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# Expanded Game Theory Based Decision Making for Medication of Essential Hypertensive Patients

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**Abstract**

In this research, expanded game theory model based decision making used for finding of optimum strategy of antihypertensive medication during a year. B-blockers and diuretics are choice prescription for control of blood pressure in hypertensive patients. But increase in blood lipid level must be considered as a side effect of b-blockers. All needed information of patients gathered from pubmed articles from 1979 to 2010. These models were evaluated: (1) atenolol (100mg/day) stable dose vs. incremental doses from 50 to100 mg/day, (2) atenolol (100mg/day) vs. propranolol (160 mg/day), (3) a combination of first and second models, (4) a B-blockers plus hydrochlorothiazide (25 mg/day) as diuretics. Then, the equilibrium point determined for each model at three time interval and optimum equilibrium point was found. On the base of first three models, atenolol (100 mg/day) consumption for 3 month effectively reduces blood pressure in the patients with the lowest side effect. Fourth model showed that a b-blocker plus hydrochlorothiazide as a diuretics are optimum decision for control of hypertension for one year. On the base expanded game, we propose consumption of atenolol for three month and then use of a b-blocker plus hydrochlorothiazide for reminder of one year as an optimum strategy of blood pressure control with lowest side effect.

**Keywords:** B-blockers, blood lipid, hypertension, game theory, Nash equilibrium.

## 1 Introduction

Hypertension is offered as a big problem of curative healthful in the world [1]. Now control and curative of this noninfectious disease was in attention of many persons and has high value, hypertension increase the risk of heart and vascular disease and brain vascular [2] and kidney diseases [3]. Even the outbreak of the disease hypertension observed in the developing country [4,5] and it seems that increase of urbanism and by following of it the sufficient inactive and use of foods with high lipid and high diabetes and also increasing of received calorie has important role in intensification of this disease [6]. On the following of affliction to hypertension, sufficient control of it has special validity, far reaching to minimum level of creating side effect because of hypertension. Also there are clear techniques for curing the hypertension, that one of them is pharmacotherapy [7]. Determining the time of optimum use, between three conventional dose of the atenolol drugs (100 mg/day) and propranolol (160 mg/day) and atenolol (50 mg/day to 100 mg/day) on the base of expanded game model are the aims of this paper. Use of different kind of strategies for curing hypertension was reported in the review paper that printed by mourad et al in 2004 [8]. This scientific pointed to three strategies. This research use of third strategy, just by little change and offered it in the kind of game.

## 2 Game Models

In all models game designed between physician and this disease. And physician as a first player can choose some cases between some strategies in curing the disease. For example he use of drug's dose change strategy, change of the kind of drug strategy and or multi drug strategy on the base of using time in curing this disease . The physician use of it for curing in the periods of three (strategy C), six (Strategy D) or twelve months (Strategy E), but the second player as the disease, responses by attention to the strategy that choose by physician. And it's included reduction of blood pressure and increase of blood lipid (TG or LDL). The physician is searched for the Equilibrium point of the game by disease that happened in it more reduction of blood pressure and the lowest side effect. In games the pay off result from those games included the percent of reduction of blood pressure against the percent of increase of blood lipid.

### 2.1 Drug's dose change strategy

In this strategy physician, change the drug's dose of the atenolol, in this way that the physician as a first player can at firs recommended the dose 100 mg/day from atenolol drug to the patient (strategy A) or begin from dose 50 mg/day, or if the blood pressure don’t reduce he increase it to 100 mg/day (Strategy B). We can show the game to the expanded form (figure 1).

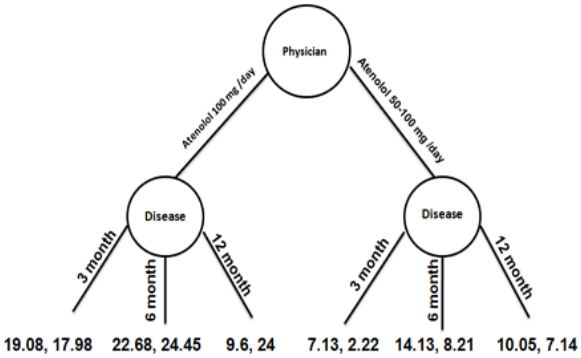


**Figure 1**: Relation between disease and physician in the drug's dose change strategy

## 2.2 Change of the kind of drug strategy

In this strategy physician change the kind of drug, the physician as a firs player can at first recommend the dose 100 mg/day of atenolol drug to the patient (strategy A) or used of dose 160 mg/day of the propranolol drug (strategy F). We can show the game to the expanded form (figure 2).

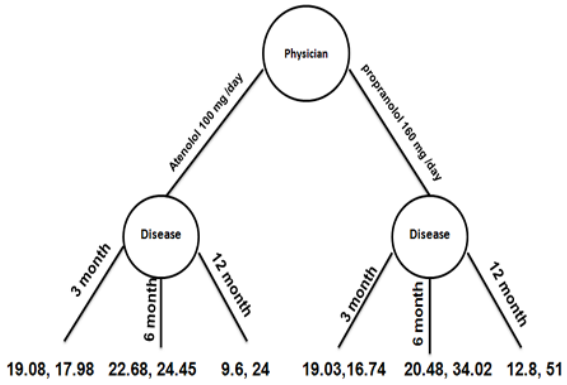


**Figure 2**: Relation between disease and physician in the change of the kind of drug strategy

## 3.2 Component of the two above model

For reached to better compare of treatment, they mixture two model of drug's dose change strategy and change of the kind of drug strategy. If the pay off result from this game included the percent of reduction of blood pressure against the percent of increase of blood triglyceride, we can show the game to the expanded and strategic form (figure 3, table 1).

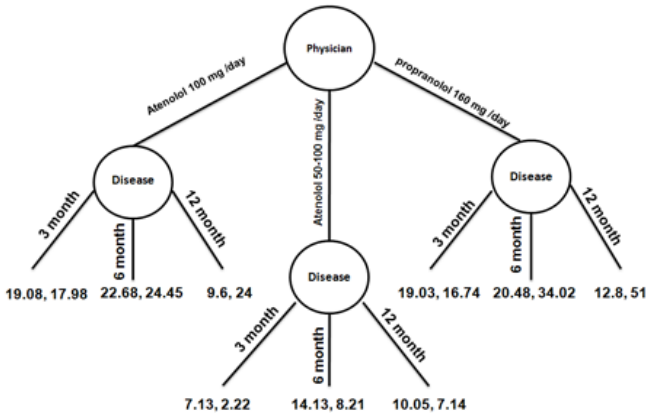


**Figure 3**: Relation between disease and physician in the multi drug strategy

**Table 1**: Matrix of Payoffs in the multi drug strategy

| | | Player 2 | | |
|---|---|---|---|---|
| | | C | D | E |
| Player 1 | A | 19.08, 17.98 | 22.68 , 24.45 | 9.6 , 24 |
| | B | 7.13,2.22 | 14.13,8.21 | 10.05,7.14 |
| | F | 19.03,16.74 | 20.48,34.02 | 12.8,51 |

(A,C)'s strategy in this game is Nash Equilibrium, it means that if the atenolol drugs with using dose 100 mg/day recommended for three months by physician, it result in the most reduction of blood pressure with the lowest increase of blood triglyceride.

Diagrams 1, 2 were drawn by attention to table 1.

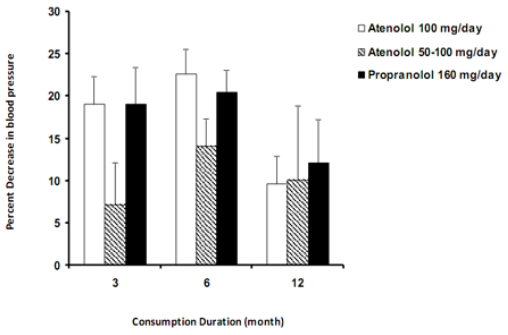


**Diagram 1**: Percent decrease in blood pressure related to consumption duration

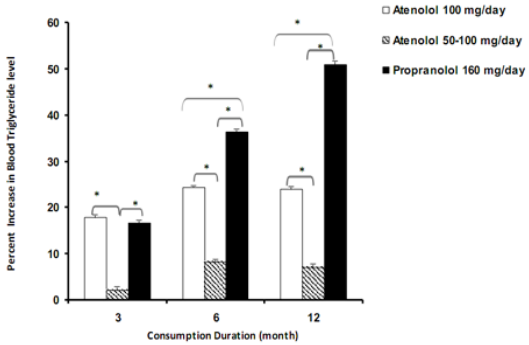


**Diagram 2**: Percent increase in blood triglyceride related to consumption duration, *P<0.001

## 4.2 multi drug strategy

Now, with regard to the findings there is a question that what must we do during and after three months using the dose 100 mg/day from atenolol drug? To answer this question we will consider the treatment by another drug [8] that is the physician is able to use a beta blocker with the 25 mg/day hydrochlorothiazide.

In this way that the physician as a first player can at firs recommended the dose 100 mg/day from atenolol drug to the patient (strategy A) or use on hydrochlorothiazide with beta blocker (strategy G). If the pay off result from this game included the percent of reduction of blood pressure against the percent of increase of blood LDL, we can show the game to the strategic form.

**Table 2**: Matrix of Payoffs in multi drug strategy

| | | Player 2 | | |
|---|---|---|---|---|
| | | C | D | E |
| Player 1 | A | 6.8 , 0.08 | 22.68 , 2 | 9.6 , 3.09 |
| | G | 11.52,3.93 | 12.93,4.5 | 13.6,2.77 |

(G,E)'s strategy in this game is Nash Equilibrium, it means that if the beta blocker with the 25 mg/day hydrochlorothiazide recommended in twelve months by physician, it result in the most reduction of blood pressure with the lowest increase of blood LDL.

Diagrams 3, 4 were drawn by attention to table 2.

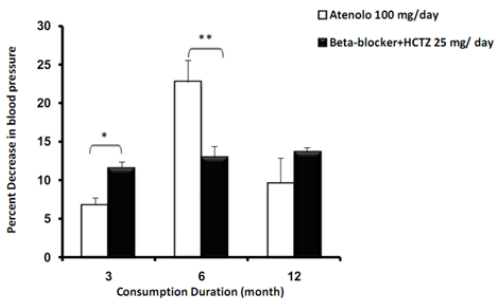


**Diagram 3**: Percent decrease in blood pressure related to consumption duration**,*** P<0.001 , ** P<0.05

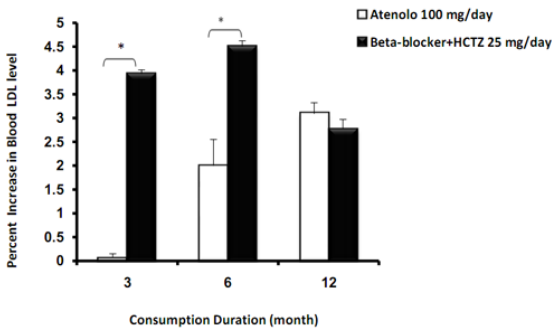


**Diagram 4:** Percent increase in blood LDL related to consumption duration, * P<0.001

# 3 Conclusions

In this pharmacotherapy research, the patient with the first blood pressure by the beta-blocker drugs and normal diuretics for treatment of the disease, this is

planned and evaluated as an improved game between a physician and disease. All input data of patients for modeling gathered from pubmed articles from 1979 to 2010. Four standard prescription models were evaluated. On the base of first three models, consumption of atenolol (100 mg/day) for 3 month effectively reduces blood pressure in the patients with the lowest side effect. Fourth model evaluation indicates that prescription of a b-blocker plus hydrochlorothiazide as diuretics are optimum decision for control of hypertension for one year. Optimum strategy of the control of the blood pressure by considering the side effect of the increasing of the lipid blood, commended the starting the recovering of the disease by use of atenolol (100 mg/day) as a Beta blocker drug for three months and then continue of the recovery by use of a Blocker with a Hydrochlorothiazide 25 mg/day Dose.

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