INNOVATION EFFECT ON THE MODEL FOR DENTAL DISEASES

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Abstract

We gave a report on the model for dental diseases at the 1987 System Dynamics Conference.
The model consists of 4 sectors: demography, cavities, pyorrhea and baby teeth. The demographic sector covered populations of 5 three -year age groups under 14 years of age and 13 five-year age groups above 15 years of age. The cavities sector and pyorrhea sector were composed of populations of five-year age groups, on the other hand, the baby teeth sector used populations of three - year age groups.

From the total number of defective teeth, total dental costs in Japan were calculated annually from 1963 and projected to 2025. We added to this model a new level variable which is technology (rate variables and multipliers) in order to demonstrate to the effect of technology on the other level variables.

New simulation results will be reported at the International System Dynamics Conference this year.

1. MODEL FOR DENTAL DISEASES

1. 1 Parts composing the model

This model consists of 5 sectors: demography, dental caries, pyorrhea, baby teeth, and technology. In each sector we deal with all of Japan. Relations among sectors are shown in Fig.1.

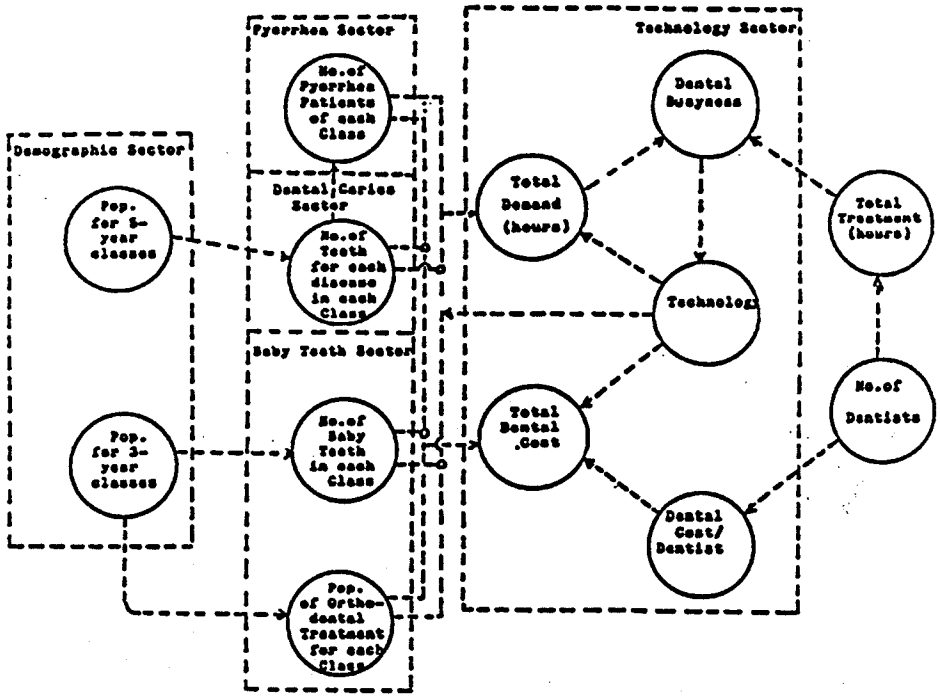

Fig.1 Relation among Sectors

1. 2 Demographic Sector

The demographic sector covers populations of 5 three-year age classes under 14 years of age and 13 five-year age classes above 15 years of age. The former are the classes 0-2, 3-5, 6-8, 9-11 and 12-14 years of age, and the latter are the classes of 15-19, 20-24, ..., 70-74 and 75- years of age. The population of each age class depends on the rates of birth and death. The first age class Z0 begins with births and end where a new age class begins or, through deaths within the age class. Our other age classes Z3, Z6,....., Z75 follow this same pattern.

The flow diagram of this sector is shown in Fig.2.

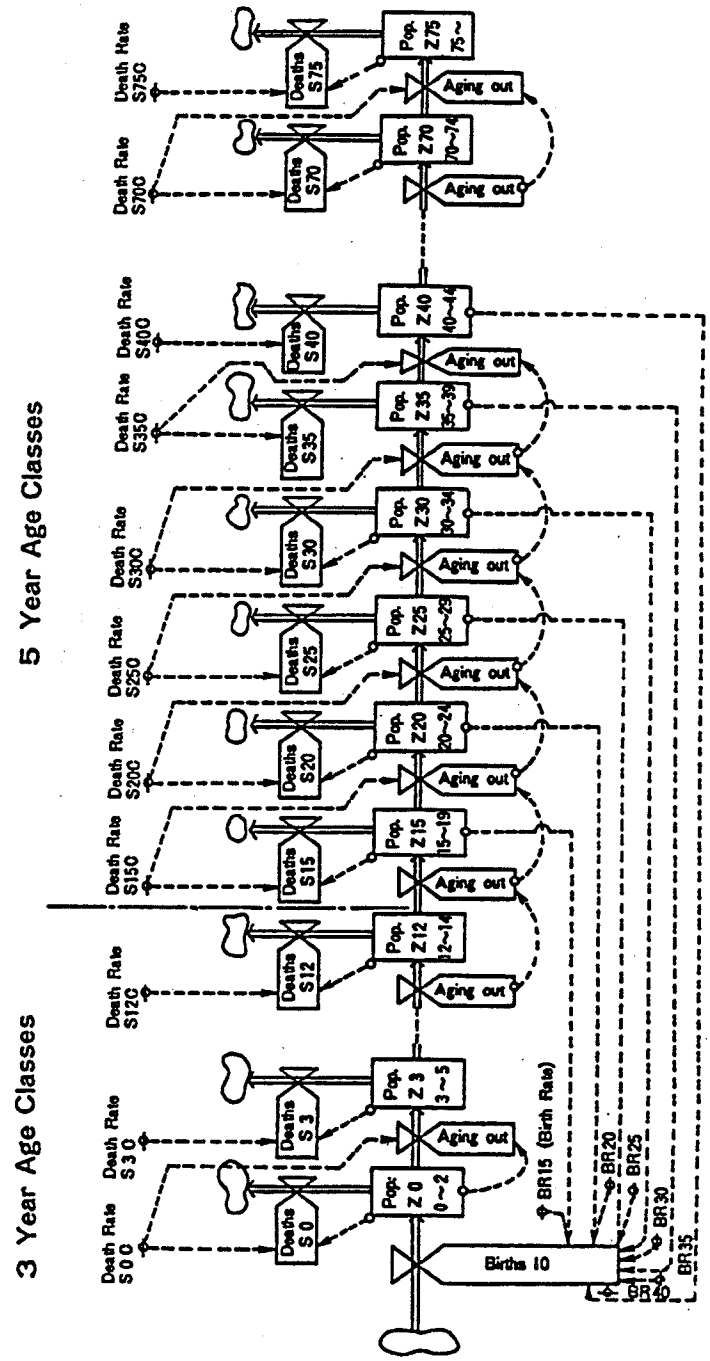

Fig.2 Flow Diagram for Demographic Sector

1. 3 Dental Caries Sector

The Dental Caries Sector has 13 subsectors corresponding to 13 five-year classes of the population sector.

Dental caries are classified as follows:

Healthy teeth : Carious symptoms and dental care are not recognized.

C0 : Similar to healthy teeth, but there is no agreement as to whether teeth are decayed or not.

C1 : Small surface cavities which may be easily filled and treated.

C2 : Cavities are worse than in C1, but health teeth may be restored by fillings being done without pulpectomy.

C3 : Cavities are worse than in C2, after pulpectomy. In some cases decayed teeth are only filled, but generally metal crowns may be used. In the case of front teeth complete care of bridges may be necessary.

C4 : Carious symptoms are serious enough that decayed teeth must be extracted and a denture may be necessary.

The number of C1 teeth is first computed. Then C2,C3,C4, filled teeth, crowns and bridges, missing teeth and dentures are successively computed as seen in Fig.3.

Data for this sector have all been collected by the Japan Dental Association.

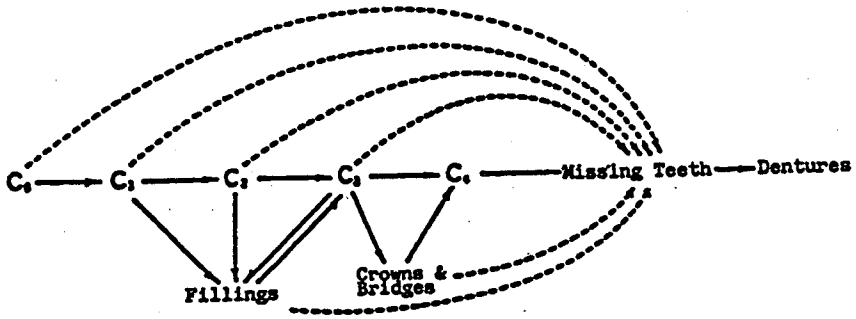

Fig.3 Relation among Diseases

1. 4 Pyorrhea Sector

1. 4.1 The Patient Population for C1,C2 and C3.

The patient population for C1,C2, and C3 is obtained from the sum of C1 C2 and C3 teeth for five-year age classes divided by the number of C1,C2,and C3 teeth per patient.

1. 4.2 The Periodontal Patient Population for Each Age Class

This variable may be calculated from the sum of the above population of periodontal patients of each age class times the cost of treatment per capita.

1. 5 Baby teeth sector

1. 5.1 Number of Defective Baby Teeth

The number of defective baby teeth for a three-year age class is obtained from the population of the class times 20 teeth per capita times the rate of defects or disease .

1. 5.2 Cost of Baby Teeth Treatment

This variable may be computed from the total sum of the number of treated baby teeth for each defect or disease and for each age class times the cost per tooth.

2. Orthodontic Treatment

First the patient population for orthodontic treatment is obtained from the sum of the population of each age class times the rate of patients for orthodontic treatment. The total cost in Japan for orthodontic treatment can be calculated from the above population for orthodontic treatment multiplied by the cost per patient.

3. Dental Cost

Total dental costs in Japan (CHIHI) are obtained as follows:

CHIHI = total demand * unit cost

total demand (hours)

unit cost (¥1,000 / hour / dentist)

Unit cost per dentist per hour is obtained from the model of a Japanese Dental Office.

For the base model the ratio of treatment cases incurred to the total was 0.94 and constant.

4. The Effect of Technology on Dental Costs

We made inquiries about the effect of technology on dental care. With reference to various expectations the technology growth rate is assumed as follows:

1993	2003	2013	2023
10%	20%	30%	40%

4.1 The Effect of Transfer Rate Changes

4.1.1 C0 -> C1 Transfer Rate Change

We assume the effect of technology on C0 -> C1 transfer change as a table function of technology as shown in Fig.4.

The simulation result shows that the total dental cost in 2025 should decrease by about 18% compared with the base model.

It is probable that the quality of dental care will improved considerably.

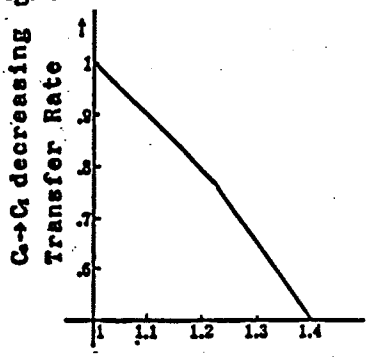

Fig.4 $C_0 - C_1$ Transfer Rate

4.1.2 Decrease in Periodontal Patient Population

A decrease in the number of periodontal patients was assumed as shown in Fig.5. The simulation result shows that the total dental cost decreases by 20% compared with the base model.

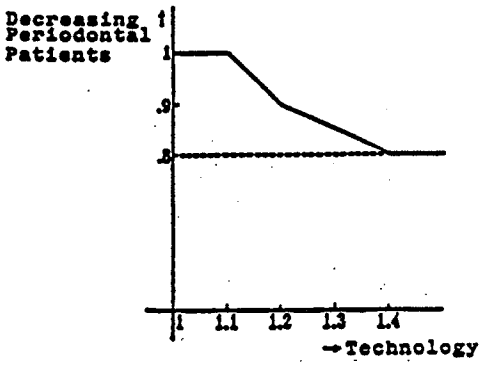

Fig 5 Periodontal Patients

4.2 The Effects of Technology on the Variables of the Dental Office Model

4.2.1. The Effect of Increase of the Number of Cases

Dental cost treated in the model of dental diseases equals the total demand multiplied by unit cost. This data was obtained from the model for a Japanese dental office.

In the dental office model the number of cases is one of main variables. It is defined to be the number of patients and new patients multiplied by the average number of cases per patient. We assume the effect of technology innovation on the number of cases, as shown in Fig.6.

The simulation result shows that in 2025 both the unit cost and the total dental cost increase to 81% compared with the base model. Thus technology may increase the unit cost and the total dental cost considerably.

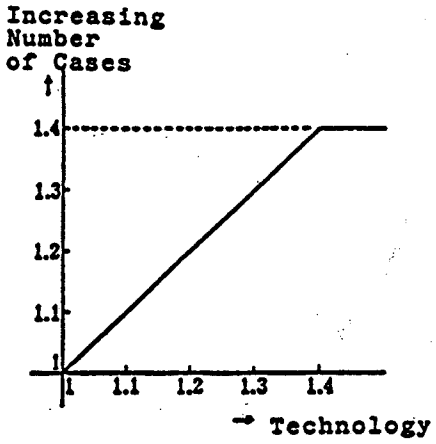

Fig.6 Number of Cases

4.2.2 Change of Average Points

We assume the change of average points up to 15% as shown in Fig.7.

The simulation result shows that in 2025 both of the unit cost and the total dental cost increase 17.2% compared with the base model.

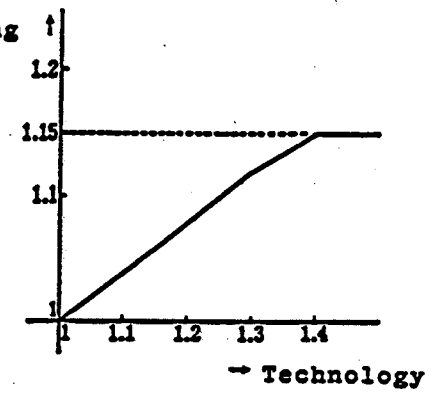

Fig.7 Average Points

4.3 Change of Treating Hours of Dentures

Dental materials must improve in terms of quality and treatment hours for dentures may increase. Thus we assume the increase rate up to 50% as shown in Fig.8. The simulation result shows that in 2025 the total dental cost increases by 23.2% compared with the base model.

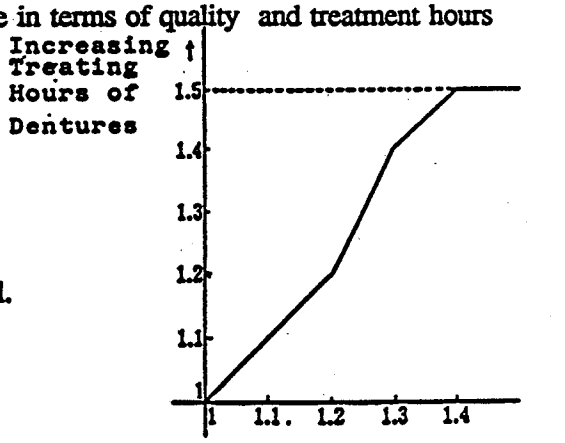

Fig.8 Treating Hours of Dentures

4.4 Mixed Change

4.4.1 10% Increase in Averaged Points and 40% Increase in the Number of Cases

The simulation result shows that the unit cost and the total dental cost both increase to 94.8% compared with the base model. This increme nt equals roughly the sum of 81% of the increase in the number of cases and 10% of the increase in average points.

4.4.2 40% Increase in the Number of Cases and 50% Increase in Treatment Hours of Dentures

The simulation result shows a 123% increase in the total dental cost in 2025 compared with the base model. This percentage is a little larger than 104.2%, that is, the sum of 81% increase in the case of 40% increase in the number of cases and 23.2% increase in the case of 50% increase in treatment hours of dentures.

This may mean, the unit cost increase with regards to the rising number of cases accelerates the total dental cost growth by the increasing hours for treatment of dentures.

5. CONCLUSION

we have attempted to formulate a System dynamics model for dental diseases which have four sectors of demography, dental caries, pyorrhea and baby teeth. We also added a new level variable (technology), rate variables and multipliers to express the effect of technology on the other level variables. Technology innovation will affect the C0->C1 transfer rate, periodental patient population, the number of cases and the average point and treatment hours of dentures.
These simulation results were explained.
This study is a research project of the Japan Dental Association.

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