. *et al*., (2008) presented the application of concepts, methods and tools of systems engineering to production systems of home care.

Javier Bajo *et al*., (2010) describe a case study in Home Care scenarios applying an abstract architecture and a computational model for large scale open multi-agent systems based on a service-oriented approach. The architecture used is THOMAS, which specifically addresses the design of Home Care systems. A case study example was employed as an illustration of the usage of THOMAS components and services.

Bashir B. *et al.*, (2011 a) presented a unified model for Home Care and health care System. In their model, they integrated Home care in the traditional health care network so that optimal decisions can be made for all patients. For this purpose, they introduced an intermediate structure called Evaluation Center between hospitalization and home care which can result in a much better use of health care system. The Evaluation Centers consisting of a team of case managers, operation research specialists and doctors for each population locality can be added. These centers can align health care case managers with family physicians through a formalized and structured partnership to create health teams uniquely equipped to provide optimal patient care. Their objective is to assign patients either to a traditional hospital network or home care service. They will study each patient case in coordination with his family physician and patient himself. After completing the care in a chosen service, the patient file will be re-assessed to analyze for further proceeding which can be continuity of care in the same service or change of service or end of treatment (if the patient is recovered).

5.2 Delivery Problem

In (Olli Bräysy, 2009), they discuss the communal home meal delivery problem. The problem is modeled as a multiple travelling salesman problem with time windows that is closely related to the well-studied vehicle routing problem with time windows.

Experimental results are reported for a real-life case study from Central Finland over several alternative scenarios using the SPIDER commercial solver. The comparison with current practice reveals that a significant savings potential can be obtained using off-the shelf optimization tools. As such, the potential for supporting real-life communal routing problems can be considered to be important for VRP practitioners.

In (Ben Bachouch R *et al*., 2009), they deal with a drug delivery problem in a French homecare. The carriers are assigned to specific areas and must visit each patient once a day while minimizing the total travelled distance. They propose to explore four strategies of delivery: (i) starting deliveries when a specified number of deliveries is achieved, (ii) starting deliveries if a specified distance is reached regarding to the planned deliveries, (iii) starting deliveries on a fixed number of deliveries per carrier and, (vi) starting deliveries on fixed hours. They use a mixed linear program which takes into account various constraints and minimize the total travelled distance. The results obtained for each strategy are compared in order to identify which one is the most efficient to solve the drug delivery problem at the homecare.

Olli Bräysy et al., (2009) studied a case from the Finnish city of Jyväskylä. The route optimization problem was modeled as a multiple Travelling Salesman Problem with time windows, with minimization of vehicles and total distance as objective components. To illustrate the potential of widely available routing software, a commercial, heuristic route optimization tool called SPIDER Designer was used to implement the model and to automatically create optimized routes. Experimental results were presented for several alternative scenarios and compared against the current manual solution. The results showed a significant savings potential, up to 50% in both distance and number of vehicles, offering quantitative decision support to communal decision makers for renewing outsourcing contracts.

Stefan Bertels and Torsten Fahle, (2006) presented the core optimization components of the PARPAP software. In the optimization kernel, a combination of linear programming, constraint programming, and (meta-) heuristics for the home health care problem was used, and they showed how to apply these different heuristics efficiently to solve home health care problems. The overall concept was to adapt to various changes in the constraint structure, thus providing the flexibility needed for real-world settings.

Chahed Salma *et al*., (2008) presented a brief description of the supply chain of anti-cancer drugs and the

problem of coupling production - distribution of these drugs detailing associated assumptions, the approach for its resolution and analysis of results.

5.3 Scheduling and Assignment Problem

Chananes Akjiratikarl e*t al.*, (2007) gave an application of a Particle Swarm Optimization (PSO) - based scheduling algorithm to care-worker scheduling. This algorithm combined local improvement techniques to schedule care-workers effectively and efficiently. The objective was the minimization of the total distance traveled by all care workers, while satisfying the capacity and delivery time window constraints. The algorithm utilized the population-based evolutionary searching characteristic of PSO to explore the solution space globally, and also exploited the local search ability of local improvement procedures (swap and insertion) to fine-tune the neighborhood area more thoroughly. A parameter study has been performed using Taguchi design of experiments in order to find the 'best' combination of parameter values for this specific application.

Alain Guinet *et al.,* (2008) described an exact method based on developing a mathematical model for mixed linear programming to assign each nurse a set of patients to visit during his tour. This model was solved by two solvers LINDO SYSTEMS of LINGO and ILOG OPL-CPLEX ILOG STUDIO. Their comparison of results showed almost similar results for the two solvers but CPLEX gave better arrival times for nurses.

Lanzarone Ettor and M.atta Andrea, (2010) dealt with the problem of assigning a Home Care (HC) patient to a health professional among a set of possible ones, under the constraint of continuity of care. Starting from a previously proposed assignment policy, they first compared the policy with that implemented in real organizations and then they derived some rules to choose the health professional that will be in charge to deliver the care service to a new admitted patient. The proposed assignment rules took into account the variability of the patient needs, expressed in terms of the number of visits requested along the time.

The HC service is rapidly growing in the France and in other countries around the world. HC can be provided directly by the state or an independent provider with the aim of achieving best value, in terms of quality and cost. The drive to maximize quality and minimize costs creates a need for care-worker scheduling algorithms to support the planning process by reducing costs, improving customer service and reducing the cost of planning, etc. Patrik Eveborn *et al*., (2006) focused on a staff planning problem arising in Sweden where people receive home care from the local authorities. The objective was to develop visiting schedules for care providers that incorporate some restrictions and soft objectives. They described the development of a decision support system LAPS CARE to aid the planners. The system consists of a number of components including information data bases, maps, optimization routines, and report possibilities. They formulated the problem using a set partitioning model and, for a solution method, they made use of a repeated matching algorithm. This time saving by itself was about 7% of the total working time. The savings in travel time corresponded to about 20%.

In (Chananes Akjiratikarl *et al.*, 2007) the PSO-based methodology had been tested on 'real' demand data and the results compared with those obtained with the existing manual approach and those obtained by the AiMES Centre at the University of Liverpool using ILOG in order to assess the solution qualities and computational performance. The PSO-based algorithm produced significantly and consistently better results across all the test problems. This work contributed to the development of an efficient methodology to improve the scheduling of care workers and also introduced the application of PSO-based algorithm to solve this type of problem and all classes of similar problems.

Bashir B. *et al.*, (2011 b) provided a state-of-the-art on the application of Location-Allocation (LA) problem in health care and Home Care (or Hospital at home problem) and proposes a unified approach for their optimization. The LA problem seeks to simultaneously determine the optimal facility locations and the assignment of customers to the selected facilities. Their objective is to maximize the population accessibility and to minimize the costs.

5.4 Resource dimensioning problem

We are also interested in resource dimensioning problem. This problem is the one dealing with the determination of number of care providers, with particular skills, and quantity of material resources of different types, necessary to meet predicted care demand with the satisfactory service quality and minimum cost.

This problem is treated by (Busby CR and Carter MW, 2006) in which they created a decision tool for the Simcoe County Community Care Access Center (SCCCAC) in Ontario. The tool enables the SCCCAC to quantitatively assess the trade-offs between three key factors: cost, quality, and waiting time of their home care patients. This information can then be used to negotiate reasonable funding levels with the Ontario government and to appropriately allocate this funding among the various patient groups at the SCCCAC. This work can be expanded to other health care organizations that use prioritized waiting lists.

5.5 Districting problem

The districting problem consists in grouping small geographic areas into larger clusters called "districts" in a way that these latter are "good" according to relevant criteria, each district being under the responsibility of a multidisciplinary team.

The districting problem has been treated in the operations research literature in a broad range of applications: the design of political districts; the definition of districts for salesmen; the establishment of districts for schools, salt spreading and police command; the construction of

turfs for telecommunications' workers and also the definition of districts for the home care workers. Hence, the political and the sales realms are the two most important applications in terms of number of publications.

We have found few articles for districting problem in home care.

This approach has been studied by (Blais *et al.*, 2003) for the case of the Côtes-des-Neiges local community health clinic in Montreal, Canada. For partitioning this community into six districts, the authors have proposed a multi-criteria approach similar to the one proposed by (Bozkaya *et al.*, 2003) for the political districting problem, where the criteria related to the visiting personnel mobility and the workload equilibrium are combined into a single objective function whereas the criteria related to the indivisibility of the basic units, the respect of borough boundaries and the connectivity are considered as hard constraints. The problem is solved by means of a Tabu search technique.

After that, (Lahrichi *et al.*, 2006) have reviewed the optimality of the method proposed by (Blais *et al.*, 2003) by analyzing the historical data of the years 1998-1999 and 2002-2003 related to the total number of visits and the distribution of these visits among districts. This analysis has proved that the territorial approach presents two main shortcomings. First, this approach could be behind a workload imbalance between the care givers due to the fact that it cannot forecast the fluctuation of the demand in each district. This imbalance could conduct to inequities in terms of the service quality between the districts. Second, this approach is not flexible enough in terms of the assignment of the care givers to the districts which does not encourage the collaboration between the different care givers.

In order to alleviate these shortcomings, (Lahrichi *et al.*, 2006) have proposed two solutions. The first one is a dynamic approach which consists in assigning the patients to the care givers according to the care givers' workload and the patients' caseload instead of the geographical location of patients. The second solution consists in combining the approach proposed by (Blais *et al.*, 2003) with the dynamic approach. To do this, the care givers are split into two groups: the first one represents care givers assigned to a fixed district while the second one groups care givers that can work in all or a part of the territory.

Once the territory is divided into districts, the different resources must be equitably assigned to the designed districts so that the workload of the care givers and the quality of the services delivered to the patients are roughly the same. In the following sub-section, we focus on the allocation of resources to the districts.

In (Benzarti E *et al.*, 2010), they presented a linear integer programming for districting problem applied in home care. Their objective functions were the workload balance, the minimizing the travel time and the weighted sum of the two criteria. In the mathematical formulation, they considered the profile of the patient which largely affects the workload balance among care workers. For this purpose, they have defined two parts of profiles, one with minimization of maximum deviation of workload and the second with tolerance interval for workload. They have also added the time dimension in this ILP by replacing the decision variables. The shortcoming of this approach according to (Lahrichi *et al.*, 2006) that it does not take into account the fluctuations of the demand which lead to imbalance of workload. These fluctuations can be caused due to various changes i.e. change in home location of patient, increase or decrease in number of patients.

5.6 Home Care in developed countries

5.6.1 Europe

Rosanna Tarricone and Agis D. Tsouros, (2008) analysed the different factors in detail that can influence the supply of and demand for home care in Europe. These factors include: policy priorities and choices such as deinstitutionalization, community-based solutions and constraints on public expenditure; demographic shifts such as ageing population and changing dependency ratios; social changes such as small family units, female labour market participation and mobility across countries; changes in epidemiology such as rise in non-communicable diseases; science and technical innovation such as medical science advances, medical and non-medical technology advances; changes in attitudes and expectations such as increased choice and individualized care.

According to FNEHAD Report, HC sector has known an important growth since its creation sixty years ago and especially over this last decade in France. Indeed, the number of HC structures has increased by 87.7% between 2005 and 2008. During the same period, the number of days during which patients are followed up by HC's care givers has risen steadily from 1 505 814 to 3 298 104 which correspond to an increase of 119.02%. Similarly, the number of patients has increased by 147.52% between 2005 and 2008 in France.

A variety of provision models was found, including monopolist agencies providing comprehensive services in an area; agencies for specific services, such as nursing or domestic care (e.g. in Sweden (Malmberg B. et al., 2003); competing commercial and non-commercial private providers and public providers. Private provision (including non-profit) was growing in several countries, such as Ireland (Timonen V. and Doyle M., 2008), Finland (Kroger T., 2003), Sweden (Sundstrom G., 2002) and England (Netten A. *et al.*, 2007), either replacing public provision or compensating for its absence. The introduction of market mechanisms in some countries appeared to have weakened co-governance between the third sector (voluntary sector) and the public sector (Bode I., 2006). The for-profit private providers may have been better adapted to the new market forces than the voluntary organizations, as was the case in the UK, where managers of voluntary organizations were more likely to have greater problems with negoti-

ating contracts than private provider managers (Kendall J., 2003).

Blanche Le Bihan and Claude Martin, (2006) is comparative studies of European social policies towards frail elderly people typically focus on the systems and their implementation. The study was conducted in 2001 in six European countries (Germany, Spain, Italy, France, the United Kingdom and Sweden). Their aim was comparing the rights of the individuals within the different care systems. The methodology used was a case study approach, which drew on a series of situations of dependent elderly people. Therefore, the analysis focused on the public authorities' responses the care packages, which determined the type of care required and the financial contribution of the user in each of the six countries, in relation to the concrete situations of frail elderly people. As local variations were important, in all the countries studied, local authorities had been chosen in each of the countries. This approach gave interesting concrete elements on the services and financial help which can be given to frail elderly people. This study also enables us to understand precisely the national care systems organized in the different countries and the main difficulties encountered by public authorities in facing this problem of frail elderly people.

Nadine Genet *et al.*, (2011) presented a review of Home Care in Europe. This review included publications provided information on 18 countries. No information was found on Bulgaria, Croatia, Cyprus, Estonia, Greece, Hungary, Iceland, Latvia, Lithuania, Luxembourg, Malta, Romania and Slovakia. Single country studies described features of home care in 15 countries. Country comparisons were made in eight publications and these contained information on three countries for which no single country studies were found (Germany, Czech Republic and Austria). The countries addressed in the largest number of publications were Sweden and the UK. The review yielded very little information on home care in the countries situated in Central and Eastern Europe. They concluded that Home care systems appeared to differ both between and within countries. The papers included, however, provided only a limited picture of home care.

Many studies only focused on one aspect of the home care system and international comparative studies were rare. Furthermore, little information emerged on home care financing and on home care in general in Eastern Europe. This review clearly showed the need for more scientific publications on home care, especially studies comparing countries. A comprehensive and more complete insight into the state of home care in Europe requires the gathering of information using a uniform framework and methodology.

5.6.2 USA

Judy Goldberg Dey *et al.*, 2011 discussed the characteristics and organization of home care structures in the United States. They also evaluated the costs associated with providing appropriate access to care to low-income beneficiaries, those residing in medically underserved areas, and those with varying severity levels illness. They proposed changes to that will ensure increased access to home health care for these beneficiaries. The literature addresses varying definitions of vulnerable populations and their associated barriers to care as well as potentially uncompensated costs.

Richard B. Greene, (2005) described that Home care monitoring may have an important role as a strategy to provide effective and cost efficient health care for heart failure patients. The use of new improved technology to monitor patients along with the support of a health care provider significantly improves heart failure management while reducing the cost of health care.

Buhler-Wilkerson K., (2007) described that the problems of caring for patients with disabling illnesses who neither get well nor die are not new in US. Such patients have always required assistance at home from family, benevolent volunteers, or paid caregivers. Despite two centuries of experimentation, however, no agreement exists concerning the balance between the public and private resources to be allocated through state funding, private insurance, and family contributions for the daily and routine care at home for chronically ill persons of all ages. This article examined these issues and the unavoidable tensions between fiscal reality and legitimate need. It also used historical and policy analyses to explain why home care had never become the cornerstone for caring for the chronically ill.

5.6.3 Canada

In 2006, more than 2.5 % (875,000 individuals) of the Canadian population reported receiving Home Care and home support; about 60 % of this group received home health care only (CIHI, 2007). In 2006, about 160,000 nurses and personal carers worked in the long-term care (LTC) sector on a full-time basis and close to 70,000 on a part-time basis (OECD Health Data, 2010 based on Census 2006). Peter C. Coyte,(2000) presented an overview of Canadian home care services; it highlighted health policy assumptions that had resulted in an increasing reliance on in-home services; and it assessed roles for the private and public sectors in the financing of home care services.

Hirdes, J. P., J. W. Poss, and N. Curtin-Telegdi., (2008) developed a methodology for prioritizing access to community and facility-based services for home care clients. Canadian and international data based on the Resident Assessment Instrument – Home Care (RAI-HC) were analyzed to identify predictors for nursing home placement, caregiver distress and for being rated as requiring alternative placement to improve outlook. They showed that the Method for Assigning Priority Levels (MAPLe) algorithm was a strong predictor of all three outcomes in the derivation sample. The algorithm was validated with additional data from five other countries, three other provinces, and an Ontario sample. They concluded that the MAPLe algorithm provided a

psychometrically sound decision-support tool that may be used to inform choices related to allocation of home care resources and prioritization of clients needing community or facility-based services.

5.7 Home Care in developing countries

The developing countries face great difficulties in planning and production medical care of good quality. Taking into account their political, demographic problems, socio-economic and resource constraints in these countries, access to health care becomes a activity of great complexity. The risk of nosocomial infections, propagation of bacteria, problems of transportation, electricity, and lack of a hospital information system are all factors that stimulate the need of implementing new techniques in order to improve the quality of health care. In these countries, it is necessary to find an alternative that afford to take care of some patients with certain diseases and that prevent them from making long distances between home and hospital.

The implementation of this structure is already experienced in some third world countries (Patrik Eveborn *et al.*, 2004). Mozambique, with the participation of several NGOs (Organization Non-Governmental) national and international, it was established a day hospital and a home care structure for HIV patients and AIDS patients. This structure responds to an agreement signed between the Ministry of Health of Mozambique and the French Cooperation in 1995.

The objective in this approach is to centralize operations and monitoring of patients infected with HIV. Cuba is experiencing a huge success in the field of production of health care, since the implementation of this structure of home care in this territory (Spiegel J. M, Yassi A., 2004), (Health in the Americas, Volume II, 1998)). With this method of HC, the physician can remotely diagnose certain diseases in the patient at his home. It can also monitor the patient's blood pressure. This avoids unnecessary hospitalizations; beds and facilities are well used in a more rational way. The Cuban experience in setting up a structure of HC is tangible evidence of the application of this system in developing countries. The objective of the work of (Norly Germani *et al.*, 2008) was to identify and analyze constraints to the problems of developing a home care structure in Haiti.

5.8 Pros and cons of Home Care

The HC has largely evolved during this last decade thanks to its human, medical and economical advantages. The pros and cons of Home Care discussed by (Benzarti E., 2012) are given in the following.

Indeed, according to (Com-Ruelle and Lebrun, 2003), 93% of the patients consider that the main advantage of the HC is to be treated in their familial environment. This would allow, according to (Raffy Pihan, 1997), the free time organization. It would also reduce the risk of appearance or worsening of a dependence state linked to a hospital stay. Furthermore, the HC avoids the de-

socialization generally caused by the traditional hospitalization which is psychologically harmful for the patients. If the patient is being cared for in his or her own home, this comes with a feeling of security, comfort, and privacy. Moreover, the HC is also advantageous for the family members as it supports them psychologically and avoids them to go to the hospital every day. The HC also guarantees the continuity of care by collaborating with hospital care givers and coordinating the care delivered by the different care givers.

Despite this, the HC is also advantageous for the practitioners as it enables them to take care of a reduced number of patients and thus to be less stressed, more autonomous and closer to their patients. The HC also presents a medical advantage that consists in reducing considerably the risks of hospital-acquired infections by approximately three times (Benzarti E., 2012).Finally, the HC represents an economical advantage by avoiding the hospital capacity saturation which would lead to the containment of the whole health system's costs. Indeed, the HC reduces the average duration of stay within hospitals and accelerates the turnover of the hospital beds and consequently allows keeping highly specialized human and material resources to the patients with acute diseases. The HC is thus less costly than the traditional hospitalization (Alignon *et al.*, 2003).

However, despite all its advantages, the HC also presents some disadvantages. The most important disadvantage of the HC is the absence of a permanent medical supervision (guaranteed 24 hours per day). This type of hospitalisation necessitates thus the permanent presence and availability of the family members who feel themselves stressed and overloaded by the domestic work (Raffy Pihan, 1997). Additionally, due to the intensity and frequency of care to deliver and severity of the pathologies treated, the HC is perceived by the general practitioners who can prescribe it since October 1992 as a badly defined responsibility that is heavy to take for. Private homes are not equipped with the emergency response systems usually in place at health care facilities.

Finally, even if the HC is economically interesting for the health system as a whole, it can paradoxically cost much for the patients and their families due to the fact that a part of the costs is shifted to the patients and their families such as lighting, hot water, acquisition of medical and/or paramedical equipments (wheelchair, specialized beds, etc.), etc. The economic analysis is presented in detail in the following section.

5.9 Cost comparison study of Home Care

Reducing costs by avoiding admission to hospital and decreasing hospital length of stay are often presented as central goals of HC. Different researchers have thus been interested in the economical evaluation of HC. Martin Hensher *et al.*, (1996) studied three HC schemes in West London for early discharge orthopedic patients, comparing their costs with those of hospital care and

showed that HC may substitute for hospitalization but it will not necessarily save the resources. Remonnay R. et al. compared the costs of anti-cancer chemotherapy in home versus hospital care in a French area. The results showed that the interest of developing home care in chemotherapy is questionable as regards costs (Remonnay R *et al.*, 2001). Frank W.J.M. Smeenk et al., (1998a) showed that home care program significantly reduced drug and re-hospitalization costs while increasing standard community nursing care and home help costs, when compared to the standard care available in the Netherlands. However, on the whole there was no significant difference in the total sum of health care costs. In view of this, and that the previous study has shown that the intervention contributed significantly to a better quality of life of patients and their direct caregivers (Frank W.J.M. Smeenk *et al.*, 1998b), the implementation of a home care program for terminal cancer patients is recommended for all hospitals with a large multidisciplinary oncology unit, (Frank W.J.M. Smeenk *et al.*, 1998c).

Jones et al., (1999) who have concluded that the HC structure can deliver care with similar or lower costs than the traditional hospitalization for an equivalent admission. (O'Brien and Nelson, 2002) have also conducted a comparison between the traditional hospitalization costs and the HC costs for elderly people who need acute care. The conclusion is that the HC is less expensive than the traditional hospitalization as it allows the saving of 30 billion dollars per year. After that, (Aligon *et al.*, 2003) have compared the average costs of nursing care within the HC context and the traditional hospitalization context between 2005 and 2007. The results of this study clearly prove that the HC is less expensive than traditional hospitalization. Another economic analysis has been developed by (Vergnenègre *et al.*, 2006) in which the authors have compared the costs of the chemotherapy delivered to patients suffering from bronchipulmonary cancers at home and in hospital. The results of this study prove that the HC allows the saving of 16.15% of the chemotherapy costs per treatment's cycle compared to the traditional hospitalization.

Carlos Rodriguez Verjan *et al.*, (2010) showed to have at least an equivalent biomedical impact and quality of life for some pathology in HC, but this point has to be secure for each pathology and treatment. When biomedical impact are equivalent, patient's satisfaction is higher at home.

The economic factors that considerably increase costs must be analyzed in order to compare the costs of both types of hospitalization as pertinently as possible. O'Brien and Neslon, (2002) have enumerated these factors. On one hand, the four factors that explain the increase of the traditional hospitalization's costs have been presented: medical errors (annual additional costs of 200 billion dollars), hospital acquired infections (the annual costs related to the infections are estimated to 4 billion dollars), decline of patients' autonomy (the hospital stay of 75% of the patients aged of more than 75

years old is extended by 12.3 days that corresponds to 4.233 dollars per patient and per day) and death rate.

On the other hand, the authors have explained that HC costs can increase due to the risks that patients make errors for taking the corresponding drugs, for using a medical equipment, etc. during the absence of the care givers. The HC costs can also increase due to the additional costs related to the home fitting; home support; transportation services; acquisition of non-medical equipment such as special chairs, ramps into the house, adapted toilets, showers, baths, special beds, etc. (Tarricone and Tsouro, 2008), (Aligon *et al.*, 2003).

In terms of costs even if a lot of studies show that HC is cheaper than traditional hospitals, costs studies are very sensitive to the point of view of costs and to the kind of costs included in the research. A lot of assumptions must be made and we cannot be sure that the conclusions will be unchanged when these assumptions are not valid anymore (Norly Germani *et al.*, 2008). Like it was pointed by (Amstrong *et al.*, 2008), one of the difficulties of a HC is the lack of pressure to discharge patients from the hospitals. This is very important since the exams are often made in the hospitals, the patients arrive at the hospitals and a lot of doctors work at hospitals. It is very probable that patients stay there and it is very difficult to pressure doctors to give their patient to another institution or structure where they may not be implicated.

The cost-effectiveness of Home Care is debated. This is partly because HC is not a homogeneous entity, and economic analyses have focused on different service models, conditions, and treatments, ranging from acute to post-acute and rehabilitation. The results of economic analyses are therefore not necessarily comparable between studies. Also, HC is a diverse entity and varies in definition from state to state and country to country. As such, it is difficult to apply the findings of any particular study to HC as a general form of care.

6 CONCLUSION

In this paper, we present an analysis of the literature related to the home care. We have presented the main issues, constraints and various types of problems faced in this domain. The literature about home care in developed and developing countries are reviewed. And we discussed the pros and cons of this type of care.

We conclude that majority of the literature work is about the assignment and routing problems. But the issues like resource dimensioning, home care modelling and districting problem are less treated.

Although the concept of home care is very old, it lacks the complete description of the process and uniform terminology. The potential opportunities for future research can be the work on the methodological aspects of the home care process, the organization of the resources, the design of care network, the integration of home care in the health care network and presentation of models and methods who can take into account of uncertainties.

REFERENCES

Alain Guinet, Ben Bachouch Rym, Fakhfakh Myriam, Hajri-Gabouj Sonia, 2008. Planification de la tournée des infirmiers dans une structure de soins à domicile. *Proceedings of conference GISEH*.

Aligon A., Com-Ruelle L., Renaud T. and Lebrun E. 2003. Le coût de prise en charge en hospitalisation à domicile (HAD). *Questions d'économie de la santé*, Vol. N°67, p.1-6.

Amstrong C. D., Hogg W. E., Lemelin J., Dahrouge S., Martin C., Viner G. S., Saginur R, 2008. Home-Based intermediate care program vs. hospitalization: Cost comparison study. *Canadian Family Physician*, vol. 54(1), p.66-73.

Bashir B., Caux C., Chabrol M. and Gourgand M., 2011 a, A Unified approach for Home Care and Health Care system, International *Conference on Industrial Engi neering and Systems Management, May 25 - 27, 2011, Metz, France.*

Bashir B., Caux C., Chabrol M. and Gourgand M., 2011 b, The Modified Location-Allocation problem and home care problem : a unified approach, *12ᵉ congrès annuel de la Société française de Recherche Opérationnelle et d'Aide à la Décision, 02-04 March, 2011, Saint-Etienne, France.*

Ben Bachouch R., Guinet A., Hajri-Gabouj S., 2009. A model for scheduling drug deliveries in a French homecare structure*, International Conference on Industrial Engineering and Systems Management (IESM09), Montréal, 13-15 Mai 2009, Canada*.

Benzarti E., Sahin E. and Dallery Y., 2010. Modelling Approaches for the home health care districting problem. MOSIM, 2010.

Benzarti E., (2012), Home Health Care Operations Management: Applying the districting approach to Home Health Care, PhD Thesis.

Bibbi Thomé, Anna-Karindykes and Ingalill Rahmhallberg, 2003. Home care with regard to definition, care recipients, content and outcome: systematic literature review, *Journal of Clinical Nursing* 2003, vol. 12, p. 860–872.

Blais M., Lapierre S.D. and Lapierre G. , 2003. Solving a home-care districting problem in an urban setting. *Journal of Operational Research Society*, vol. 54, p.1141-1147.

Blanche Le Bihan and Claude Martin, 2006. A Comparative Case Study of Care Systems for Frail Elderly People: Germany, Spain, France, Italy, United Kingdom and Sweden, Social Policy & Administration**,** Volume 40, Issue 1, 26–46.

Bode I, 2006.Co-Governance within Networks and the Non-Profit-For-Profit Divide: A Cross-Cultural Perspective on the Evolution of Domiciliary Elderly Care. *Public Management Review*, 8:551-566.

Bozkaya B., Erkut E. and Laporte G., 2003. A Tabu search heuristic and adaptive memory procedure for political districting. *European Journal of Research*, vol. 44(1), p.12–26.

Buhler-Wilkerson, K., 2007. Care of the Chronically Ill at Home: An Unresolved Dilemma in Health Policy for the United States. *The Milbank Quarterl, 85* (4), 611-639.

CIHI - Public-Sector Expenditure and Utilization of Home Care Services in Canada: Exploring the Data

2007, National Health Expenditure Database, Canadian Institute for Health Information http://secure.cihi.ca/cihiweb/products/trends_home_care_mar_2007_e.pdf

Clémentz C., Pourcel C. and Bistorin O., 2008. L'ingénierie système : application aux systèmes productifs de soins hors les murs. *Proceedings of conference GISEH 2008.*

Com-Ruelle L. and Lebrun E. , 2003. Indicateurs d'état de santé des patients hospitalisés à domicile (ENHAD 1999-2000). *Questions d'économie et de santé*, Vol. N°77, p.1-6.

Crétien van Campen, Isolde B. Woittiez, 2003. Client demands and the allocation of home care in the Netherlands. A multinomial logit model of client types, care needs and referrals. *Health Policy,* p. 229-/241.

Chananes Akjiratikarl, Pisal Yenradee and Paul R. Drake, 2007. PSO-based algorithm for home care worker scheduling in the UK. *Computers & Industrial Engineering*, vol. 53, p. 559–583.

Frank W.J.M. Smeenk, Andre J.H.A. Ament, Jolanda C.M. van Haastregt, Luc P. de Witte, Harry F.J.M. Crebolder, 1998a. Cost analysis of transmural home care for terminal cancer patients. Patient Education and Counseling, vol. 35, p. 201–211.

Frank W.J.M. Smeenk, de Witte LP, van Haastregt JCM, Schipper RM, Biezemans JPH, Crebolder HFJM, 1998b. Transmural care of terminal cancer patients: Effects on the quality of life of direct caregiver. *Nursing Research*, vol. 47(3), p.129–136

Frank W.J.M. Smeenk, de Witte LP, van Haastregt JCM, Schipper RM, Biezemans JPH, Crebolder HFJM, 1998c. Transmural care. A new approach in the care for terminal cancer patients: Its effects on rehospitalization and quality of life. *Patient Education and Counseling*, vol. 35(3), p. 189-99.

FNEHAD Report http:/www.fnehad.fr/images/stories/ /1.Evolution_offre_HAD_0509_Site_FNEHAD.pdf.

Health in the Americas, Volume II, 1998. Edition.

Hirdes, J. P., J. W. Poss, and N. Curtin-Telegdi., 2008. The Method for Assigning Priority Levels (MAPLe): New Decision-Support System for Allocating Home Care Resources. BioMed Central 6.9 (2008) Print.

Javier Bajo, Juan A. Fraile, Belén Pérez-Lancho, Juan M. Corchado, 2010. The THOMAS architecture in Home Care scenarios: A case study. *Expert Systems with Applications*, vol. 12, p. 3986–3999.

Jones J., Wilson A., Wynn A., Jagger C., Spiers N. and Parker G. (1999). Economic evaluation of hospital at home versus hospital care: cost minimisation

analysis of data from randomised controlled trial. *British Medical Journal*, Vol. N°319, p. 1547-1550.

Judy Goldberg Dey, Margaret Johnson, William Pajerowski Pajerowski, Myra Tanamor and Alyson Ward, 2011. Home Health Study Report, Centers for Medicare and Medicaid Services.

Kendall J, Matosevic T, Forder J, Knapp M, Hardy B, and Ware P, 2003. The Motivations of Domiciliary Care Providers in England: New Concepts, New Findings. *Journal of Social Policy*, 32:489-511.

Kroger T, 2003. Universalism in Social Care for Older People in Finland -Weak and Still Getting Weaker. *Nordisk Sosialt Arbeid*, vol. 23:30-34.

Lanzarone Ettor, M.atta Andrea, 2010. Analysis of a Patient-Nurse Assignment Policy in Home Care Services. *Proceedings of conference GISEH, Clermont-Ferrand, France.*

Lahrichi N., S. D. Lapierre, A. Hertz, and A. Talib, 2006. Analysis of a territorial approach to the delivery of nursing home care services based on historical data. *Journal of medical systems*, 30, p. 283-291.

Malmberg B, Ernsth M, Larsson B, Zarit SH., 2003. Angels of the Night: Evening and Night Patrols for Homebound Elders in Sweden. Gerontologist, 43:761-765.

Martin Hensher, Naomi Fulop, Sonja Hood, Sarah Ujah, October 1996. Does hospital-at-home make economic sense? Early discharge versus standard care for orthopaedic patients. *Journal of the Royal Society of Medicine*, vol. 89, p. 548-551.

Nadine Genet, Wienke GW Boerma, Dionne S Kringos, Ans Bouman, Anneke L Francke, Cecilia Fagerström, Maria G Melchiorre, Cosetta Greco and Walter Devillé, 2011, Home Care In Europe : A Systematic Overview, *BMC Health Services Research*.

Netten A, Jones K, Sandhu S., 2007.Provider and care workforce influences on quality of home-care services in England. *J Aging Soc Policy* vol. 19:81-97.

Norly Germani, Thibaud Monteiro, Evens Emmanuel, Nidhal Rezg, 2008. Problématiques de mise en oeuvre d'une Hospitalisation Hors les Murs dans un pays en voie de développement : le cas Haïti. *Proceedings of conference GISEH 2008.*

O'Brien L. and Nelson C.W., 2002. Home or Hospital Care: An Economic Debate of Health Care Delivery Sites for Medicare Beneficiaries. Policy, *Politics and Nursing Practice*, Vol. N°3 (1), p. 73-80.

OECD (2010) Health Data 2010, Paris.

Olli Bräysy, Pentti Nakari, Wout Dullaert, Pekka Neittaanmäki, 2009. An optimization approach for communal home meal delivery service: A case study. *Journal of Computational and Applied Mathematics*, vol. 232, p. 46-53.

Patrik Eveborn, Patrik Flisberg, Mikael Ronnqvist, 2006. LAPS CARE - an operational system for staff planning of home care. *European Journal of Operational Research*, vol. 171, p. 962–976.

Peter C. Coyte, 2000. Home Care in Canada: Passing the Buck, Home Care Evaluation and Research Centre (HCERC), Department of Health Administration, University of Toronto, Canada.

Raffy-Pihan N. (1997). L'hospitalisation à domicile: une alternative également adaptée auxpersonnes âgées. Communication au Colloque «« SYSTED 97 » à Chicago.

Rapport DREAM., 2004. Soigner le SIDA en Afrique : Un modèle pour l'introduction des trithérapies antirétrovirales contre l'infection par le VIH dans les systèmes de santé des pays à faible revenu. Rapport de Drug Resource Enhancement against AIDS and Malnutrition (DREAM). *Leonardo International s.r.l. Milan, Italie, 2004.*

Remonnay R, Devaux Y, Spath H, Chauvine F, Carrere Mo, 2001. Cost comparison between chemotherapy in Home Care versus standard hospital care based on a randomised crossover trial. *International Society of Technolog Assessment in Health Care*, Meeting, 17.

Richard B. Greene , (2005), A Literature Review of Home Care Monitoring of Heart Failure Patients, Final Paper at College of Pharmacy University of Florida.

Rosanna Tarricone and Agis D. Tsouros, 2008 .The Solid Facts: Home Care In Europe, World Health Or ganization.

Spiegel J. M, Yassi A, 2004. Lessons from the margins of globalization: appreciating the Cuban health paradox. Journal of Public Health Policy, vol. 25(1), p. 85-110.

Stefan Bertels, Torsten Fahle, 2006. A hybrid setup for a hybrid scenario: combining heuristics for the home health care problem. Computers & Operations Research, vol. 33, p. 2866–2890.

Sundstrom G, Johansson L, Hassing LB, 2002. The shifting balance of long-term care in Sweden. *The Gerontologist*, vol. 42:350-355.

Tarricone R. and Tsouros A.D., 2008. The solid facts: a Home Care in Europe. World Health Organization.

Timonen V, Doyle M, 2008. From the Workhouse to the Home: Evolution of Care Policy for Older People in Ireland. *International Journal of Sociology and Social Policy* vol 28:76-89.

Vergnenègre A., Decroisette C., Vincent F., Dalmay F., Melloni B., Bonnaud F. and Eichler B. (2006). économique de l'administration d'une chimiothérapie en hospitalisation à domicile (HAD) comparée à l'hospita-lisation de jour dans les cancers bronchopulmonaires non à petites cellules de stade IV. *Revue des Maladies Respiratoires*, Vol. N°23, p. 255-63.