# Research achievements of new medical quality evaluation indictor system

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**Abstract:** Innovative technology is not necessarily useful technology. Whether innovative medical results have actual curative effect, safety and adverse reactions should be paid attention to. In this paper, an indictor system for evaluating the quality of new medical achievements is established from three aspects of technical practicability, technical reliability and technical benefit, which is conducive to improving the quality of scientific research achievements and promoting the market transformation of new technologies.

## 1. Introduction

At present, the evaluation of the quality of new medical achievements mainly depends on the evaluation of innovation degree. Innovation degree refers to the repetition or difference between new technology and history. Not all innovations are useful. Whether innovative technologies can promote the development of disciplines or be adopted by enterprises is not enough [1]. Currently, there is still a lack of mature model for the quality evaluation of medical achievements in China, and the lack of evaluation indictor system is one of the factors restricting the development of evaluation [2]. Insufficient attention has been paid to the clinical effectiveness, practicability, safety and market value of new technologies [3]. Only useful innovative technologies can be recognized by the market, and scientific evaluation on the quality of new medical technologies can be strengthened, which is conducive to market transformation of results [4].

## 2. Methodology

### 2.1 Indictors selection

Through the analysis of the academic literature, the government science and technology policy analysis, group discussion, expert consultation and so on way of preliminary selection: the ethical morality of medical achievements, technology of practical value, the results of the real benefits of the achievements of science and technology level, such as the primary indictor, and set up under the primary indictor 12 secondary indicators, 39 tertiary indicators. After the first review, adjust all indicators, delete the low score, and adjust the names of individual indicators to form the final indicator system.

### 2.2 Expert selection

According to the research purpose and content, the admission criteria for experts are :(1) associate senior or above titles; (2) having been engaged in medical work for more than 5 years; (3) the specialty is limited to medicine. Number of experts: more than 30 each time. 35 experts effectively participated in the first time; Second effective participation of 33 people.

### 2.3 Distribution of consultation questionnaires

Issued from February 10, 2019 to March 26, 2019. The first consultation questionnaire was composed of the introduction, the basic information of experts, the evaluation indictor system of the quality of new medical achievements, and the expert judgment and familiarity. Likert five-level scoring method was adopted for the indicators, which were successively divided into 5, 4, 3, 2 and 1. At the end of the first consultation, the results of expert consultation were sorted out, and the positive

coefficient, authority coefficient, coordination degree, importance assignment of indicators, full score ratio and variation coefficient were calculated.

### 2.4 Indictor construction and selection

The evaluation indictor system is constructed by using the defile method [5]. The analytic hierarchy process (AHP) was used to conduct statistical analysis of expert opinions [6]. According to the finally established indictor system, AHP calculation is carried out for the first and second level indictores, and finally the weights are obtained and synthesized.

The criteria for selection and retention of criteria were as follows: (1) assigning an indictor importance value ≥4.0, a full score ratio ≥0.30, or a variation coefficient < 0.25. And combine the opinions of experts to make a choice and form a new indictor system until the indictor coefficients reach a satisfactory level and the experts have no objection.

### 2.5 Expert authority coefficient method

Experts coefficient is determined by judgment and familiarity, judgment was divided into large, medium and small, including work experience (score of 0.50, 0.40, 0.30), the theoretical analysis (score of 0.30, 0.20, 0.10), reference (score, in turn, 0.20, 0.15, 0.10), and intuition (score, in turn, 0.10, 0.10, 0.10) in four aspects. The degree of familiarity is divided into "very unfamiliar", "not familiar", "medium", "relatively familiar" and "very familiar", with scores of 0.20, 0.40, 0.60,0.80 and 1.00 respectively. Expert authority = (judgment basis + familiarity)/2. When the expert authority coefficient is greater than 0.70, the expert authority is higher.

### 2.6 statistical analysis

Excel was used to establish the database, and SPSS25.0 software and Excel were used for statistical analysis and processing. P<0.05 was considered to be statistically significant. Kendall's W expert consistency analysis was conducted for the reliability analysis of the final indictor scoring data.

## 3. Results

### 3.1 Reliability analysis of questionnaire and expert review

The cronbach coefficients of reliability and reliability were 0.709 and 0.921 respectively. It indicates that the reliability of the first questionnaire is acceptable and needs to be revised appropriately, while the second questionnaire has extremely high reliability (Ca > 0.90). The Kendall coefficient of expert consistency in the two scores was 0.623, 0.551, respectively, and P=0.000<0.05, indicating high expert consistency. See table 1.

Table 1. Reliability and expert consistency of the two expert evaluation forms

| | Cronbach’s Alpha | Standardization Items Cronbach's Alpha | Kendall's W | P |
|---|---|---|---|---|
| First | 0.709 | 0.724 | 0.632 | 0.000 |
| Second | 0.921 | 0.932 | 0.551 | 0.000 |

### 3.2 Indictor screening

The situation of the first actual evaluation indictor is as follows: 3 first-level indicators, 12 second-level indicators and 39 third-level indicators are formed. The items with low score and high coefficient of variation were deleted after expert score statistics and expert revision opinions. Finally, three primary indicators, nine secondary indicators and 21 tertiary indicators were formed. After the second bisection, the score of each indictor was > 4.0, and the coefficient of variation was < 0.15. The overall situation was good, and the experts had no objection. Are shown in table 2.

Table 2. Final indicator system score

| indictor | Importance integral | Full marks | Coefficient of variation |
|---|---|---|---|
| B technical practicability | 4.88±0.32 | 87.9% | 0.07 |
| B1 market demand rate | 4.48±0.51 | 48.5% | 0.11 |
| B11 market size | 4.21±0.55 | 27.3% | 0.13 |
| B12 residual size | 4.18±0.53 | 24.2% | 0.13 |
| B13 market expansion potential | 4.06±0.50 | 15.2% | 0.12 |
| B2 potency ratio | 4.70±0.47 | 69.7% | 0.10 |
| B21 curative effect cost advantage | 4.61±0.50 | 60.6% | 0.11 |
| B22 raw materials are readily available | 4.52±0.57 | 54.5% | 0.13 |
| B3 generality | 4.36±0.55 | 39.4% | 0.13 |
| B31 is suitable for many diseases | 4.73±0.45 | 72.7% | 0.10 |
| B32 is suitable for many patients | 4.52±0.62 | 57.6% | 0.14 |
| C technical reliability | 4.85±0.36 | 84.8% | 0.08 |
| Feasibility of C1 | 4.82±0.39 | 81.8% | 0.08 |
| C11 production difficulty | 4.64±0.49 | 63.60% | 0.11 |
| Ease of use C12 | 4.55±0.51 | 54.5% | 0.11 |
| C2 curative effect | 4.82±0.39 | 81.8% | 0.08 |
| C21 cure rate | 4.91±0.30 | 90.9% | 0.06 |
| C22 significant efficiency | 4.06±0.61 | 21.2% | 0.15 |
| C3 security | 4.67±0.48 | 66.7% | 0.10 |
| C31 structural stability | 4.76±0.44 | 75.7% | 0.10 |
| Toxic side effects of C32 | 4.58±0.50 | 57.6% | 0.11 |
| C33 adverse reactions | 4.64±0.65 | 63.6% | 0.11 |
| D technical benefits | 4.79±0.49 | 78.8% | 0.09 |
| D1 economic benefits | 4.58±0.56 | 60.6% | 0.13 |
| D11 annual profit | 4.39±0.50 | 39.4% | 0.11 |
| D12 market share | 4.24±0.44 | 24.2% | 0.10 |
| D2 social benefits | 4.64±0.55 | 66.7% | 0.12 |
| Family satisfaction of D21 patients | 4.76±0.44 | 75.8% | 0.09 |
| D22 satisfaction of medical staff | 4.55±0.51 | 54.5% | 0.11 |
| D3 benefit cycle | 4.31±0.67 | 21.2% | 0.12 |
| D31 years of earnings | 4.61±0.56 | 63.6% | 0.12 |
| D32 market saturation period | 4.45±1.51 | 45.5% | 0.11 |
| D33 potential for continuous improvement | 4.30±0.53 | 33.3% | 0.12 |

## 4. Analytic hierarchy process of indictor system weight

### 4.1 Evaluation indictor composition

Analytic hierarchy process (AHP) is a practical multi-scheme or multi-objective decision-making method proposed by American operations research scientist professor t.l. schaaty in the 1980s. A

qualitative and quantitative combined, systematic, hierarchical analysis method. After two expert reviews, the evaluation indictor system of the effectiveness of medical innovation is finally constituted by three first-level indicators, nine second-level indicators and 21 third-level indicators. The weight of the indictor system is calculated by using the analytic hierarchy process.

### 4.2 Construct a pairwise judgment matrix

Through the discussion of the expert group, the weights of the first-level indicators were compared and assigned by the 1-9 scale method. A pairwise judgment matrix is constructed by integrating the scores of experts, as shown in table 3.

Table 3. Judgment matrix of primary indictor

| | B.Practicality | C.Reliability y | D. Benefits |
|---|---|---|---|
| B.Practicality | 1 | 1 | 3 |
| C. Reliability | 1 | 1 | 5 |
| D. Benefits | 1/3 | 1/5 | 1 |

Then, the judgment matrix can be obtained:

$$A=\begin{bmatrix} 1 & 1 & 3 \\ 1 & 1 & 5 \\ 1/3 & 1/5 & 1 \end{bmatrix} \quad (1)$$

Calculating weight

(1) calculate the product Mi of each row element of the judgment matrix A:

$$M1=1 * 1 * 3 = 3 \quad (2)$$

$$M2=1 * 1 * 5 = 5 \quad (3)$$

$$M3=1/3 \text{ x x } 1\ 1/5 = 1/15 = 0.0667 \quad (4)$$

(2) calculate the cubic root Wi of Mi

$$W1=\sqrt[3]{}\ 3 = 1.4423 \quad (5)$$

$$W2=\sqrt[3]{}\ 5 = 1.710 \quad (6)$$

$$W3=\sqrt[3]{}\ 0.0667 = 0.4055 \quad (7)$$

The pair vector

$$Wi=[1.4423\ \ 1.710\ \ 0.4055]T \quad (8)$$

Then the normalization is performed:

$$V1=0.4054 \quad (9)$$

$$V2=0.4806 \quad (10)$$

$$V3=0.1140 \quad (11)$$

### 4.3 Accuracy and reliability test

First of all, the consistency of judgement matrix, to calculate the maximum eigenvalue: $\lambda_{max}=\sum_{j=1}^{3}\frac{(AV)i}{3Vi}$=3.0291, consistency, CI = 0.0145; The average random consistency indictor CR=0.025 < 0.1, indicating that the first-level indictor matrix has a high degree of consistency, and there is no logic error in the weight of each indictor, so the first-level indictor weight is set as: [0.4054, 0.4806, 0.1140]. This method is also used to obtain the weights of the secondary and tertiary indictor, as shown in table 4.

Table 4. Weight table of evaluation indictor system

| first-level indictor | weight | second-level indictor | weight | Synthetic weight | third-level indictor | weight | Synthetic weight |
|---|---|---|---|---|---|---|---|
| B | 0.4054 | B1 | 0.4353 | 0.1765 | B11 | 0.4353 | 0.1895 |
| | | | | | B12 | 0.4869 | 0.2119 |
| | | | | | B13 | 0.0778 | 0.0339 |
| | | B2 | 0.4869 | 0.1974 | B21 | 0.6753 | 0.3288 |
| | | | | | B22 | 0.3247 | 0.1581 |
| | | B3 | 0.0778 | 0.0315 | B31 | 0.50 | 0.0389 |
| | | | | | B32 | 0.50 | 0.0389 |
| C | 0.4806 | C1 | 0.1140 | 0.0548 | C11 | 0.6753 | 0.0972 |
| | | | | | C12 | 0.3247 | 0.0370 |
| | | C2 | 0.4806 | 0.2310 | C21 | 0.7854 | 0.3775 |
| | | | | | C22 | 0.2146 | 0.1031 |
| | | C3 | 0.4054 | 0.1948 | C31 | 0.4286 | 0.1738 |
| | | | | | C32 | 0.4286 | 0.1738 |
| D | 0.1140 | | | | C33 | 0.1428 | 0.0579 |
| | | D1 | 0.4815 | 0.0549 | D11 | 0.50 | 0.2407 |
| | | | | | D12 | 0.50 | 0.2407 |
| | | D2 | 0.4815 | 0.0549 | D21 | 0.6753 | 0.3251 |
| | | | | | D22 | 0.3247 | 0.1563 |
| | | D3 | 0.0370 | 0.0042 | D31 | 0.60 | 0.0222 |
| | | | | | D32 | 0.20 | 0.0074 |
| | | | | | D33 | 0.20 | 0.0074 |

## 5. Conclusion

Three first-level indicators: technical practicability, technical reliability and technical benefit comprehensively cover the evaluation of new medical technology, which can fully system the quality degree of a new technology. After the selection of indictores and the establishment of three-level indictor system, the evaluation of the quality and effectiveness of new medical achievements can be realized. Can not only for the party, the medical results investors in decision link provide reliable evaluation method, can more effectively guide the medical researchers attach importance to the validity of the medical project innovation, avoid blind development, causing the appearance of the useless medical achievements, to improve the quality of medical scientific research projects and market conversion rate has important value.

Although this indictor system is established based on scientific means and reflects the scientific approach of medical new technology evaluation in a comprehensive and prominent way, due to the complexity of medical science itself and the uncertainty of the market, there may be differences in indicators and weights in different branches of science, so limitations are inevitable.

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