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Comparison of Fuzzy-based MCDM and Non-fuzzy MCDM in Setting a New Fee Schedule for Orthopedic Procedures in Taiwan's National Health Insurance Program

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Abstract: Among numerous approaches and techniques documented in the literature for setting fee schedule, the most frequently adopted approach is experts' opinions. Regrettably, these various methods reach qualitative conclusions mainly. Such a deficiency brings great difficulties in quantifying and summarizing practical for setting a fee schedule. To mitigate these weaknesses, in this paper, we for the first time propose a fuzzy-based multiple criteria decision-making (FMCDM) in setting a new fee schedule for orthopedic procedures in a national health insurance program. For comparison purpose, same set of data were also repeated on the non-fuzzy method. The results from the illustrative case show that the new fee schedule as obtained from applying the FMCDM model is much more convincing to practitioners than that of previous schedule. It is also more persuasive as references for policy making. In addition, it has one major advantage over the traditional non-fuzzy based counterpart. The method eliminated the occurrences of bitter argument that frequently lead to undesirable halting of discussion among experts and thus the progress of the fee-setting project.

Key-Words: fee schedule, orthopedic procedures, national health insurance, fuzzy multiple criteria decision making

1 Introduction

Over the past two decades, the Health Care Financing Administration of the United States (US) has periodically sponsored comprehensive national surveys of fee schedules of physician payment in the Medicare and Medicaid programs [1]. Not only US, but also many other countries with health insurance programs review fee schedules periodically. The main reasons are to address continually rising health care costs [2] and to ensure an equitable allocation of resources [3,4].

Among numerous methods and techniques documented in the literature for setting fee schedules, the most frequently adopted approach is experts' opinions. Related techniques include: in-depth interviews [5], focus group [6], nominal group method [7], and the Delphi method [8]. Regrettably, these research methods, which range from personal interviews to extensive negotiations, reach qualitative conclusions mainly. Such a deficiency brings great difficulties in quantifying and summarizing practical for setting a fee schedule.

This research design a fuzzy-based multiple criteria decision-making (FMCDM) framework to precisely capture experts' opinions. As an application, this research coordinates the opinions of orthopedic surgeons in the Taiwan Surgical Association to establish a new fee schedule for orthopedic procedures by both fuzzy-based and non-fuzzy MCDM approaches.

2 Methods

In an increasingly complex and diversified decision making environment, there is much correlated information that needs to be analyzed where traditional analysis is not suitable [9, 10]. In a pioneering work, Hsiao [3,4] proposed the Resource Based Relative Value Scale (RBRVS). His work changed the Medicare fee schedule for physician payment. The RBRVS could be described as a fee schedule based on multiple criteria decision making. However, it was expensive to building up such schedule [1].

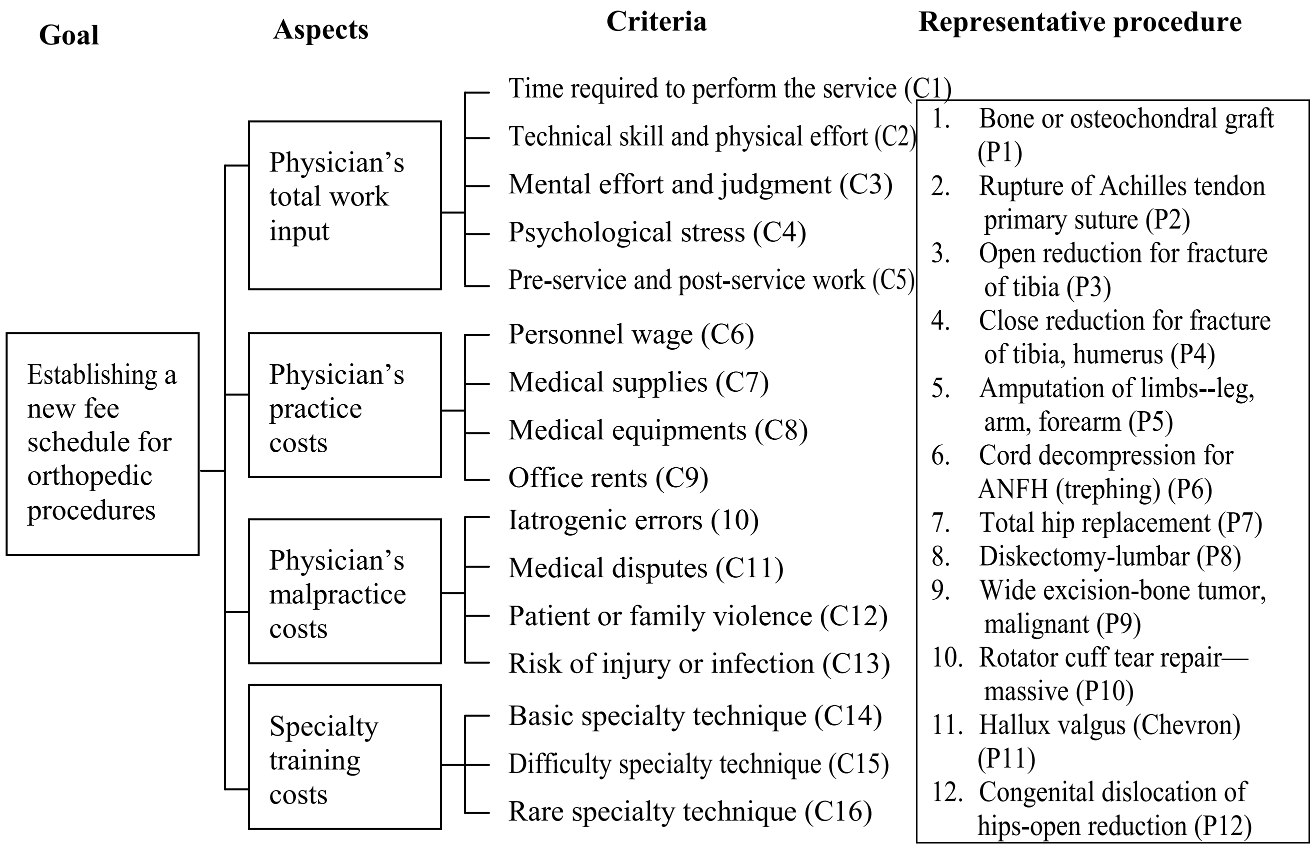
In this paper, we examined the fee schedule for orthopedic procedures in a draft announced by the Taiwan's Bureau of National Health Insurance (BNHI) authority on March, 21, 2003, and then designed a study accordingly. Our purpose was to obtain a new fee schedule. The study was conducted in three steps: first, to classify all existing orthopedic procedures into 12 groups through questionnaire survey of experts' opinions; second, to construct the main FMCDM framework; and finally, to perform an empirical study of the FMCDM and non-fuzzy models and obtain a new fee schedule.

2.1 Questionnaire survey of orthopedic experts' opinions

Nine senior surgeons from the Taiwan Surgical Association were requested to express their opinions about classifying existing orthopedic procedures promulgated by the BNHI into groups. As a result, all 194 orthopedic procedures were classified into 12 groups according to the similarity of characteristics of the organ systems, operation sites, and the difficulty of techniques of each procedure. Finally, one procedure was chosen from each group as a representative procedure.

2.2 Constructing the main FMCDM framework

In order to integrate surgeons' hetero-perceptions, we adopted a FMCDM model for establishing the new fee schedule for orthopedic procedures, as illustrated in Figure 1, contains four evaluation aspects, sixteen criteria, and eleven representative procedures.



The evaluation process includes two steps:

2.1.1 Using AHP to Evaluate the relative weightings

The AHP weighting is determined by the evaluators who conduct pairwise comparisons, so as to reveal the comparative importance of two criteria [11, 12]. Saaty used the principle eigenvector of the pairwise comparison matrix derived from the scaling ration to find the comparative weight among the criteria of the hierarchy system [11, 12].

2.1.2 Obtain the performance value

The evaluators choose a score for each surgical procedure based on their subjective judgment. By doing this, we can use the methods of fuzzy theory to estimate the payment level of each procedure in a fuzzy environment [9, 10]. Since Zadeh introduced fuzzy set theory [13, 14], and Bellman and Zadeh (1970) described the decision-making method in fuzzy environments, an increasing number of studies have dealt with uncertain fuzzy problems by applying fuzzy set theory [15, 16]. We use fuzzy theory to get the performance values of the procedures.

2.3 Empirical study of FMCDM model

A temporary Board meeting of the Taiwan Surgical Association was held on June 18, 2003. Thirty-five orthopedic surgeons participated in answering our FMCDM questionnaire. Based on the FMCDM framework, every expert could express his subjective preference in pairs of comparisons among the hierarchy system. These subjective and qualitative judgments were then transformed through mathematical programming into objective and quantitative results.

3 Results

100% (35/35) of the surveys were returned by respondents, and 88% (31/35) of those returned were valid. The invalid surveys were those that could not pass the AHP consistency verification tests or weren't completely answered.

3.1 Evaluating the criteria weights

In the first-tier evaluation aspects, the rankings of factors among the 31 surgery respondents were: (1) physician's total work input (0.475); (2) specialty training costs (0.190); (3) physician's practice costs (0.185); and (4) physician's malpractice costs (0.150). In the second-tier valuation criteria, of the 16 factors, the top five ranked as follows: (1) Time required to perform the service (0.138); (2) mental effort and judgment (0.106); (3) technical skill and physical effort (0.091); (4) personnel wage (0.083); and (5) psychological stress (0.076).

3.2 Estimating the performance matrix

The relative weighting of a total of 16 criteria can also be interpreted as a vector and ranked as follow: $\vec{W}$ = (0.138, 0.091, 0.106, 0.076, 0.063, 0.083, 0.045, 0.041, 0.016, 0.036, 0.046, 0.027, 0.04, 0.062, 0.066, 0.061). The subjective performance value on the 12 representative procedures of the respondent i can be expressed as another vector $U_{respondent\ i}$ (i = 1~31). $\vec{W}$ is then multiplied with $U_{respondent\ i}$ and a synthetic value matrix on the new fee schedule is obtained as the equation:

New fee schedule = $U_{respondent\ i} = [u_{i1}, u_{i2}, u_{i3}, \ldots u_{i12}]$

Where u_{i1} represents the new fee schedule of respondent i regarding procedure 1; u_{i2} represents the new fee schedule of respondent i regarding procedure 2; …and u_{i12} represents the new fee schedule of respondent i regarding procedure12. The results composed by their average of 31 experts are shown in Table1 and Table2. Two sets of vector $U_{respondent\ i}$ (i = 1~31) are proposed, one is fuzzy-based, which experts can express their own subject preference value freely according the rule of fuzzy set theory; the other is non-fuzzy MCDM, which the value of utility is assigned prospectively.

3.3 Comparison of fuzzy MCDM and non-fuzzy MCDM

From the results of Table 1 and Table 2, we can see the synthetic value matrix obtained form fuzzy-based MCDM are no significant difference to that of non-fuzzy MCDM. However, in the fuzzy-based matrix, the utility value can express freely by each experts, and can got a crisp value, or a range of value according to the different defuzzification methods. This feature gives more elastic decision-making space to the policy makers when setting a fee schedule, and increases the successful rate of negotiation.

4 Discussion and Conclusion

In the past, expert opinions from various groups were usually gathered to determine fee schedule for each orthopedic or surgical procedure. If expert opinions were not in consensus then there was no way to come to a conclusion and it would pose a great obstacle toward rationally adjusting a fee schedule. The FMCDM model developed in this study and verified by results show precise principles, easy operation, and effective gathering of the opinions of surgical experts. The complicated determination of relative values for fee schedule for orthopedic procedures can be shown by using a simplified hierarchy structure. After expert evaluation and mathematical calculations, each influencing factor can be concretely shown as a ranked value and thus, a new fee schedule values can be obtained.

The biggest difference between the FMCDM model and traditional methods is that our model has more precise calculations and the results are both qualitative and quantitative. It can tackle problems that formerly quantitative data and research methods could not solve easily. Examples of these problems are differences in expert opinions, difficulty in coming to a consensus, analytical results that are qualitative data, tests and conclusions not easily verified, and experts' bias sampling that would severely skew reference points.

In conclusion, the new method effectively consolidates expert opinions, is suitable for integrating opinions from different groups, and can solve the complex problem of many evaluating factors. The values derived from the FMCDM model are convincing and can serve as an important reference for setting or revising the fee schedule. The result is more convincing than previous programs and more persuasive to be the references for the BNHI policy setting.

Table1 Summary of the fuzzy-based synthetic value matrix composed by the average of 31 experts.

Procedure / Criteria	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
C1	3.68	5.56	7.01	4.04	6.08	5.81	7.83	7.04	10.27	7.71	4.96	6.73
C2	3.04	3.86	4.74	3.54	4.16	4.57	5.84	5.22	7.15	5.58	4.37	5.78
C3	4.49	5.37	6.02	4.26	5.51	6.08	8.31	7.54	8.95	7.58	6.24	8.30
C4	2.31	3.03	3.61	2.39	3.23	3.42	4.69	4.75	5.87	4.03	3.59	4.68
C5	1.93	2.05	2.50	2.08	2.85	2.89	3.62	3.47	4.32	2.91	2.11	3.61
C6	3.18	3.66	4.37	2.75	4.16	4.41	5.46	4.71	6.16	4.35	3.78	5.09
C7	1.74	1.84	3.02	1.59	2.07	2.17	3.61	2.56	3.15	2.36	1.98	2.34
C8	1.15	1.58	1.89	1.09	1.60	1.54	2.25	2.05	3.01	1.93	1.60	2.18
C9	0.43	0.62	0.76	0.41	0.63	0.61	0.89	0.81	1.18	0.73	0.58	0.81
C10	1.42	1.37	2.23	1.61	1.73	1.87	2.64	2.45	2.24	1.78	1.47	1.84
C11	1.38	1.36	2.05	1.52	1.62	1.60	2.47	2.57	2.04	1.60	1.44	1.89
C12	0.49	0.65	0.94	0.67	0.75	0.72	0.99	1.11	0.94	0.80	0.65	0.84
C13	1.38	1.29	1.55	1.10	1.51	1.46	2.07	1.98	1.74	1.45	1.15	1.28
C14	2.94	3.67	3.70	2.89	3.55	4.28	5.02	5.07	5.46	5.09	4.90	5.41
C15	1.68	2.02	1.99	1.95	1.98	2.24	3.10	3.22	4.96	3.55	2.59	4.16
C16	1.34	2.10	1.42	1.46	1.95	2.45	2.17	2.58	4.76	3.06	2.52	3.92
Total	32.58	40.02	47.80	33.36	43.38	46.12	60.95	57.15	72.19	54.51	43.93	58.91

Table 2 Summary of the non-fuzzy synthetic value matrix composed by the average of 31 experts.

Procedure / Criteria	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
C1	2.98	4.81	6.43	3.35	5.32	4.91	7.41	6.28	10.20	7.06	4.43	6.29
C2	2.10	3.13	4.02	2.72	3.31	3.96	5.40	4.69	7.08	4.92	3.79	5.39
C3	3.76	4.77	5.35	3.42	4.82	5.62	8.05	7.16	9.04	7.30	5.77	8.16
C4	1.82	2.55	3.15	2.05	2.80	3.02	4.36	4.49	5.88	3.79	3.09	4.49
C5	1.75	1.91	2.36	1.88	2.74	2.78	3.53	3.38	4.39	2.75	1.85	3.55
C6	2.75	3.30	4.05	2.51	3.84	4.10	5.30	4.58	6.42	4.14	3.53	4.97
C7	1.52	1.73	3.13	1.50	1.93	2.11	3.89	2.52	3.21	3.12	1.88	2.32
C8	0.85	1.31	1.71	0.74	1.32	1.24	2.21	1.84	3.06	1.72	1.38	2.02
C9	0.30	0.55	0.71	0.29	0.55	0.51	0.88	0.73	1.19	0.67	0.50	0.75
C10	1.30	1.32	2.13	1.56	1.67	1.75	2.58	2.41	2.20	1.70	1.32	1.79
C11	1.08	1.15	1.89	1.29	1.46	1.46	2.41	2.48	1.93	1.43	1.27	1.83
C12	0.48	0.66	0.94	0.70	0.82	0.75	1.04	1.12	0.96	0.78	0.66	0.87
C13	1.35	1.23	1.54	1.12	1.54	1.47	2.13	1.92	1.78	1.45	1.14	1.35
C14	2.26	3.20	3.18	2.24	2.97	3.92	4.85	5.04	5.47	5.01	4.58	5.19
C15	0.87	1.35	1.30	1.41	1.38	1.66	2.76	2.79	4.97	3.08	2.01	3.78
C16	0.95	1.73	1.08	1.13	1.51	2.18	1.83	2.29	4.73	2.78	2.33	3.82
Total	26.14	34.71	42.98	27.92	37.99	41.44	58.63	53.73	72.52	51.70	39.53	56.57

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