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A Mathematical Model of Hospital Attraction Area

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Introduction

The aim of this study was to elaborate an efficient tool for observation and prediction of the attraction area for hospital decision-makers and health policy makers. Our mathematical model is based on “the principle of least effort” to go from home location to hospital regarding the gravitation Newton law. We used a geometric algorithm called Relative Neighbourhood Graph (RNG) which calculate the proximity area of attraction, in order to draw and weight the model and to calculate the balance distance point between two attractive masses. Through the equation, we tried to analyse some parameters which influence the attraction of a dedicated hospital, and to give a measure of this attraction area. It was assumed that the hospital attraction could be relate to: The distance to hospital; Geographic accessibility; Number of beds and size of population from the estimated hospital proximity area.

Methods and Results

This study was split in four phases. The first phase was a descriptive geographic study, from observed situation of the drainage area of six hematological departments (1). We drew and obtained maps of the attraction area of department at canton scale – type A. Second phase was an implementation of the spatial mathematical model. We calculated the balance distance point and drew map of the estimated attraction area – type B. The equation was weighted by the estimated population attraction depended on the RNG. In the third phase with the assistance of maps resulted from type A, we compared it with the map of type B given by the model, superposing the both plans. We deduced of it, if the observed attraction on maps of type A were less, more or equivalent to the expected model. The fourth phase was a spatial practice prediction on attraction evolution inside the Nord – Pas-de-Calais region by simulation map model. The simulation map - type C built upon a fictive hematology department from estimated masses which represented by number of bed and the weighting parameter from the estimated population.

Discussion

On the whole, we have observed a proximity attraction area for the four peripheral hematological hospital departments unlike Lille departments' attraction which have been regional. In the third phase, by superposition of the maps of type A and B and after studied the observed and calculated frontiers, the model had validated. We noticed that the attraction areas were similar in size, not a large difference. That is confirming our theory and literature of the proximity attraction of peripheral hospital. We used some parameters seeming to be pertinent and linked with previous studies, not the only ones but available at the beginning of this research work (2). That is validating the choice of this model and our hypothesis: is that there exists correlations between health care access and the distance-decay (in Km and / or in time or on “the principle of least effort”). Our spatial mathematical model might be a useful predictive tool for health policy makers in order to simulate the hospital attraction area. In France, in general for light diseases and light care, people have freedom of choice of the hospital. We are currently testing the model with three other surgical specialties heavy and less before the generalization of this spatial practice mathematical model, to determine and predict the geographic attraction areas for public/private hospitals.

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