Case study of supply induced demand: the case of provision of imaging scans (computed tomography and magnetic resonance) at Unimed-Manaus

Edson de Oliveira Andrade[1], Elizabeth Nogueira de Andrade[2], José Hiran Gallo[3]

[1] Ph.D. in Health Sciences; Associate Professor, Universidade Federal do Amazonas; Ph.D. Student in Bioethics, Universidade do Porto, Portugal
[2] M.Sc. in Health Sciences; Associate Professor, Universidade Federal do Amazonas; Ph.D. Student in Bioethics, Universidade do Porto, Portugal
[3] Specialist in Gynecology and Obstetrics; Ph.D. Student in Bioethics, Universidade do Porto, Portugal

Summary

Objective: To present the experience of a health plan operator (Unimed-Manaus) in Manaus, Amazonas, Brazil, with the accreditation of imaging services and the demand induced by the supply of new services (Roemer's Law). **Methods:** This is a retrospective work studying a time series covering the period from January 1998 to June 2004, in which the computed tomography and the magnetic resonance imaging services were implemented as part of the services offered by that health plan operator. Statistical analysis consisted of a descriptive and an inferential part, with the latter using a mean parametric test (Student T-test and ANOVA) and the Pearson correlation test. A 5% alpha and a 95% confidence interval were adopted. **Results:** At Unimed-Manaus, the supply of new imaging services, by itself, was identified as capable of generating an increased service demand, thus characterizing the phenomenon described by Roemer. **Conclusion:** The results underscore the need to be aware of the fact that the supply of new health services could bring about their increased use without a real demand.

Keywords: Financing in health; diagnostic imaging; need and demand of health services.

From Medicine School, Universidade Federal do Amazonas, Manaus, Amazonas, Brazil, and Ph.D Research in Bioethics, Universidade do Porto, Portugal

Submitted on: 12/21/2010
Approved on: 01/28/2011

Correspondence to:
Edson de Oliveira Andrade
Rua Paraíba, Conj. Abílio Nery,
Quadra H, Casa 2
Adrianópolis
Manaus – AM
Phone: + 55 92 8429 3579
dredsonandrade@gmail.com

Conflicts of interest: None.

Introduction

Health is a natural human desire, although facilitator social mechanisms to pursue it are not available to everyone. Brazilian Federal Constitution, promulgated in 1988, is very clear in recognizing this human disposition when, under the Social Order Heading, declares as follows:

Art. 196 – Health is everyone's right and a duty of the State, assured by social and economic policies aiming at reduced disease and other injury risk and by universal and egalitarian access to actions and services for promoting it, protecting it, and restoring it.

Brazilian health system organization operates through *Sistema Único de Saúde* (SUS) [Single Health System]. This model includes delivering both a public and a supplementary system. The supplementary system is responsible for about 40-million-people care and is regulated by the *Agência Nacional de Saúde Suplementar* (ANS) [National Supplementary Health Agency], while health care is directly provided by the State to 160 million Brazilians.

As the constitutional text makes clear, the Brazilian State should have appropriate and sufficient social and economic policies so that legislators rulings are fulfilled. Public economic policies are understood not only as financial resources allocated to health, but also as a policy for rationally using these resources. The balance between inflow and outflow is one of the touchstones of the competent health management.

This study aims at studying a small aspect of health resource use — supply induced demand — whose observation was inspired by Roemer's pioneering work that, by studying hospital bed availability in a county in New York State in the 50's, detected that increased bed supply created full occupancy not warranted by a restrained demand. Supply was stimulating demand[1].

The importance of studying health economics, a description of factors interfering with supply and demand in health care, an exposition about national regulatory guidelines for health care, and presentation of the case addressing imaging services at the Medical Work Cooperative Unimed-Manaus will be briefly reviewed below in order to contextualize and systematize the study.

Economics and health

The current economic status of health care system is scarcity of resources and/or their waste, no incentives for the several players involved, incorporation of new health care technology with no defined criteria, and a great variability in using inputs and medical procedures[2]. Thus, it is very important to understand the various factors in this equation called health care.

Although necessary, the relationship between health care professionals, economists, and other management professionals has not been too peaceful, citing Del Nero as an example stating in his introductory article on the subject: "Economics has a very tough interaction with health care professions. Many reasons arise from the different ways each one of them considers health care.Traditionally, health care professionals focus on individualistic ethics, according to which health is priceless and any effort is justified to save a life. On the other hand, economics is settled on common good or social ethics"[3].

This unnecessary conflict has hindered the interaction of two sectors not working independently. There is no possibility of achieving a good health care without a good medical care – not underestimating the other professionals providing health care – committed to the best care for the patients and an accountable management concerned about following up the care required by the physician as a result from either individual or collective patients' needs. Centrally to the management of this dilemma are financial resources (funding), their application (cost), and results of their use.

Upon analyzing those components, several methodologies are employed, all of them aiming to evaluate the relationship between what has been spent and what has been gained. Some of such strategies are:

a) cost-effectiveness analysis, the most used in literature, measures the cost in monetary units divided by a non-monetary unit called natural unit, e.g. survival years after a certain health intervention;

b) cost-benefit analysis, the cost is divided by the benefit monetary value, which lends methodological complexity, as monetary value is to be assigned to life;

c) cost-minimization analysis, comparing the treatment cost alternatives, on the premise the final medical effect is equivalent; its purpose is identifying the least costly way of reaching the desired endpoint;

d) cost-utility analysis is a special way to analyze cost-effectiveness, in which the cost per utility unit (unit related to the individual well-being) is calculated. The most commonly used unit is termed Quality-Adjusted Life Years (QALY)[2].

Factors interfering with health service demand and supply

In December 1963, Kenneth Arrow published an article[4], "Uncertainty and the Welfare Economics of Medical Care", which would become a classic in health economics literature, including a *fac-simile* recent edition by the World Health Organization[4]. In his study, Arrow lists a group of characteristics that he believes distinguish health care from other economic sectors. These characteristics are: a) the nature of the demand, which is strongly individual, irregular, and uncertain in this sector; b) the physician acting as a health service seller, but with a different behavior from any other business person, as it is expected; c) the uncertain product that, according to Arrow, may be the main characteristic distinguishing

the product health care from other commodities; d) conditions of market supply, where a regulated professional market prevents the free access to new service providers, thus elevating the service cost; e) pricing policy with unusual pricing practices and high variability.

Several factors were found to affect the quantity of a good or a service people intend to use. These determinants can also be classified in a more simplified way into the following groups: a) considering what has been previously exposed, it becomes clear that the structure of consumer preferences is one of the main determinants of a good or a service demand; b) the perceived quality of a product or service; c) the good or service price; d) the price of other products or services; e) the consumer available income[5].

Other important aspects also influence health service use. One of them is the psychosocial aspect. Working women, as an example, experience more acute and chronic morbidities than housewives[6].

The fact that Brazilian Law provides unlimited access to health services (in the private system a few residual restrictions remain) has stimulated its use[7]. In the private sector, there is recurrent communication of system's non-rational use with frequent reports of patients undergoing laboratory tests, but never coming to get their results[8].

Technological progress generates both supply and demand[7]. It is a real double-edged sword. It provides undeniable gains for individuals, but, on the other hand, it is a source of growing cost. The physician is pressed to use it and the patient insists on its use, as he/she is motivated by an aggressive advertisement selling technology as the most important part of health care[9].

Increasing lawsuits against physicians have led many professionals to adopt defensive behaviors, among which is the overuse of diagnostic resources with the justification of "better safe than sorry", thus avoiding, future liability and eventual convictions for neglect or malpractice[10].

In a consumerist world, if there is supply, there will be demand, even though this consumption not always means a real health service need, since health care necessity should be distinguished from health care use[11].

Therefore, the demand concept often clashes directly against the need concept. While the former focuses the consumers' freedom to choose according to their own preference frame, the need concept is an exogenous definition by an expert. Thus, we will be facing a need to consume health care when an individual is ill or disabled and knows there is a treatment or cure for his condition, while health care use is shown when an individual considers he requires and desires to receive a treatment.

As one can see, dynamics of health service use is too complex and has numerous variables, being some of them concurrent and others antagonistic, generating a problem to solve equation that requires a lot of effort to be understood, but a better health care will be derived from this understanding.

Given these facts, this work aims at finding supply induced demand (Roomer's Law) occurring at imaging (Computed Tomography and Magnetic Resonance) services accredited by Unimed-Manaus from January 1998 to June 2004.

Methods

Study outline: This a retrospective study covering the period from January 1998 to June 2004, a time when computed tomography and magnetic resonance services were implemented as facilities supplied by that health care plan.

Data base: Data were collected from de health plan data base (SIAMED), organized into a statistical software spreadsheet SPSS (version 15), and underwent statistical analysis.

Data processing: Aiming at the study objectives, the data were descriptively organized in the first instance, listing information resulting from types of scans performed sites where they were carried out and the system user population. An adjustment of the number of scans monthly performed to the user population in the corresponding month was made to evaluate appropriately the effect of supply on demand. For that, five indexes were created, namely:

a) **Utilization index (UI)**, consisting of the ratio of the monthly number of scans to the number of users in the corresponding month;

b) **Monthly user variation index (USVI)**, consisting of monthly variation of system users;

c) **Monthly utilization variation index (UTVI)**, consisting of the monthly variation of scan utilization by the system;

d) **Variation ratios (VR)**, consisting of the USVI to UTVI ratio;

e) **Monthly demand incremental index (MDII)**, calculated as a percentage based on the first UI calculated.

The statistical analysis consisted of a descriptive part and an inferential part, the latter using mean parametric tests (Student's T test and ANOVA) and Pearson correlation. A 5% alpha and a 95% confidence interval (CI) were adopted to determine the statistical significance level.

Results

The results will be described independently, i.e., the data on computed tomography and magnetic resonance will be shown separately, as the two kinds of scans have different delivery periods.

Over the study time period, Unimed-Manaus was a medical work cooperative responsible for delivering medical care to 141,373 users (SD ± 15.08), corresponding to about 10% of Manaus population at the time (the popu-

lation estimated by *Instituto Brasileiro de Geografia e Estatística* [Brazilian Geographical and Statistical Institute - IBGE] was 1,422,905)[12]. A total of physicians ranging from 830 to 1,099 professionals provided health care, with a monthly mean of 947 (SD ± 84) physician members having asset links to the cooperative, that is, they owned the health plan operator.

The study began on January 1st, 1998, when the health plan starts to record systematically the computed tomography and magnetic resonance scans offer. On that occasion, the imaging services were performed in several centers. Tomographic scans were performed at CLÍNICATC1 and CLÍNICATC2 and, in February 2000, a new center, CLÍNICATC3, was accredited.

Magnetic resonance scans were initially performed in only one center, CLÍNICARM1, a situation that continued until July 1999, when CLÍNICARM2 was accredited. Only in December 2000 a third center, CLÍNICARM3, was accredited.

According to a personal communication from the cooperative chairpersons at the time of the service implantation, accreditations were motivated by the desire to provide a better service to the health plan users, although there was no evidence of restrained demand.

Tomographic scans

Over the months studied, 25,286 scans were performed, with a monthly mean of 324 scans (SD ± 90). The month with the lowest number of scans performed (195) was December 1999.The month with the highest number of scans performed was May 2004, with 524 scans. Figure 1 shows the monthly number of computed tomography scans performed.

In Figure 1, the temporal series detailing every imaging clinic participation is observed. Clearly the computed tomography use curve behaved differently after the third clinic was accredited. A new use level is reached, where there is no redistribution of the numbers previously achieved, but an increment due to the new service provided, also resulting from an increasing yield in a clinic already running (CLÍNICATC1). This is the first evidence of the supply induced demand phenomenon.

The possibility of increased use occurring from an increment in the number of system users, with this hypothesis possibly explaining the scan use behavior, is not confirmed by the study data. The UI-CT analysis shows such a situation did not occur. If the increased number of scans had occurred because of an increases user population, the UI-CT should remain stable or it could even be reduced. In fact, a trend to increased UI-CT was observed. The UI-CT in the period ranged from 1.39 to 3.21, with a mean value of 2.26 and SD ± 0.41.

Another important finding confirming the user number did not influence the increased demand is the lack of correlation between the monthly user variation (USVI-CT) and utilization (UTVI-CT). When the Pearson correlation is assessed between those variables, no association is found ($p > 0.05$).

The possibility of randomness in the occurrence of increased demand was discarded as the UI-CT was assessed in two groups. The first composite includes values before CLÍNICATC3 input was considered and the second composite already includes this clinic contribution. The Student's T test showed a statistically significant difference between the two groups ($p < 0.001$).

Perceivably, the increased use of tomography scan observed is not a result from possible increased demand arising from a higher user number, but rather from the availability of one more service.

Next, complementing this line of thinking, Figure 2 shows the MDII-CT, indirectly demonstrating the estimated economic impact entailed by the scan use (increment).

Figure 2 shows the MDII-CT for the two clinics presented a balanced behavior until the time when the third clinic started operating. Thereafter, the clinic CLÍNICATC2, possibly pressured by the new competitor, starts

Figure 1 – Computed tomography consumption at Unimed-Manaus per provider unit from January 1998 to June 2004.

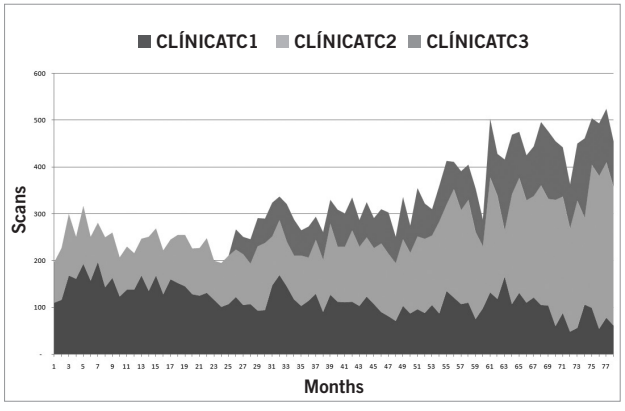
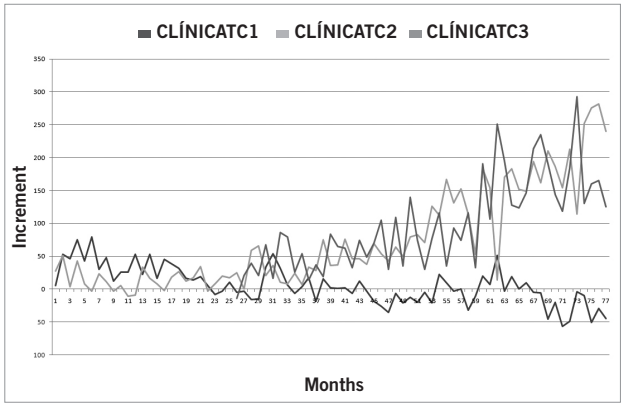


Figure 2 – Computed tomography incremental use at Unimed-Manaus per service provider from January 1998 to June 2004.



having an ascending MDII-CT, following the MDII-CT curve slope of the new clinic (CLÍNICATC3). This made the general MDII-CT reach a 300% increment based on the early 1998 values.

This data can show the supply induced demand phenomenon, described by Roomer, occurring at Unimed-Manaus concerning computed tomography scans. However, the magnetic resonance data analysis makes this situation even more evident.

Magnetic resonance

Figure 3 shows the growing use of magnetic resonance within the study period. In contrast with the CT scans supply, it is possible to observe the impact of new provisions in two specific moments of magnetic resonance use, since initially there was only one clinic providing the service, with two new clinics providing the same service later, but in different moments.

It is evident from Figure 3 that each new service did not split the previously available market, but added a new demand.

Adjusting for the system user population at that time (UI-MR), we found that the increased scan use occurs positively. As it was seen regarding computed tomography, the VR-MR and the correlation between USVI-MR and UTVI-RM shows dissociation between the scan use and the number of users ($p > 0.05$).

The statistical analysis by ANOVA shows the CLÍNICARM3 admittance into the system completely changes the scan use profile ($p < 0.001$), making CLÍNICARM2 change the yield profile, as Figure 4 shows, with the monthly demand incremental profile (DMII-MR) per clinic.

Figure 3 – Numbers of magnetic resonances performed at Unimed-Manaus per provider unit from January 1998 to June 2004.

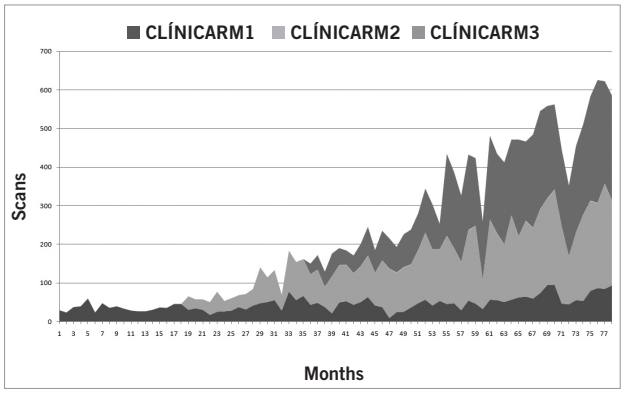
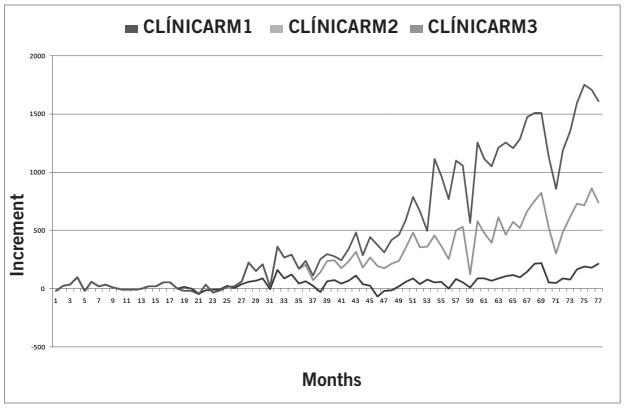


Figure 4 – Magnetic resonance incremental use at Unimed-Manaus per service providers from January 1998 to June 2004.



Discussion and conclusions

As discussed above, many factors interfere with supply and demand of health services. In this study specific case, clearly the new service supply must be preceded by correct study on the real need of supply enlargement. Otherwise, a system cost elevation could occur, resulting from the supply induced demand alone. This situation will be even more serious if the deliver is associated with advertising campaigns or if the media is drawing attention to the technological progress that might be associated with the new service provided. The aggravating factor is this increased outflow not always means a better health care, which would be better assessed by taking into account the efficacy and the effectiveness of the provided services[13].

In this specific case, the current study could identify a supply induced demand phenomenon (Roemer's Law) occurring from the retrospective review of imaging service data (computed tomography and magnetic resonance) from the Medical Work Cooperative Unimed-Manaus health care plan. This became more evident for magnetic resonance scans, as the services were delivered more definitely in three discrete moments, providing a clearer identification of each clinic contribution to the study phenomenon.

Whether in public or private level, the appropriate incorporation of new technology is a great challenge in health resources managing in the present days. Currently, Manaus has 15 computed tomography scanners and four magnetic resonance scanners. This fact, apart from constituting a huge capital, is also, as this study quantitatively demonstrated, an encouragement to consumption, bringing with it potentially enormous expenses that will certainly affect substantially the already limited and sparing health resources.

New services might be very important to cover a population health care correctly, but their incorporation with no previous need study causes a potential managing destabilization and instead of providing efficiency gains, they turn into factors creating elevated cost and financial unbalance.

Although the presented data originated from supplementary health care system in Brazil, we should consider this fact as possibly occurring in public management where cost control is knowingly lower than in the private initiative.

References

1. Roemer MI. Bed supply and hospital utilization: a natural experiment. Hospitals 196135:36-42.
2. Vianna D, Mesquita ET. Economia da saúde:ferramenta para a tomada de decisão em Medicina. Revista da SOCERJ 2003;16(4):258-61.
3. Del Nero CR. O que é economia da saúde. In: Piola SFVSM, editor. Economia da saúde. Conceito e contribuição para a gestão da saúde. Rio de Janeiro: IPEA; 1995. p.5-23.
4. Arrow KJ. Uncertainty and the welfare economics of medical care. 1963. Bull World Health Organ. 2004;82:141-9.
5. Iunes RF. Demanda e demanda em saúde. In: Piola SFVSM, editor. Economia da saúde: conceito e contribuição para a gestão da saúde. Brasília (DF): IPEA; 1995. p.99-121.
6. Gomes KR, Tanaka AC. Morbidade referida e uso dos serviços de saúde por mulheres trabalhadoras, Município de São Paulo. Rev Saúde Pública 2003;37(1):75-82.
7. Zucchi P, Del Nero CR, Malik AM. Gastos em saúde: os fatores que agem na demanda e na oferta dos serviços. Saúde Sociedade 2000;9(1/2):127-50.
8. Magalhães P. Utilização de exames complementares na Unimed-Manaus. 1993.
9. Barros JAC. Propagandas de medicamentos: atentado à saúde?. São Paulo: HAUCITEC-SOBRAVIME; 1995.
10. Porter ME, Teisberg EO. Política de assistência à saúde e competição baseada em Valor. Repensando a saúde. Porto Alegre: Bookman; 2007. p.275-319.
11. William A. Need-an economic exegesis. In: Culyer AJKW, editor. Economic aspects of health services. London: Martin Robertson; 1978.
12. Instituto Brasileiro de Geografia e Estatística. IBGE. [citado 19 mar 2008]. Disponível em: http://www.ibge.gov.br/home/2008.
13. Nunes R, Rego G. Eficácia e eficiência dos serviços de saúde. Prioridades na saúde. Lisboa: McGraw-Hill; 2002. p.107-32.