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REAL OPTIONS THEORY AND CLASSIFICATION OF PATIENTS BY DIAGNOSIS RELATED GROUPS: HOW THESE DIFFERENT FIELDS COULD RELATE?[1]

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ABSTRACT

In a complex environment, the managers of hospital organizations should take hard decisions all the time. Therefore, tools and techniques, which seek to understand the past and project the future, are very important. In some situations, the complexity encountered requires the transfer of knowledge from other areas, to find solutions and develop tools that provide efficient management of resources. In this scenario, this article has the main objective to present a theoretical discussion that brings the relationship between the Theory of Real Options and the Diagnosis Related Groups, to identify possible points that underlie the use of real options in Diagnosis Related Groups. The results demonstrate that, with the patient's condition as the focus, both are applied in the hospital environment with the objective of supporting decision-making, but not together. In addition, the differences observed make the combination of some of its concepts relevant for decision-making.
Keywords: Classification of patients. Diagnosis-related group. Real options.

TEORIA DAS OPÇÕES REAIS E CLASSIFICAÇÃO DE PACIENTES POR *DIAGNOSIS RELATED GROUPS*: COMO ESSES DIFERENTES CAMPOS PODERIAM SE RELACIONAR?

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Em um ambiente complexo, os gestores das organizações hospitalares devem tomar decisões difíceis o tempo todo. Por isso, ferramentas e técnicas, que buscam compreender o passado e projetar o futuro, são muito importantes. Em algumas situações, a complexidade encontrada exige a transferência de conhecimento de outras áreas, a fim de encontrar soluções e desenvolver ferramentas que proporcionem uma gestão eficiente dos recursos. Nesse cenário, este artigo tem como objetivo principal apresentar uma discussão teórica que traz a relação entre a Teoria das Opções Reais e os *Diagnosis Related Groups* (DRG), a fim de identificar possíveis pontos que fundamentam o uso de opções reais em DRG. Os resultados demonstram que, tendo como foco principal a condição do paciente, ambos são aplicados no ambiente hospitalar com o objetivo de subsidiar a tomada de decisão, mas não em conjunto. Além disso, as diferenças observadas tornam a combinação de alguns de seus conceitos relevantes para a tomada de decisão.
Palavras-chave: classificação de pacientes; grupo relacionado ao diagnóstico; opções reais.

TEORÍA DE LAS OPCIONES REALES Y CLASIFICACIÓN DE LOS PACIENTES POR GRUPOS RELACIONADOS CON EL DIAGNÓSTICO: ¿CÓMO SE PODRÍAN RELACIONAR ESTOS DIFERENTES CAMPOS?

En un entorno complejo, los gerentes de las organizaciones hospitalarias deben tomar decisiones difíciles todo el tiempo. Por lo tanto, las herramientas y técnicas que buscan comprender el pasado y proyectar el futuro son muy importantes. En algunas situaciones, la complejidad encontrada requiere la transferencia de conocimientos de otras áreas para encontrar soluciones y desarrollar herramientas que permitan una gestión eficiente de los recursos. En ese escenario, este artículo tiene como principal objetivo presentar una discusión teórica que traiga la relación entre la Teoría de las Opciones Reales y los Grupos Relacionados con el Diagnóstico, con el fin de identificar posibles puntos que subyacen en el uso de opciones reales en Grupos Relacionados con el Diagnóstico. Los resultados demuestran que, teniendo como foco principal la condición del paciente, ambas se aplican en el ámbito hospitalario con el objetivo de subsidiar la toma de decisiones, pero no juntas. Además, las diferencias observadas hacen que la combinación de algunos de sus conceptos sea relevante para la toma de decisiones.
Palabras clave: Clasificación de pacientes. Grupo relacionado al diagnostico. Opciones reales.

INTRODUCTION

The combination of different types of services, which need to be executed in a harmonious way so that the final product is delivered, makes hospital managers face daily challenges.

According to Urbano and Bentes (1990), when we consider that each patient, in their individuality, will receive a set of different resources and services, we can say that a hospital will have different types of products, which vary according to the profile of each patient attended. This situation makes the hospital can not create a single pattern that will be followed in all services provided.

Fetter and Freeman (1986) add that as individual patients receive different amounts and types of services, the hospital can be seen as a multi-product company with a product line, which in theory, is as extensive as the number of patients served. In addition, the specific product provided to each patient is correlated with their condition as well as the treatment process they undergo during hospitalization.

Face this situation, hospital managers have been using the patient's classification to assist in the management challenge. There are differents kinds of classification, as Patient Classification System (PCS), which focus on nursing efforts, and others broader that was developed based on severity, such as APACHE II (*Acute Physiology and Chronic Health Evaluation*), *MedisGroups* (*Medical Illness Severity Grouping System*), *Computerized Severity Index* (CSI), *Disease Staging, Patient Management Categories* (PMCs), *Acuity Index Method* (AIM), and *Diagnosis Related Groups* (DRG).

The last one, the DRG, has been the most used by several countries. It is important to highlight the countries that have used the Diagnosis Related Groups made adaptations to the original model considering local variables, such as: Brazil (DRG-Brasil), Canada (CMG), EUA (DRG), Portugal (AP-DRG), Australia (AR-DRG), England (HRG), Hungary, Bélgium, Finland, Italy (APR-DRG), Sweden (NordDRG), Spain AP-DRG (CMS-DRG), Austria (LKF), South Koren (K-DRG), South Africa (IR DRG), Estonia (NordDRG), Germany (G-DRG), Netherlands (DBC), Poland (JGP), Taiwan (Tw-DRG), Bulgaria (AP-DRG), and others countries.

The adoption of DRG by several countries can be explained by the fact that this classification creates patient groups that are clinically coherent and similar or homogeneous with the consumption of hospital resources. This allows hospital managers to manage aspects related to in-patient care monitoring, budgeting, cost control, and planning. Another point worth highlighting about its adoption is the fact that the DRG can be used to determine the payment.

Although DRG is a tool that helps managers a great deal, it should be noted that the variables such as: day of hospitalization and resource consumption are fixed and predetermined. In this way, the provisions for the budget, as well as the payment of the service, are made on the basis of fixed variables.

It is known that in the environment in which the hospital product is developed there are many uncertainties, ranging from uncertainties related to the management of hospital resources to uncertainties related to the clinical and physiological conditions of the patient.

Also, the irreversibility of the resources invested in the treatment of the patient is observed in this environment. In other words, the invested resources can not be recovered in their partiality or totality.

The DRG does not consider these variables. Although this classification seeks to contribute to the optimization of the result, considering management and assistance aspects.

The concern related to optimization is observed in several studies in Modern Finance, where business strategies are defined based on the analysis of opportunities, cost of capital, planning, and control, seeking to increase profits without changing the volume of products/services sold.

Among the studies, which discuss and present models that seek to corroborate this need, there is the Real Options Theory - ROT, which began with the studies of Black and Scholes (1972), and Merton (1973). According to the ROT, in decision-making is important to consider the various managerial flexibilities (real options), giving the manager a better evaluation of investments in scenarios where there are uncertainty and partial or total irreversibility of the initial investment.

The applicability of ROT is observed in many sectors, especially in health, whose applicability has been to evaluate investment in substitution of the techniques of Net Present Value - NPV, Internal Rate of Return - IRR and other deterministic techniques. It is also observed the application to evaluate the value of the treatment option. Finally, the ROT has been applied in medical decision-making regarding the treatment of patients.

In the hospital environment, the manager has no control over demand and this demand can not be stimulated like in other sectors. Thus, optimization should be considered in hospital decision-making.

In this context, besides knowing the nosological profile of the hospital, it is important to adopt techniques and tools that contribute to decision-making that contemplates the many possible opportunities, considering the uncertainties present in this environment.

Both, DRG and TOR, are helping managers in the decision-making process. Thus, this article aims to discuss the points of intersection of both and how it can complement each other, offering hospital managers more information.

This paper is divided into three different sections. In the first section, some aspects related to Real Options and Health are discussed. The second section presents some points about DRG. Finally, the third section presents the points of intersection between TOR and DRG. In the last section, it is still presented as TOR and DRG can complement each other.

1 REAL OPTIONS AND HEALTH[5]

The real options were created from the analogy made, by Myers (1977), between a financial option, which is understood as a contract that gives the right to its holder, without obligation to buy (*call option*) or sell (*put option*) a financial asset. This type of derivative is traded in the market, with a pre-established price and period between the parties, in which the holder can choose to exercise its right or not. In this case, the advance payment, called the premium, is required to reflect the value of flexibility (BREALEY et al., 2008; DAMODARAN, 1999; HULL, 1996; SILVA NETO, 1996; SOUZA NETO et al., 2008).

This derivative, according to Fortuna (2005), offers investors the possibility of avoiding the scenarios that give negative results. Therefore, this right of future purchase and sale reduces the losses that would have on the purchase of shares. In this way, the value paid for the premium, in practice, represents the cost of eliminating unfavorable scenarios.

Unlike financial options (originating from derivative assets), real options are linked to the real assets. According to Copeland and Antikarov (2001), a real option represents the right of an entrepreneur to take action, where the holder may defer, expand, contract or abandon the project at a pre-determined cost for a pre-established period.

In other words, real option reflects the various investment alternatives (flexibilities) of a capital investment project, where a manager can, in a positive situation; raise the present value of the expected cash flows when exercising the right of action, or in a situation of uncertainties, the manager can minimize the losses.

Dixit and Pindyck (1994) report that the existence of a real option is only possible if there is irreversibility, this means, it is not possible to recover the initial investment if changes occur in the plans. Another relevant point for the existence of a real option is the existence of uncertainty, which represents the lack of prior knowledge of the cash flows. Finally, it is necessary to have a possibility of reassessment, in which it is possible to postpone the action to obtain more information about the future situation.

Although the studies related to the Real Option Theory - ROT began with Myers (1977), it was only in 1996 that journals reported the application of ROT in the health sector. The application of the ROT in the health sector started when Magiera and McLean (1996) demonstrated how the Real Option Analyses - ROA can effectively support the decision to invest in either a stationary or mobile lithotripter.

[5] The authors do not consider the papers developed in the pharmaceutical industry.

After Magiera and McLean (1996), the number of studies in the health sector has increased as well as the form of its application. Table 1 shows the main studies on ROT in the health that focused on the traditional application of ROT.

Table 1 - Research with focus on traditional investment analysis

Author	Main focus
Magiera and McLean (1996)	Analysis of investment in equipment
Mahul and Gohin (1999)	Analysis of investment in public health
Palmer and Smith (2000)	Analysis of investment in technology
Kallapur and Eldenburg (2005)	Analysis of investment in technology
Smith (2007)	Analysis of investment in the future treatment
Levaggi and Moretto (2008)	Analysis of investment in technology
Pertile (2008)	Analysis of investment in technology
Pertile et al. (2008)	Analysis of investment in equipment
Eckermann and Willan (2008)	Analysis of investment in technology
Özogul et al. (2009)	Analysis of investment in technology
Wyant (2009)	Analysis of investment in technology
Pertile (2009)	Analysis of investment in equipment
Attema et al. (2010)	Analysis of investment in medication
Sengupta and Kreier (2011)	Analysis of investment in health plan
Grutters et al. (2011)	Analysis of investment in therapies
Forster and Pertile (2012)	Analysis of investment in technology
Cruz and Marques (2013)	Analysis of investment in production line
Pertile et al. (2013)	Analysis of investment in technology
Pike et al. (2014)	Analysis of investment in public health
Girling et al. (2015)	Analysis of investment
Park (2016)	Analysis of investment in public health
Smith and Yip (2016)	Analysis of investment

Source: Elaborated by the authors (2019)

These studies represent the traditional application of the real option, in which the investor analyzes whether to invest his money in any project and if that project must present a return that exceeds the cost of capital of the company.

In addition, it is possible to see some applications of the ROT to discuss option value. As the case of studies presented in Table 2.

Table 2 - Research with focus on option value

Author	Main focus
Lovejoy, W. S.; Desmond, J. S. (2011)	To define the value of being able to delay the use of an inpatient bed for an inpatient in an observation status.
Sanchez et al. (2012)	To define the option value of innovative treatments in the context of Chronic Myeloid Leukemia.
Favato et al. (2013)	To discuss the potential advantages shown by using the payoff method in the valuation of the cost-effectiveness of competing HPV immunization programs.
Thornton et al. (2017)	To define the option value of innovative treatments for Non–Small Cell Lung Cancer and Renal Cell Carcinoma

Source: Elaborated by the authors (2019)

In summary, the studies presented in Table 2 focused on: a) measuring the value of the option of treatment, b) analyzing the delay in the consumption of hospital resources. It should be noted that, in healthcare, the cost-effectiveness analysis is used to decide which treatment should be adopted. However, these papers showed that the value of the option could be used to decide whether the new treatment should be considered.

Finally, there are papers, which present the application of ROT to medical decision-making, as shown in Table 3.

Table 3 - Research with focus on medical decision-making

Author	Main focus
Driffield, T.; Smith, P. C. (2007)	Watchful waiting
Grutters et al (2011)	Switch the patient therapy
Meyer, E; Rees, R. (2012)	Watchful waiting
Mello-Sampayo, F. (2015)	Switch the patient therapy

Source: Elaborated by the authors (2019)

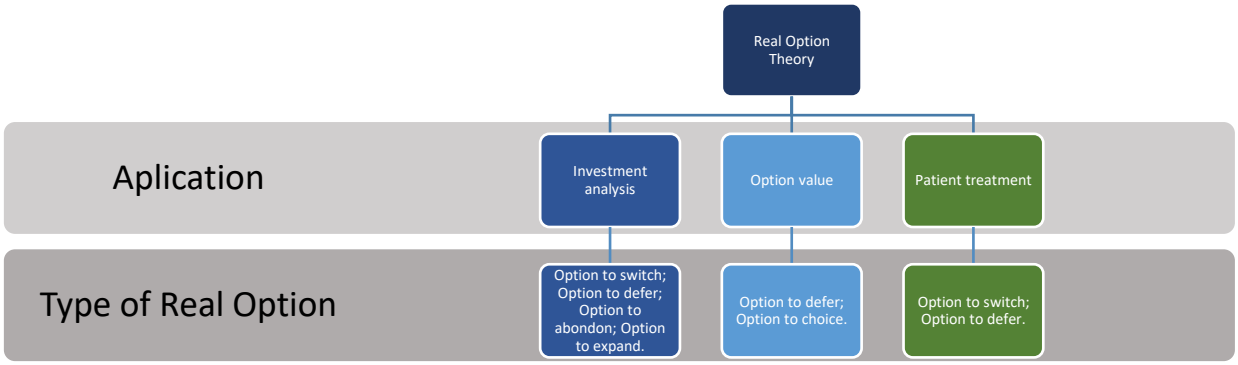
In the watchful waiting approach, the ROT is applied to help the physician decide whether some treatment should start in time zero or the treatment should start at another time in the future. However, this approach also helps to manage resources because hospital resources are consumed when the treatment is done. In addition, this approach is interesting because the life condition of the patient should be considered part of the return and risk equation followed by the investor.

When the ROT is applied to evaluate whether the patient's therapy should be switched, it is possible to observe that this approach helps the physician resolve the therapeutic dilemma of changing treatment by comparing the options.

It is worth mentioning that there are other papers, which do not fall into the classifications presented in Tables 1, 2 and 3, such as Dortland et al. (2012), Dortland et al. (2013), Dortland et al. (2014) that had focused on scenario planning. Also, Garrison Jr et al. (2017) and Lakdawalla et al. (2018) discuss the relevance of the real option in health. Finally, Williams and Hammes (2007) evaluated the cognitive and strategic aspects of the real options and Wernz et al. (2013) compare ROA and NPV in decision-making.

Almost all these articles discuss one or more types of real options. In these researches are observed the option to switch, option to defer, option of abandon, option to expand, and option to choice[6]. Figure 1 illustrates what kind of real option each group (Tables 1, 2, 3) discusses.

Figure 1. Focus of studies and type of real option



Source: Elaborated by the authors (2019)

It is possible to observe that the ROT has been applied in health with different proposals, especially in medical decision-making. This type of approach is possible because it does not matter if the focus of analysis is buying/expanding assets, or treating patients, both situations involve irreversibility and uncertainty, variables that, according to Dixit and Pindyck (1994), are essential for the option to exist.

2 DIAGNOSIS RELATED GROUPS - DRG

[6] This name "option to choice" was not found in the literature of real option theory. However, the authors of this papers used it because this name represents the idea of the option, to choose between two or more different options presented at the same time.

According to Mullin (1986), Diagnosis Related Groups (DRG) is understood as a classification system for patients hospitalized in acute care hospitals[7]. Averil (1985) adds that this classification system creates groups of patients considered clinically coherent and similar or even homogeneous in relation to the hospital resources consumed. This happened because the DRG tries to correlate the types of patients attended with the resources consumed throughout the period of hospitalization.

In addition, Fetter and Freeman (1986) mentioned that the DRG provides hospital administrators and physicians with a mechanism to control quality and costs through a more accurate understanding of the hospital's production process. For this, medical knowledge is used with statistical and computational techniques.

It should be noted that DRG is a type of classification that considers the severity. According to Smits et al. (1984), and McMahon and Newbold (1986), severity can be defined as conforming to the criteria of the physician, nurse, manager, or payer.

As stated in Aronow (1988), physicians' definitions of severity generally equate to the severity with an increased physiological risk of morbidity and mortality. Nurses, however, equate gravity with some aspects of physiopathology but focus on the psychological and activity status of patient dependence. Finally, the definitions given by managers and payers usually equate severity with the increased consumption of health resources.

As the definition of severity passes through the idea of resource consumption, in some moments, it is observed that this concept also brings a discussion about necessary resources versus resources consumed (JENCKS et al. 1984; GERTMAN; LOWENSTEIN 1984; CLIFFORD; PLOMANN 1985).

Aronow (1988) explains that the necessary resources are linked with an intellectual assessment of the patient that the physician makes as part of the treatment plan. On the other side, the use of resources reflects the updating of this plan in the concrete world of the manager of health services.

In short, patient classification systems are used to guide the activities carried out in the care and administrative part of the hospital, seeking to optimize the resources used in patient care. In this way, it is possible to manage the hospital activities in order to maximize the investor's results, not only based on issues related to cost reduction and revenue increase, but also considering aspects of health care.

[7] According to Palmer et al. (1989), hospitals that attend acute cases are those that the average hospital stay does not exceed 30 days.

It is possible to observe the application of DRG to manage performance as presented by Jung et.al (2018), Xourafas et. al (2018), McCormick, et. al (2018), and Knoll et. al (2018). In addition, DRG is being used for payment as presents Jiao (2018), Kim et. al (2018), Annear et. al (2018), Kwak et. al (2018) and Zhao et. al (2018).

When used in order to manage performance, DRG enables evaluations of service efficiency, allowing the analysis of the relationship between resource consumption, the service process, and the results of the treatment performed. In addition to allowing comparisons of the financial resources used, in the same DRG, between physicians, nurses, or hospitals.

For payment, the DRG is used as base to the Prospective Payment System. According to Noranha et al. (1991), the Prospective Payment System determines that the amount of payment for services should be defined before the service is provided, based on the diagnostic group in which the patient is classified. Thus, the value is based on the average cost of care of the diagnostic group, not on the amount that was actually spent with each patient. Therefore, the hospital assumes the risk of possible losses or also possible surpluses due to the differences between the pre-fixed amount and the costs incurred during the service.

Note that in practice the DRG can contribute to increasing productivity, improving medical efficiency, increasing transparency of hospital expenses, and reducing the number of readmissions and excessive treatments, which can lead to a reduction in hospital costs.

These points are possible due to the principle that the resulting groups should contain patients clinically homogeneous from the point of view of resource consumption (FETTER et al., 1980).

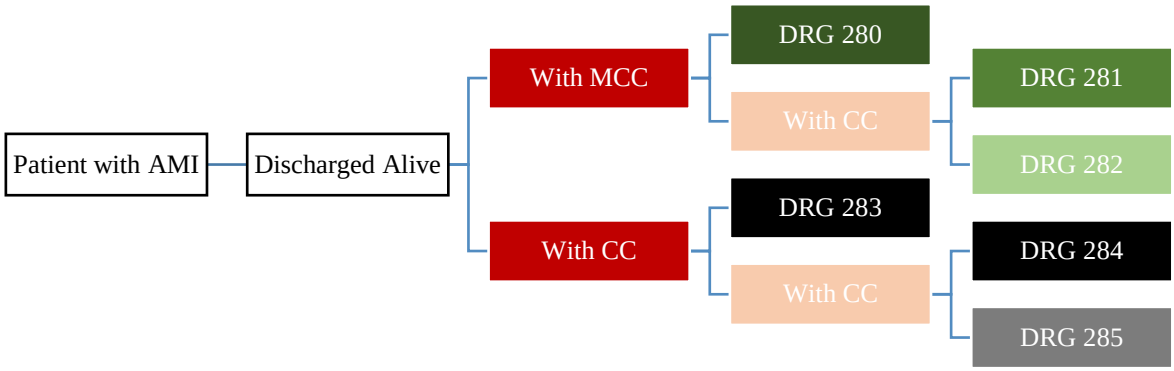
As an example of this interaction, consider DRG 280, 281, 282, 283, 284 e 285. All are DRG's related to Acute Myocardial Infarction. The combination of the principal diagnoses, secondary diagnoses, and the result of the treatment (death or life) are the variables, in these cases, that end up having greater influence in the formation of the groups.

This is because some diagnostic combinations lead to consider that the patient presents major complication or comorbidity (MCC), or complications or comorbid conditions (CC).

When treating a patient with MCC, the idea is that this patient presents a more complex clinical situation and, consequently, will consume more resources than a patient who has CC or does not present either situation.

Based on this idea, Figure 2 illustrates the decision tree for the grouping of Brazilian hospital patients, who presented the diagnosis of Acute Myocardial Infarction.

Figure 2. Decision tree releated DRG's 280, 281, 282, 283, 284 and 285



Data: Governador Israel Pinheiro Hospital (HGIP)
Source: Elaborated by the authors (2019)

DRGs 280, 281, and 282 are composed of surviving patients, on the opposite side DRGs 283, 284, and 285 are composed of patients who do not survive.

DRGs 280 and 283 are composed of patients who have MCC. DRGs 281 and 284 have only patients who have CC. Finally, DRGs 282 and 285 are composed of patients who do not have MCC or CC.

In summary, it can be said that DRG, besides offering information about the length of stay and resource consumption, also has been important for decision-making in hospitals, helping both financial and productive planning, as well as in the management and evaluation of care at various levels of the health system.

3 INSERTION POINTS BETWEEN REAL OPTIONS THEORY AND DIAGNOSIS RELATED GROUP

This section will present the principal insertion points between real options theory and diagnosis-related group. The first insertion point is about applicability and the second insertion point is the main point. Also, it will present how ROT and DRG could complement each other.

3.1 DESICION MAKING

When these different subjects are analyzed the first point that can be mentioned is that both are used to support decision-making. In the case of ROT, the idea is to look to the future and try to identify the different possibilities that uncertainty can bring and consider these possibilities in decision-making.

According to Dixit and Pindyck (1994), it is necessary to capture the value of possible alternatives that may arise during the implementation period of an investment.

This idea brought by ROT it is the solution found to settle the problem that deterministic models had. According to Dixit and Pindyck (1994), the orthodox theory of investment does not recognize the implications of the interaction between irreversibility, uncertainty, and the choice of the time in which the investment will be realized. In this sense, Paddock et al. (1988) add that deterministic methods can lead the investor to inadequate results by disregarding possible uncertainties that have the investment.

Amram and Kulatilaka (2000) report that traditional methods, based on evaluation techniques and decision-making, do not work for the new reality of the business that have:

- ✓ Strategic investments with numerous uncertainties and immense capital needs;
- ✓ Projects that need to adapt to market conditions;
- ✓ Partnerships with complex asset structures and with great pressure on the part of the financial market to adopt actions that resulted in value.

On the opposite side, the DRG is a method that supports decision-making by looking to the past. The group's information considers the information about patients who were treated by the hospital. In this case, the manager looks to the past, understands what happened, and plans for the future.

Diagnostic information, hospitalization time, age, procedures performed, type of hospitalization, type of discharge, and gender, besides to providing knowledge about the nosological profile of the hospital, also offers managers to manage the aspects of patient care, budgeting, cost control, reimbursement, and planning.

Despite the great contribution of this tool to decision-making, it is important to highlight that no matter if the DRG is used to manage performance or in financial aspects. When the managers decide took a decision based only on DRG, they can not see the possibilities brought by the change of scenarios.

In special, when the DRG is used as based of measure the payment of the services, this payment is based on the Prospective Payment System, in which the amount of payment for services is defined before the service is provided. On the other hand, this type of payment force the manager to have more control over the resources, however, it is not considered the uncertainty and possibilities that there are in the exact time, at which the treatment will be done.

This situation could be compared with the deterministic model in the investment analyses, and it does not reflex reality. For example, consider that one hospital treats patients who are in the DRG 280 - Acute myocardial infarction, discharged alive with MCC.

According to information on the DRG 280, the patient should stay at the hospital between 2 and 5 days. Thus, the health plan paid for the hospital the amount for a maximum of

5 days for treatment the of one patient who has a major complication or comorbidity. When the hospital database is analyzed it is possible to see that patients who are in the DRG 280 spent between 0,1 and 65,5 days in the hospital. If considered that the hospital does not have any problems and the treatment was done as should be done, it is possible to see that the hospital assumes the costs for the days that the health plan did not pay.

In addition, the planning that was done about investment needs and spending did not reflex reality, because when the managers took their decision based just on the DRG, the uncertainty is not considered.

3.2 DESICION MAKING UNDER UNCERTAINATY

Uncertainty is part of the hospital setting in which decisions are made. Thus, it is important to discuss this variable in decision-making.

Kimura and Pereira (2005) present a discussion related to venture capital for companies, based on the theorems formulated by Modigliani and Miller (1958). According to the authors, if it is considered that the capital market is perfect and that information is symmetrical, it can be verified that strategic investment decisions are defined and independent of financing decisions, since the creation of value for the shareholder is the result of the proper exploitation, in real projects, of the investment opportunities. In this way, risk management is not relevant to the creation of value.

However, in the real world, the premises described by Modigliani and Miller (1958) do not reflect reality, because the market is imperfect and has information asymmetry. Thus, Kimura and Pereira (2005) report that risk management can generate value for companies since unexpected fluctuations related to risk factors can result in levels of indebtedness and liquidity that influence the value.

According to these authors, in situations that are a high use of third-party capital, Stakeholders may require greater disclosure of information and can impose a higher cost on the probability of bankruptcy due to the level of indebtedness.

In this sense, risk management, which avoids excessive borrowing or protects liquidity, can be considered a source of wealth generation.

Applying this idea in the investment analysis, it is possible to say that the risk variable is of great relevance to the evaluations carried out. It is known that the main objective of investment analysis is to verify the economic chances of an investment project, for that it is calculated the expected returns, based on projections of the cash flows of the project.

Thus, the idea that the market is not perfect, and changes can happen at any moment is rescued, which causes uncertainty regarding the behavior of the variables included in a project, making it difficult to estimate the real returns that will be obtained in the future.

Given this situation, there is a possibility of liquidity impairment, as well as the possibility of obtaining external financial resources to cover possible obligations that were not honored as a result of the non-cash flow generation, which may lead the company to increase their debts, consequently, increase the cost of capital and not generate value. Thus, the consideration of risk in the investment analysis is something relevant and necessary, being treated by several authors.

Although Knight (1921) described the risk as the quantifiable part of uncertainty, it was with Markowitz's (1952) that risk studies gained relevance. Markowitz (1952) brings the discussion of risk and return. The author argues that the valuation of assets should incorporate the volatility of their returns since the price oscillation can modify the results obtained from an investment. Thus, the author gave certain relevance to the discussions about risk and suggested the diversification of the investments to mitigate it.

There are different ways to incorporate risk in the investment analysis, one of that is by managerial flexibility. Known as real options, it comes to be incorporated in analyzes because it fitted the foundations of modern financial theory, brought from the neoclassical economic theory. Thus, it is assumed the idea that individuals are rational being and their decisions are taken following the utility function of expected utility theory.

This new way to see the investor plus the positivist functionalist paradigm leads to the conclusion that it would be wrong to think that throughout the execution of the project other options cannot arise and be able to maximize the project's profit. Thus, an investment analysis, which captures the value of managerial flexibility in an environment of uncertainties, allows the creation of options that can value the investment.

According to Trigeorgis and Mason (1987), these flexibilities add an asymmetry in the distribution of NPV probabilities of an investment. Therefore, a project has an expanded value that corresponds to the sum of the additional option for the possibility of adaptation of the project and the net present value. This is because the asymmetry expands the expected value of NPV and adds a premium for managerial flexibility.

The hospital environment is inserted in this market described; however, some particularities are observed, in special because to maximize the equation about risk and return, one of the inputs should be considered the patient. The conditions of the patient influence direct the consumption of resources, then the return.

The DRG helps the managers manage this situation when it put together patient with the same characteristics. Another relevant point is that DRG was developed based on the severity, then, the risk related to the patient's condition at zero time is considered. However, the risks present at others time do not be considered.

The risk of a patient in the other time (t1, t2, t3 … tn) is important and varies. Driffield and Smith (2007), and Meyer and Rees (2012) apply the ROT in the decision medical. The authors show how it is possible to preserve the option to start treatment at some point in the future and reduce the risk with new information about the patient's conditions that could not be obtained in zero time. These studies provide to observe the applicability of the option to defer the process of treatment of the patient and show how the time and conditions of the patient can interfere with all services provided by the hospital.

The physician knows that when the treatment has started the resources invested do not be recovered, in other words, there is irreversibility, which makes waiting for more information has value because it helps to decrease the uncertainty related to the patient's condition. In addition to saving resources, it is possible to avoid procedures that can compromise the patient's quality of life after its execution.

Face the application done by Driffield and Smith (2007), and Meyer and Rees (2012) it is possible to observe and understand that the ROT helps to reduce the risk of the general investment of the hospital, and the risk related to the patient condition.

In addition, note that the risk related to patient condition, in most cases, does not could be diversified, as suggested Markowitz's (1952). However, Mello-Sampayo (2015) shows that the option to switch treatment could help to decrease the risk.

If the risk of the patient's condition should be considered, the return of the patient also is relevant for the hospital. Based on this, the strategy taken by the hospital should seek a satisfactory financial return, which involves the patient return, since the patient's returns influence the final return. The DRG, when used to analyze performance, helps in this point and leads the hospital to obtain a good return with patients because the quality of service is monitored.

Is possible to conclude that the hospital environment is like the tradition, not perfect. In addition, it has the risk brought by the physiological conditions of the patient. For this reason, the decision-making should consider the assistance and management aspects plus the uncertainty as part of the business world. When these are identified and understood it can be managed and even controlled by flexibility.

In view of the above, it is possible to say that the ROT and DRG can complement each other in the decision-making process.

On the one hand, the DRG is a tool that allows the manager to make management based on the hospital product that is developed and monitor the quality at the same time. In addition, it provides information that makes future decision-making consider the conditions of the patients cared for.

On the other hand, there is the ROT, which is a theory that gives physicians and managers protection in their decisions, reducing risk through real options in medical decision-making whose focus is the patient.

4 THE PATIENT IS THE FOCUS

The hospital organization is one of the most complex because presenting a multidisciplinary team with a high degree of autonomy to provide health care. In addition, this complexity is represented by the fact that the hospital has a multi-organizational structural profile with different types of organizations in the same place, such as a hotel, laundry, laboratory, pharmacy, restaurant, ambulatory, surgical suite, etc.

In the middle of this environment is the patient, who is the client and receiver of the service provided at the same time. This makes him become extremely important when talking about management in a hospital. In addition, their clinical and physical condition directly influence the type of hospital product that will be performed and the hospital return, as was said in the previous section.

It may seem logical to include care aspects in hospital management. However, in practice it is observed hospitals that design their strategies in order to maximize return without considering assistance aspects, being driven only by the idea of obtaining a greater financial return independent of the ethical aspects. As well as hospitals that are driven only by assistance aspects, not having control and presenting serious financial problems, which compromises the sustainability of the business. Due to the lack of balance often observed is that the DRG is being used.

According to Fetter (1989), the main objective of a hospital is to provide care to patients. Then, the focus of the hospital product analysis would be directly related to the patients served, characterizing the diagnostic services, and social and therapeutic services as intermediary products, since it is services that assist in the care of a patient in the search for the treatment of a specific health problem.

Based on this idea, the DRG was developed, and makes the decision-making could be based on a balance between management and care, with the patient at the center. In relation to ROT, when the ROT is applied in decision-making treatment, as presented by Driffield and Smith (2007), Meyer and Rees (2012), and Mello-Sampayo (2015), it is possible to observe that the investment, which is considered to obtain some return, it is lead by the patient conditions. In other words, it is possible to say that focus is on the patient. The options discussed by the authors have the patient as the center of the decision-making because it will be this patient who will consume the hospital resources.

This approach makes resource consumption be thought of from the perspective of resource management and from the perspective of health care. In other words, it is possible to make decisions based on concepts from the administrative sciences and the medical sciences, such as the DRG.

5 CONCLUSION

Although ROT and DRG are different tools and developed for distinct purposes, it is possible to observe that both are used in decision-making within a hospital, having the patient at the center of the analysis, and providing the interaction between care and management.

These points (applicability, and patient focus) are the central and intersection points between these two themes.

As mentioned, ROT and DRG were developed for different purposes. The first one seeks to circumvent the limitations of the deterministic models, demonstrating that uncertainty is something that can be managed based on the opportunities brought by scenario change.

The second one offers the manager a tool that provides management based on rational aspects that involve management and assistance, giving great importance to the quality and consumption of resources, as from the diagnosis of the patients.

The use of these tools is observed separately, however, through the Driffield and Smith (2007), Meyer and Rees (2012), and Mello-Sampayo (2015) it is possible to verify the relevance of the real options in decision-making by reducing the risk brought by the patient's clinical conditions.

On the other hand, the DRG does not consider the possible variations of patient scenarios, which can compromise the hospital’s financial planning.

As this classification seeks to contribute to resource-based management, it is believed that the inclusion of real options in the DRG can provide information more in line with reality

and provide a new application of ROT. This would bring a theoretical contribution to both fields of knowledge, bringing a new application of ROT, as well as a possible paradigm shift in relation to DRG.

Therefore, it is suggested as future research incorporate the concepts of real options theory into the DRG, since this will lead to the abandonment of a deterministic model and the adoption of a model that seeks to directly consider the uncertainty present in the environment in which the hospital product is developed.

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