A Case Study – Allotment of Qualified Caregivers in Hospitals by Goal Programming Model

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Abstract
Qualified Caregivers scheduling arrangements usually consists of several objectives to be achievedat once. The value of each objective cannot be certainly determined. With Fuzzy Goal Programming application using the MINMAX approach, the multi-objective nurse scheduling problem with uncertain value in this article can be solved. Tolerance limits have been set for each objective, and the computation results showthat the solution is within the interval of allowable tolerance. Constraints regarding requests for nurse leave, the minimum number of nurses on duty per shift, the number of consecutive working days allowed, and hospital policies can be met properly. The sensitivity analysis can be done easily by changing the maximum deviation value in equations.This study contributes to the future by revealing that the use of fuzzy set theorywith unbalanced positive and negative deviation can be effectively used to solve nurse scheduling problem. The resulting schedule is quite satisfying because it can meet nurse preferences and hospital policies. In the further studies, this model is expected to be developed with more complex problem constraints by adjusting to existing policies. This model is also expected to be developed into user-friendly software so that the process of decision making can be carried out faster by anyone.

Introduction-

Resource allocation in health and Caregivers care raises a number of important political, social and ethical issues. As populations increase, population demographics change and/or demand for health and Caregivers care outstrips supply, this moves us either to make a decision to increase investment in health care, redistribute resources from lower priority services to those

of higher priority, or limit access to the services that exist – the latter is called rationing of health care [1].

Decisions regarding resource allocation and rationing in health care, though potentially highly emotive, are important political and social decisions and thus should receive careful attention, analysis and consideration. This chapter aims to explore issues of resource allocation and rationing, within the context of Caregivers practice and the provision of Caregivers care [3].

Health care resource-related discussions, which reach the public domain, often focus on headline grabbing issues such as whether a particular life-saving treatment should be provided by the relevant national health system (NHS in the UK or the HSE in Ireland) regardless of cost, organ transplants and shortage of organs, or whether particular groups in society, such as smokers, the obese and the elderly, should receive the same access to health care as those who exercise, look after their health or are young, tax-paying adults with caring responsibilities[5].

To date, the topic of resource allocation in Caregivers has not generated extensive, public discussion. However recent inquiries such as the Francis Inquiry in England (Francis 2010, 2013), the Vale of Leven Inquiry in Scotland (Vale of Leven 2014), and the Tallaght Hospital, Halapanaver and Portlaoise Hospital inquiries in Ireland (HIQA 2012, 2013, 2015) all have important things to say about the Caregivers resource and its impact on patient care[7]

Similarly, since the early years of this century, the work of Linda Aiken and her team, across a variety of health systems and countries (in the USA, UK and Europe) is suggesting a clear pattern in terms of the correlation between nurse staffing, nurse education levels and the outcomes for patients in acute surgical wards (Aiken et al. 2002, 2003, 2014; Rafftery et al. 2007).

All of the above would seem to suggest that it is timely to explore issues of resource allocation and rationing and its relevance for Caregivers and the provision of Caregivers care. This is particularly the case as we know that in a number of countries, including Ireland, the impact of the recent recession and the imposition of austerity measures across the public sector has had a direct impact on front line staffing in the health service. For example the Irish health system has experienced the loss of 5,000 Caregivers and midwifery posts from the sector between the years 2009 and 2014. Currently there are three thousand fewer front line Caregivers and midwifery staff in the Irish health system than was the case in 2007 (WIN 2016). This reduction in staffing has happened at a time when the general population continues to increase, with significant pressures emerging across both acute hospital and community services [9].

Consideration of the different positions, presented in the above definitions, seems important for a number of reasons. For example it does seem that Caplan is correct to draw a distinction between resource allocation and rationing. In resource allocation we allocate the resources we have, one's salary for example, to do particular things – pay our mortgage, buy food, clothes, entertainment, and so forth. In an ideal world we may wish we had slightly more resource to allocate. However generally there is enough to go around and no one loses out significantly in the allocation. Allocating family budget for a holiday might be an example here. If Family A

had €10,000 to spend they might chooses to go on a 10-day cruise on the Mediterranean. However because they actually only have €5,000 to allocate towards a holiday, they choose a very pleasant two week holiday on Lake Garda. While a cruise on the Mediterranean is still a dream to be worked towards, the families are happy [15].

In the Caregivers context let us imagine that there are 12 staff on Medical Ward B – this is, in general, an adequate number of nurses to provide the required patient care, assuming staff work at a reasonable pace and there are no more than the normal admissions, discharges and activity demands. Staff are allocated according to the model of care being used and the normal patient care is given during the Caregivers shift. However, if one morning the nurse in charge comes on duty and the normal 12 members of staff is reduced to 8, as a result of illness or other reasons, then she may well have to consider how to ration care to some patients in order to ensure that others get the care they require. This should involve explicit discussion, agreement and direction at the Caregivers hand-over and reporting period at the commencement of and throughout the particular shift – in order to try to ensure some degree of transparency, fairness and peer review of the rationing decisions. The nurse in-charge will also alert the central Caregivers office in order to try to get additional help for this particular shift, so that the depleted Caregivers resource can be augmented, by agency nurses or nurses "on loan" from a quieter part of the hospital – to try to maintain the normal, good standard of care provided to the patients on Ward B.

In the context of reduced staffing, or perceived inadequate staffing, it is relevant to explore some implications of not making the staffing resource issues explicit. Let us return briefly to Alice whom we met in Chap. 8 (please see p. 102 above). Alice seems to have very little Caregivers resource allocated to her. This gives rise to a number of questions such as "Why has Alice received little Caregivers care/Caregivers resource?"; "Who has made the decision that Alice will not have Caregivers care and on what basis?"; "Who is aware of the decision to ration the Caregivers care that Alice is to receive?" "Has this been discussed with Alice, her parents, her medical team?" Caregivers care is a social resource. Alice is in hospital because her doctor has decided that she needs medical and Caregivers care. Given the description in her case study it could be argued that Alice is not getting what she needs from Caregivers staff – what is due to her as a patient.

In Alice's case it seems pertinent to ask who determined that there is not enough Caregivers time/care to go around? Who is responsible for the decision to ration Caregivers care, if it is perceived that there is not enough Caregivers care to go around? Who is accountable for the decision to ration Caregivers care? What is the basis for the decision? Who knows about the decision? Are the nurses on Alice's ward aware, as a collective staff group, that Alice is receiving little or no Caregivers care – or has Alice somehow become "invisible" to Caregivers staff; is she being actively discriminated against for whatever reason? Is the decision to ration Caregivers care explicit or implicit – and does this matter? How is the rationing of care monitored? Who maintains oversight of care rationing and is accountable for the impact on patient care? Are there any other factors that can help with more effective allocation of the Caregivers resource available and thus potentially reduce or remove the need to ration Caregivers care in certain contexts and circumstances? It would seem that implicit rationing

decisions are particularly problematic as, by definition, these decisions are unlikely to be transparent, or open to review. Implicit rationing decisions therefore also do not provide the stimulus or opportunity to consider alternative ways of allocating the available Caregivers resource, which may remove the need to ration Caregivers care in the first place.

Data of the Problem

Nurses and midwives form the backbone of health systems across the world and constitute the largest occupational group in the health care sector, accounting for almost 59% of the health professions. To highlight and focus on their contributions, their status, their work and working conditions, and the challenges they face as they provide vital clinical and health care, the year 2020 had been designated by WHO as the Year of the Nurse and the Midwife. As detailed in the State of the World's Caregivers Report, Caregivers remains a highly gendered profession, with nearly 90% of the Caregivers workforce being female. Nurses in many countries, including India, face professional and social discrimination, gender bias and lack representation and leadership in policy making. Moreover, there is inadequate to poor regulation of their employment and working conditions. Since February 2020, the COVID-19 pandemic has aggravated these problems, and given rise to new challenges for them at their workplace.

Studies on Caregivers in India have largely examined distribution, composition and shortage of nurses for the health care services and how to address the gaps identified. They have also focused on migration of nurses from India, the caste-gender features in Caregivers and the hierarchies and discrimination against the Caregivers profession. In spite of policy recommendations and government orders to promote decent working conditions, there are no systematic studies exclusively focusing on the actual employment, work and working conditions of nurses in India, whether in public or private institutions. This, despite the fact that there are numerous references to the role of working conditions in influencing migration and in leading to occupational stress. While there is increasing participation of private sector in delivery of medical care in India, there is scarce documentation of the status of health care workers. Little is known about their working conditions, their perspectives and day-to-day experiences in the private sector. This exploratory study documents and analyzes the employment and working conditions of nurses in selected private hospitals in Delhi, along with relevant government provisions/legislation to regulate the same.

It is a case study, employing qualitative in-depth interviews (IDIs) and desk research for study of relevant documents and narrative literature review. Ethical approval for the study was taken from Institutional Ethics Committee of Public Health Resource Society (PHRS). Semi-structured interviews were conducted in English or Hindi, using a schedule of open-ended questions with nurses and key informants from among Caregivers association office bearers, and lawyers. Relevant information from an online event organized by this study group (PHRS, PSI, JSA and WHO India) on occupational safety and health (OSH) of nurses in India, on the occasion of the World Patient Safety Day (WPSD) on September 17th, has been also incorporated in this analysis.

The disruptions in the health care system in India in the face of the COVID-19 pandemic and the subsequent pressures on health care workers, particularly nurses, led to several challenges in recruiting nurse respondents. In all 31 nurses, 15 of them female, working or with experience of work in private hospitals, were interviewed. Interviews were recorded after obtaining consent, recordings were transcribed, translated and stored in the NVivo software provided by WHO-India Office, The data was subsequently coded and analyzed thematically.

The findings and discussion encapsulate the voices and perspectives of the nurses on important aspects of their work, such as, the recruitment process, remuneration, workload and nurse-patient ratio. They also focus on basic facilities at workplace and other employment benefits, such as medical insurance and maternity benefits.

The nurse respondents also shared their experiences of harassment, victimization and discrimination at workplace, occupational safety and health, gender dimensions and migration. Issues of Grievance redressal mechanisms, unionization, regulation of salary and working conditions, accreditation and its impact and experiences during COVID-19 were also mentioned by the respondents.

The study revealed an all-round failure of the private health care sector to acknowledge the Caregivers cadre as health care professionals with a high level of training and experience.

Table-1 Caregivers Workload

S.No.	Respondent profile	M/F	Code no. in report
	Nurse respondents		
1	CCU Nurse in 200+ bed hospital of a corporate chain, with more than 10 years of experience, currently working as the Team Leader; earlier experience in small hospitals, and a stint in an African country through a government programme	M	N 1
2	Staff nurse with four years of experience in two non-corporate hospitals, at time of interview out of work from the 150+ bed hospital because of downsizing during COVID-19 pandemic	F	N 2
3	Staff nurse working for past two years in a 200+ bed hospital of a corporate chain; has experience of working as a Caregivers tutor for two years	F	N 3
4	Day-care nurse at 500-bed hospital of a corporate chain for the past four years	M	N 4
5	Nurse with around three years' experience in two different hospitals, post-graduate in Caregivers, resigned recently from position in corporate hospital	F	N 5
6	In-charge at a non-corporate, 100+ bed single-specialty non-corporate hospital with 10+ years' experience, post-graduate in Caregivers	F	N 6

7	In-charge at a 200+ bed non-corporate hospital for the past 20 years, earlier experience in smaller hospitals	F	N 7
8	Team Leader in 100+ bed hospital of a corporate chain, with more than 10 years' experience; about 3-4 yeas in 50-bed hospital	M	N 8
9	Infection control nurse in 500-bed hospital of a corporate chain for the past seven years; diploma in hospital infection control from earlier hospital he was working in; stint in a middle-eastern country through government programme	M	N 9
10	In-charge in emergency at 400-bed, non-corporate hospital (trust hospital) for the past 12 years, previous experience in Caregivers home	M	N 10
11	Team Leader in 75-bed hospital of a corporate chain for the past five years, previous experience in three small-medium hospitals, of which one shut down	M	N 11
12	Staff nurse since two years in 450-bed trust hospital attached to medical college	F	N 12
13	Nurse in ICU in 500+ bed hospital of a corporate chain since 10 years	M	N 13
	Key informants		
14	Office bearer, with work experience as nurse and professor	M	OB 1
15	Office bearer, currently working as Caregivers supervisor in 200+ bed corporate hospital; 16 years of work experience	M	OB 2
16	Office bearer – was working as staff nurse; removed after being part of a strike in hospital, ongoing case in labour court	M	OB 3
17	Office bearer – working in a government hospital	M	OB 4
18	Advocate, taken-up several cases of violation of nurses' rights in Delhi courts	M	KI 1
19	Nurse-cum-midwife, with post-graduate qualification, in policy advocacy	F	KI 2
20	Specialist nurse with 13 years' experience in 100+ bed single specialty non-corporate hospital, completed specialized course in hospital; one year in corporate hospital as Caregivers quality manager, not working at the time of interview	F	KI 3
21	Advocate specializing in labour law	F	KI 4
	FGD with seven female and five male nurses, all with up to five years' experience in different departments in same hospital		

Fuzzy Goal Programming Model

Decision models are simply a means to an end. A decision model represents, to some degree, an existing problem. Analysis of the model then should yield results that indicate optimal or preferred courses of action to be taken in the solution of the actual problem. It seems intuitively

obvious that, the "better" the model, the more likely it is that the results from such a model will determine the proper actions to be taken. One objective of this thesis is to furnish the ability to build a decision model that is, in general, hopefully better than those that have traditionally been taught. This is because the models with in this thesis will both acknowledge and deal with the fact that, in most real world problems, multiple conflicting objectives will exist. Unfortunately, with only a few exceptions, most works in the area of decision analysis (or mathematical programming optimization, etc.,) consider only models having a "single" objective. In fact, in most instances, the very existence of multiple objectives is completely ignored.

The multiple objective approaches, on the other hand, attempts to include all pertinent objectives. Such an approach recognizes that no all objectives can (or should) be optimized. However, one may establish aspired levels of achievement or goals for each of these objectives. Goal programming is then used to establish a solution that comes as "close as possible" to the satisfaction of all of these goals. Thus, while traditional approaches stress the optimization of single objectives, goal programming stresses the satisfaction of multiple objectives and one should recognize the significant differences between these two approaches.

Another, related, aspects of goal programming that is different from the traditional approach lies in the treatment of the so-called system "constraints". Such constraints are used to determine the design boundaries of a system and, with traditional methods, a solution must satisfy each and every constraint in order for it to be considered "feasible". Those employing goal programming, however, realize that is highly unlikely that all of these "constraints" are truly absolute. Consequently, for the no absolute "constraint", goal programming attempts to minimize the deviation from a pre specified level rather than to satisfy this level absolutely.

Although goal programming (GP) is itself a development of the 1950s, it has only been since the mid 1970's that GP has finally received truly substantial and wide spread attention. Much of the reason for such interest is due to GP's demonstrated ability to serve as an efficient and effective tool for the modeling, solution, and analysis of mathematical models that involve multiple and conflicting goals and objectives – the types of models that involve that most naturally represent real-world problems. Yet another reason for the interest in GP is a result of a growing recognition that conventional (i.e., single objective) mathematical programming methods (e.g., linear programming) do not always provide reasonable answers, not do they typically lead to a true understanding of and insight in to actual problem.

$$\min \sum P_i \left(w_i^- d_i^- + w_i^+ d_i^+ \right)$$

$$i = 1$$

$$\text{s.t. } c^1 x + d_1^- - d_1^+ = t_1$$

$$c^k x + d_k^- - d_k^+ = t_k$$

$$x \; \varepsilon \; S$$

$$x, d_k^-, d_k^+ \geq 0$$

in which S is the feasible region, P_i is the priority of the i'th goal, $c^i x$ is the i th goal criterion function, and the i th are the target values of the k goal criteria. The d_i^- and d_i^+ are deviational variables, which measure achievements below and above goal. The w_i^- and w_i^+ are relative importance weights attached to the underachievement and overachievement deviational variables.

The advantage of GP is that multiple criteria can be incorporated into a model that can be solved using conventional (single criterion) optimization software. GP's disadvantage is that information about the decision maker's preferences is required a priori in the form of priority levels, importance weights, and goal target values.

Goal-1

The number of over workload and under workload constraint is as follows:

$$\sum_i^n \quad \sum_{j1}^n \quad p_i \, d^+ - p_c \, d_c^- = \text{target}$$

Goal 2

The suift scheduling of goals of nurses as follows :

$$\sum_i^n \quad \sum_{j1}^n \quad S_i \, d^+ - S_i \, d_c^- = S_i$$

Goal 3

The nurses assigned goal is as follows:

$$\sum_i^n \quad \sum_{ji}^n \quad A_i \, d^+ - A_i \, d_c^- = PA_i$$

Result and Analysis

The solution will be obtained by using LINDO software may be interrelated as follows:

The study clearly reveals that they implement the bare minimum required to satisfy the law or regulation to maintain their image, rather than any genuine concerns for nurses' rights or for parity within their own hierarchical structures.

It would be expected that regulatory mechanisms that have been set up to ensure quality of care would take care of at least those issues related to the working condition of nurses that pertain directly to patient care. However, the study throws light upon how these processes are circumvented by the management, presumably with the connivance of the regulatory authorities. Prescribed standards and conditions are observed only during the inspection for accreditation and diluted once it is over. The study also points to the reluctance and resistance among private hospitals to abide by court and government orders to improve the salary and working conditions of nurses, and finally to the lack of political will to enforce such orders.

In summary, the existing environment of a poor regulatory mechanism, in combination with the imperative to maximize profits by keeping costs for human resources (HR) down in a sector

that is largely HR- dependent, is enabling a widespread neglect of the Caregivers cadre in the private sector in Delhi. It is hoped that this study contributes to firm action by the state to ensure long overdue reforms and regulations, an improvement in the employment and working conditions of nurses as it is also essential for the well-being of patients, as well as the entire health care sector.

1. The Centre and the state governments must immediately and strictly implement the JP Committee recommendations and initiate steps towards enacting legislation to regulate salary and working conditions of nurses. In doing so, policymakers need to subscribe to the recommendations laid down in the Decent Work theme of ILO, upheld by WHO for health care workers, the ILO Caregivers Convention 149 and ILO Convention Number 155 - the Occupational Safety and Health Convention.

2. A statutory supervisory mechanism needs to be set up to ensure and monitor compliance on a regular basis. Accreditation should not be treated as a substitute for these statutory mechanisms.

3. Recognizing the fact that a high percentage of health care requirements are currently being taken care of by private sector, the government needs to explicitly acknowledge its regulatory role in ensuring that existing quality control frameworks, entitlements, schemes and laws apply to the private sector.

4. Formation of health workers' unions must be permitted as a matter of right and any discouragement needs to be curtailed proactively by the supervisory mechanism set up as recommended above. A unionized health workforce not only leads to a higher patient safety and better working conditions for health care workers, but also creates a robust public health system. There is ample evidence internationally that higher levels of union density led to better outcomes for both workers and patients.

5. Nurses must be directly represented, respectfully heard and formally made part of the decision- making process at their workplace and in public health policy-making.

Separate Caregivers Directorate, Caregivers universities, and genuinely autonomous state Caregivers councils must be established in each state to facilitate authentic representation of nurses.

6. Nurse staffing norms in India must be revised in the light of international norms and research evidence available on actual workload of nurses, optimal Caregivers requirements for patient outcomes and quality of care. Nurse to patient ratios must be included in the oversight mechanisms enacted and strictly adhered to in health care facilities.

7. Considering that nurses are a permanent requirement for running any hospital, recruiting nurses on short-term contracts needs to be stopped and they must be included in the formal HR structure of the employing institutions.

8. Reforms and effective supervision structure need to be urgently established in Caregivers institutions to address the poor quality of education. Course content needs to be reformed to

ensure that it is not only technical, but also empowers nurses with respect to public health issues as well as their own rights and duties.

Goal	Achieved	Not Achieved
Goal 1	Achieved	
Goal 2		Not Achieved
Goal 3	Achieved	

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