J Med Syst (2011) 35:625–637
DOI 10.1007/s10916-009-9400-8

ORIGINAL PAPER

New Indicators Based on Personnel Cost for Management Efficiency in a Hospital

Yoshiaki Nakagawa · Hiroyuki Yoshihara · Yoshinobu Nakagawa

Received: 30 August 2009 / Accepted: 9 November 2009 / Published online: 27 November 2009

Abstract A simple and fair benchmarking system or financial indicators for use on the clinical department level have been lacking to evaluate the management efficiency and activity of each clinical department or division of a hospital. New financial indicators have therefore been developed based on personnel costs. Indicator 1: The ratio of marginal profit after personnel cost per personnel cost (RMP). Indicator 2: The ratio of investment (=indirect cost) per personnel cost (RIP). The difference between RMP and RIP demonstrates the operation profit in US Dollars for personnel cost (OPP). A turning point in profitability similar to the break-even point (BEP) and break-even ratio (BER) could be also defined by the combination of the RMP and RIP. The merits of these two indicators are not only the ability to indicate the relationship between the medical profit and the investments in the hospital, but also the capability to demonstrate such indicators as BEP, BER and OPP on a single graph. The two indicators were applied to the hospitals in the National Hospital Organization and to the clinical department in one hospital. Using these two indicators, it was possible to evaluate the management efficiency and medical activity not only in the whole hospital but also in each department and DPC/DRG group. This will be of use to a manager of a hospital in checking the management efficiency of his/her hospital despite the variations among hospitals, departments and divisions.

Keywords Financial indicator · Benchmark · Break-even point · Break-even ratio · Management efficiency · Hospital cost accounting

Y. Nakagawa (✉) · H. Yoshihara
Department of Medical Informatics, Graduate School,
Kyoto University,
54 Shogoin Kawahara-cho, Sakyo-ku,
Kyoto, Japan
e-mail: paora@kuhp.kyoto-u.ac.jp

Y. Nakagawa
Kagawa National Children's Hospital, National Hospital Organization,
Zentsuji-cho 2609,
Zentsuji City, Kagawa 765-8501, Japan

Introduction

In order to efficiently operate a hospital and determine the future management strategy, a hospital manager must utilized benchmark and/or indicators—which mainly include the cost of medical materials as well as cost accounting, per-treatment cost, medical practice revenue, balance between medical practice revenue and expenditure, bed occupancy rate, bed turnover rate, etc., [1, 2]. However, from the perspective of management, these indicators do not always directly indicate the management efficiency of health care. Despite high per-treatment cost and medical practice revenue, there remain deficits in the balance between medical practice revenue and cost [3]. Therefore, it is undeniably difficult for a hospital manager to evaluate the management efficiency in each section of health care, especially the services of each department and within departments, using traditional indicators. In this modern society, where the streamlining of hospital administration is required, it is essential to conduct evaluations at the clinical-department level or each division (which can be referred to as evaluations for each sales department), and a simple and standard evaluation method has become necessary [3, 4]. The average length of stay (ALOS) or cost per patient etc. are good indicators for a hospital manager to compare his hospital to another hospital or individual clinical department together in his own hospital [1, 2, 5]. However, few indicators

demonstrate the relationship between the investment and medical activity or management efficiency in a hospital.

The Medicare reimbursement system was restructured and DRG/PPS was introduced in U.S.A to control the medical costs [6]. The modified payment system based on Diagnosis Procedure Combinations (DPC) was developed in 2003 and introduced in the medical treatment fee system of Japan [7–9]. While the DRG is a "per case payment" system, the DPC based payment system is a "per day payment" system. One of the aims of such a payment system is to standardize the medical care including medical cost. Since the restructuring of the Medicare reimbursement system in 1983, cost accounting predominately used a traditional method, such as the ratio-cost-to charge (RCC) method, the relative value unit (RVU) method [10]. However, the problem has been how to allocate the indirect costs (or fixed costs) [11, 12]. Depreciation and maintenance costs for the hospital were allocated in accordance with the rate of medical revenue, occupancy space and the floor space [29]. However, there is inconsistency between the rule of the allocation and the actual condition of medical service. The other problem is an allocation rule of the personnel cost which accounts for about 50% of medical revenue (or expenditure). Time studies have used an activity-based costing (ABC) method recommended as a tool for proportionally dividing the allowance [13–17]. ABC is considered to be a more exact costing method than RCC and RVU. Peden Al and Baker JJ used the same accounting technique to allocate physician overhead costs to activities and reported that if overhead costs are to be allocated on the basis of work (pay multiplied by hours), and if physician and nonphysician work are somewhat substitutable, then (overhead) costs may be allocated on the basis of physician and nonphysician work combined, which is closely related to the sum of physician work and direct costs [18]. However, since time studies require extensive time and manpower, their use is limited to once or twice a year in a hospital. Factory labor is somewhat standardized and uniform and can be averaged based on the number of materials. On the other hand, the physical condition of a patient changes dramatically from day to day in hospitals offering acute medical care and the number of patients in each clinical department is not uniform throughout the year. Therefore, if the results from a 1- or 2-day study are applied to the whole year, then such an evaluation might prove to be widely different from the actual conditions, and may cause incorrect results. This is the reason that, a few managers found it unsuitable to use ABC to analyze medical cost account of a hospital with very variable situation. In addition, although patients seem to be treated in a specific department; however, they usually receive medical care or service from other sections such as radiology, laboratory, pharmacy, operating room, rehabilitation clinics and restaurants. When a hospital is considered as an aggregate of various departments and sections, it might be better to proportionally allocate the total indirect cost to all patients according to the amount of the medical service which they received. We previously reported a simpler cost accounting system which was based on personnel cost for calculating medical cost and financial balance [19]. The system consisted of three calculation systems; a medical revenue calculation system based on the DPC (DRGs) system, a medical cost accounting system and an allocation system of indirect cost calculations using the allocation rule of personnel cost (Fig. 1).

The aim of this study is to develop new indicators using the data computed by the accounting system previously reported and prove that these two indicators can be successfully adapted as new benchmarking indicators for management efficiency and medical activity of a hospital and each medical department [19, 20].

Method

The costs in industry are usually divided into two categories: namely, fixed costs and variable cost. On the other hand, the costs, especially medical costs have also been divided into two groups. One is "direct costs" which includes personnel costs, the cost of medical materials, and food expenses. The other is "indirect costs" which includes depreciation cost for a building and medical facilities and the cost for maintaining the hospital (Fig. 2). The direct cost can be directly allocated into each patient and department. The indirect cost; depreciation cost and maintenance cost for a hospital was divided based on personnel cost in this study [19].

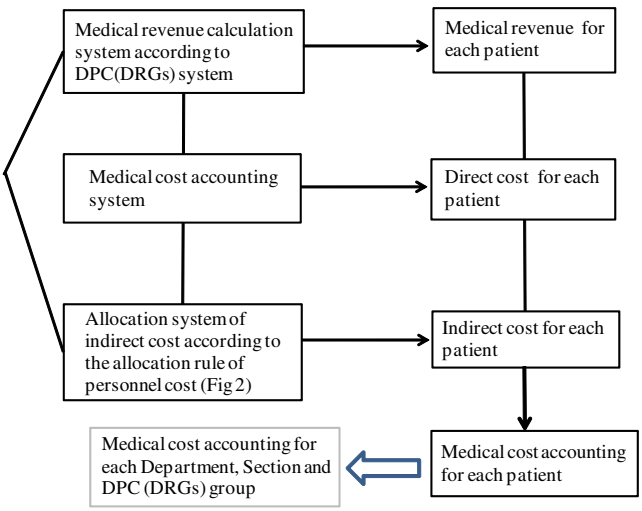


Fig. 1 Logical design of the accounting system

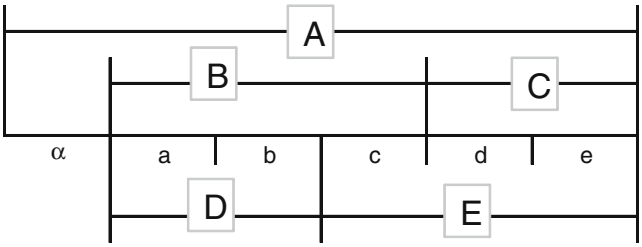
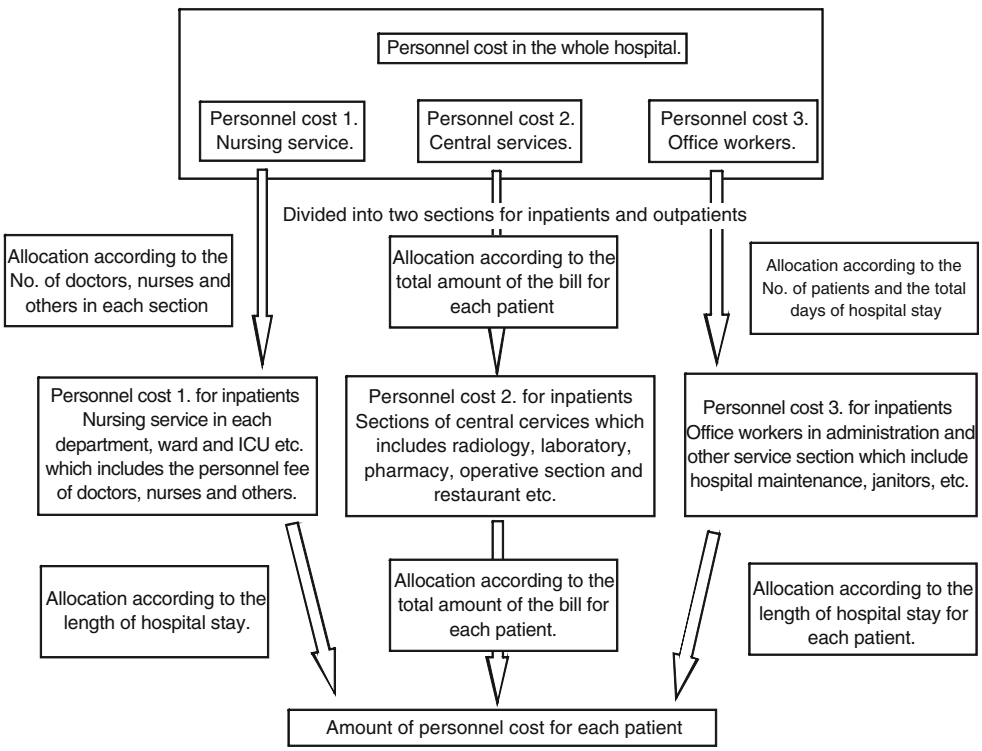


Fig. 2 Parameters are defined as follows: *A* (medical) revenue, *B* fixed cost, *C* variable cost, *D* indirect cost, *E* direct cost, *a* depreciation cost for a hospital, *b* maintenance cost for a hospital, *c* personnel costs, *d* cost of medical materials, *e* food expenses, α medical profit. A new entity "medical marginal profit after personnel cost" was defined as what remains after the subtraction of direct costs (*E*) from medical revenues (*A*)

The medical revenue is basically composed of two parts; one is a basic hospital fee which includes nursing services in a ward (Nursing services), the other is a medical fee which reflects the direct medical services for each patient in individual departments, such as radiology, laboratory, surgery (anesthesiology and operation room), rehabilitation, pharmacy and restaurant etc., for which the costs for their direct services are charged by bills (Central cervices). Therefore, the personnel costs in the entire hospital were divided into three groups (Fig. 3): personnel cost-1 (Nursing services), personnel cost-2 (Central services) and personnel cost-3 (Office workers). Nursing services include the personnel cost of doctors, nurses and other paramedical staff belong to the ward (or department) or ICU. The personnel cost-1 was allocated into two sections for inpatients and outpatients according to the number of registered staff members in a ward and outpatient department (Personnel cost-1 for inpatients). The individual ward usually belongs to each clinical department in a hospital in Japan. (Two or three minor departments keep one ward together). Then the personnel cost-1 (nursing services) for inpatients was divided into each clinical department according to the number of staff members in each department. The personnel cost of nurses in the ward includes other paramedical staff. Furthermore, the personnel cost of each department was allocated to an individual patient in accordance with the length of hospital stay. Central services include radiology, laboratory, surgery (anesthesiology and operation room), rehabilitation pharmacy and restaurant etc. which cost for their direct services is charged by bills. The cost of central crevices (Personnel cost-2) was allocated into two sections for inpatient and outpatient according to the total amount of the bills of each patient. Next, the personnel cost-2 for inpatients (Fig. 3) was allocated to each patient. The costs of central services include the costs of doctors who belong to each section, such as a radiologist in radiology, a pathologist in the laboratory, an anesthesiologist in the surgical section and a doctor in rehabilitation. The personnel cost of nurses includes the cost of the other paramedical staffs that belong to an individual section. Personnel cost-2 for the central

Fig. 3 Allocation rule of personnel cost



service for inpatients was divided by a similar rule and allocated to each patient according to the total amount of the bills of individual patient. Office workers who offer indirect service include the administration, staff for maintenance service, laundry and other indirect services which are not billed as medical services. The cost for office work (Personnel cost-3) was divided into the inpatient group and outpatient group according to the number of outpatients and total length of hospital stay of all inpatients. Thereafter, personnel cost-3 for inpatients was allocated to each patient according to the length of their hospital stay.

The personnel cost of each patient is the total amount of personnel cost-1, 2, and 3 of the individual patients.

Before making the new indicators, "marginal profit" was defined as what remains after the subtraction of variable costs (cost of medical materials and food expenses) from medical revenues.

Indicator 1. Ratio of marginal profit after personnel cost per personnel cost (RMP)

RMP is defined as an index which reflects the ratio of marginal profit after personnel cost per one US Dollar of personnel cost.

The marginal profit in a whole hospital, each department and DPC (DRGs) group was calculated using the previously reported accounting system. The personnel cost is the total of all personnel costs computed by the allocation rule of personnel cost in a whole hospital or the individual clinical departments or the DPC group.

The RMP is expressed using the definition in Fig. 2 as:

$$RMP = \frac{A - E}{c}$$

Indicator 2. Ratio of investment per personnel cost (RIP)

RIP is defined as an index which reflects the ratio of investment (=indirect cost) per one US Dollar of personnel cost. Investment is the sum of depreciation cost for various facilities and the cost of maintaining the hospital. It is not merely the amount of the investment itself but also includes the depreciation for a building and medical equipment. The maintenance cost for a hospital includes taxes, public charges, traveling expenses, light, heat, and water expenses. The personnel cost is the total of all personnel costs in the whole hospital. All the components: the depreciation cost, maintenance cost for a hospital and personnel cost are categorized as fixed cost. Therefore, the RIP is fixed in a hospital, which therefore means that the RIP in individual departments and the DPC group thus have the same value.

RIP is expressed using the definition in Fig. 1 as:

$$RIP = \frac{D}{c}$$

Indirect cost in each department or DPC group can be computed as:

amount of personnel cost × RIP

Relationship between the RMP, RIP and medical efficiency

BEP (Break even point) can be expressed by the following formula:

$$BEP = \frac{a+b+c}{1-\frac{d+e}{A}} = \frac{A(a+b+c)}{A-(d+e)} = \frac{A(a+b+c)}{\alpha+a+b+c} \quad (1)$$

The RMP is expressed by the following formula

$$RMP = \frac{A - E}{c}$$

$$RMP = \frac{A-(c+d+e)}{c} = \frac{a+b+\alpha}{c}$$

Therefore

$$cRMP = a + b + a \quad (2)$$

RIP is expressed by the following formula

$$RIP = \frac{D}{c} = \frac{a+b}{c}$$

Therefore

$$cRIP = a + b \quad (3)$$

Substituting Eqs. 2 and 3 into Eq. 1 gives

$$BEP = \frac{A(cRIP+c)}{cRMP+c} = \frac{Ac(RIP+1)}{c(RMP+1)} = \frac{A(RIP+1)}{RMP+1} \quad (4)$$

If RMP<RIP, BEP>A; which means that the financial balance is in the red.

If RMP>RIP, BEP<A; which means that the financial balance is in the black.

If RMP=RIP,

BEP=A (α=0)

BER (Break-even ratio) is expressed by the following formula

$$BER = BEP \times \frac{1}{A} = \frac{A(RIP+1)}{RMP+1} \times \frac{1}{A} = \frac{RIP+1}{RMP+1}$$

Therefore

$$BER(RMP+1) = RIP + 1$$
$$RIP = BER(RMP+1) - 1 \quad (5)$$

On the other hand operating profit per personnel cost (OPP) is expressed by the following formula

$$OPP = \frac{\alpha}{c}$$

Therefore

$$\mathrm{OPP} = \mathrm{RMP} - \mathrm{RIP} \quad \text{(Fig. 4)}$$

The relationship between RMP, RIP, BEP and OPP was demonstrated in Fig. 4. There are two models; One is Hospital A with (RMP, RIP)=(0.423, 0.721); which is in the red, the other is Hospital B with (RMP, RIP)=(0.683, 0.365) which is black. BEP should be located on the line: RMP=RIP according to the Eq. 4. Therefore the line y=x means the break even line. The line of the break even ratio can be demonstrated using the Eq. 5. The intersection of the straight line of y=x and a line parallel to the x axis pulled from Hospital A shows BEP. The width between Hospital A and BER of hospital A (RMP−RIP of Hospital A; −0.298) demonstrates the operating profit per one US Dollar of personnel cost (OPP). The OPP of Hospital B can be calculated in the same way, which was 0.318. The individual OPP demonstrated a clear difference in the medical efficiency from the stand point of medical management.

Application of the indicators to the hospitals of the NHO

The data of each hospital reported by the administration of NHO from 2004 to 2007 was analyzed in this study. There were 146 hospitals in 2004; however, four hospitals were excluded in this study because of integration into two hospitals before 2007. Seventy three hospitals out of the 144 offer mainly acute-phase medical care services. The other 71 hospitals offer medical services mainly for chronic patients. They have wards for handicapped children (or adults), wards for patients with severe neurological diseases such as muscular dystrophy and amyotrophic lateral

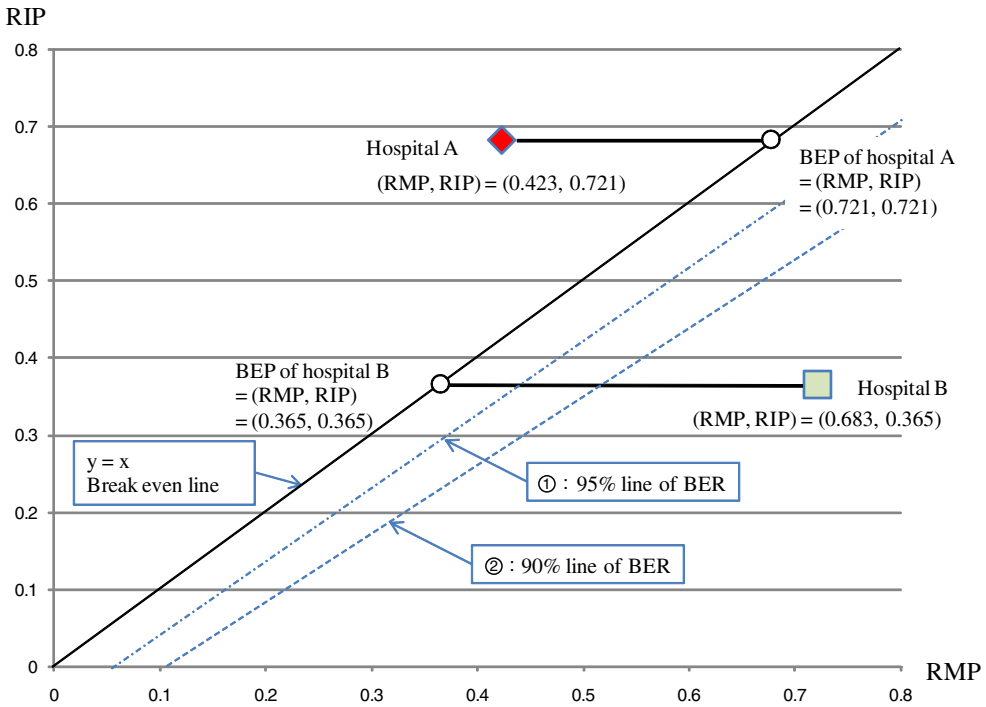


Fig. 4 The relationship between RMP, RIP, BEP and OPP. *Diamond* hospital A with (RMP, RIP)=(0.423, 0.721) and financial balance in the *red*. *Square* hospital B with (RMP, RIP)=(0.683, 0.365) and financial balance in the *black*. The *line y=x* demonstrates break even line. ① demonstrated 95% line of brake even ratio (BER): y=0.95x−0.05 calculated by the formula: RIP=BER(RMP+1)−1. ② demonstrated 90% line of BER: y=0.90x−0.10. The width between hospital A and BEP of hospital A; 0.423−0.721=−0.298 demonstrates operating profit per one dollar of personnel cost (OPP). The value −0.298 revealed poor medical efficiency. The width between hospital B and BEP of hospital B; 0.683−0.365=0.318 demonstrates operating profit per one dollar of personnel cost (OPP) of the hospital B. The value 0.318 revealed good medical efficiency

sclerosis, wards for patients with tuberculosis, or wards for psychiatric patients. The 144 hospitals that were used in the investigation are all organized and operated under the same rules and have the same payroll system. The new financial indicators, RMP and RIP were applied to evaluate the management efficiency and medical activity in each hospital.

Application of the indicators to each clinical departments and DPC group

A modified version of the DRG payment system in the U.S.A based on Diagnosis Procedure Combinations (DPC) was introduced in the medical treatment fee system of Japan in 2003. The medical revenue and cost were analyzed for each clinical department and individual DPC group using the analytic system based on personnel cost. The new indicators were applied to a hospital composed of 535 beds and 16 clinics for acute phase patients to evaluate the management efficiency and medical activity in individual clinical departments. Data from the financial statement for the period from June to December 2006 were used and the RMP and the RIP were computed not only in this hospital but also in individual departments and each DPC group. The RIP is fixed in the hospital. Therefore, the individual RMP with fixed RIP was applied to evaluate the medical efficiency and activity in each department and DPC group.

Result

Relationship between the RMP, RIP and financial balance in NHO hospitals

The relationship between the RMP, RIP, and the financial balance in 73 hospitals offering acute-phase medical care services of NHO is demonstrated in Fig. 5a. BEP is demonstrated on the line; y=x (RMP=RIP). The 95% line of brake-even ratio (BER) is demonstrated on the line: y=0.95x−0.05, 90% line of BER is on the line y=0.90x−0.10 which were calculated by the formula: RIP=BER(RMP+1)−1. Forty-seven hospitals out of 73 were in the black in 2004 (OPP>0). The other 26 hospitals were in the red (OPP<0). Only 3 hospitals out of 12 hospitals which had an RIP value more than 0.6 were in the black On the other hand there were ten hospitals which demonstrated a low OPP; (RMP-RIP), namely less than −0.2. The balance between the RMP and RIP (OPP) was gradually improved but 18 hospitals were still in the red in 2007 (Fig. 5b). There were still five hospitals whose OPP were less than −0.2, thereby suggesting either insufficient medical efficiency or management. Eighteen hospitals were in the black, however, the BER is over 95% which means their financial condition is still not stable. On the other hand, the BER of 14 hospitals were less than 90% which means their financial condition is stabilized.

Characteristic changes of the indicators in four hospitals through 2004–2007

The characteristic changes of two indicators in four hospitals are shown in Fig. 6. The four hospitals offering acute-phase medical care services have 580 beds in A, 500 beds in hospital B, 600 beds in C and 580 beds in D. After the comparison of both indicators and financial balance through 4 years, the transition of the management efficiency and activities of each hospital became clear (Fig. 6).

The factors which resulted in changes of the RMP

In order to study the related factors which influenced the changes of the RMP, the cost of medical materials, personnel cost and the RMP were compared between 2004 and 2007 in Fig. 7. More than 70% of the hospitals showing a larger fluctuation rate of medical cost than that of personnel cost increased the RMP. On the other hand, 73% of the hospitals with a remarkable decline of the fluctuation rate of medical cost in comparison to personnel cost from 2004 to 2007 demonstrated a decreasing RMP, which thus suggested an attenuation of both the management efficiency and activity of medical care.

Comparison of the indicators in hospitals offering chronic medical care

Fifty-six hospitals out of 71 were in the black in 2007 (Fig. 8). The other 15 hospitals were in the red. Two hospitals were outside the scale because of lower RMP less than 0.100. Forty-eight hospitals out of 56 hospitals (95.7%) which were in the black had an RIP value less than 0.4. There were only two hospitals which had an RMP more than 0.60. On the other hand, it was difficult to move into the black in the hospitals which had an RMP less than 0.2. The RIP was more than 0.4 in four hospitals that were in the red, which may therefore indicate a possible over investment at those hospitals. There were significant differences between hospitals offering chronic medical care and hospitals offering acute medical care (Fig. 5). Seventeen hospitals were in the black; however, the BER is over 95% which means their financial condition is still not stable. On the other hand, the BER of 12 hospitals were less than 90% which means their financial condition was stabilized.

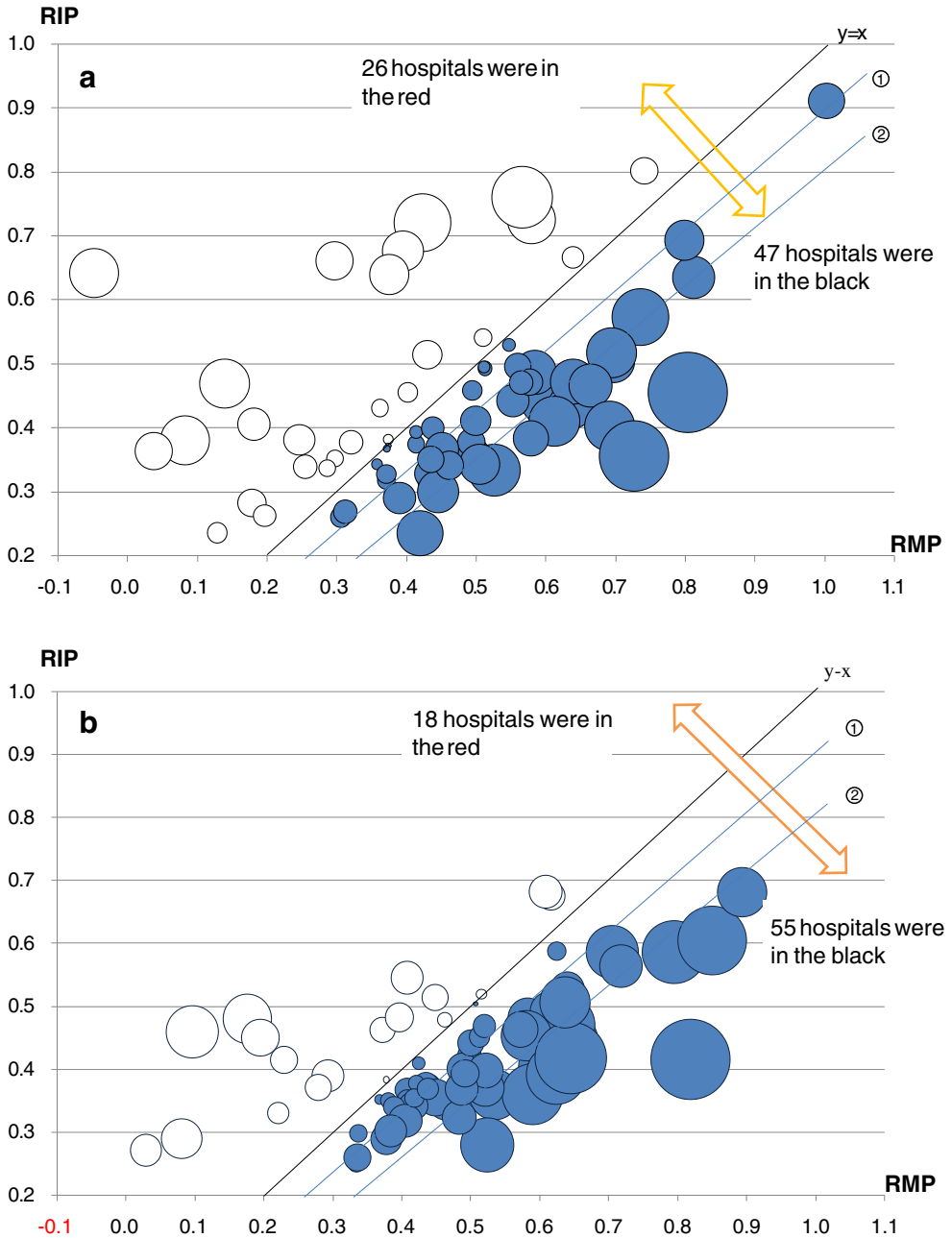


Fig. 5 **a** Relationship between RMP, RIP and medical profit in 73 hospitals, 2004. *Closed circle* hospitals with financial balance in the *black*. *Open circle* hospitals with financial balance in the *red*. ① demonstrated 95% line of brake-even ratio (BER): y=0.95x−0.05 calculated by the formula: RIP=BER(RMP+1)−1. ② demonstrated 90% line of BER: y=0.90x−0.10. The size of the *circle* indicates medical account rate (percentage) in each hospital. The minimum point of the RMP in hospitals with financial balances in the *black* was 0.31. The value of RIP in more than 95% of the hospitals with favorable balances was less than 0.60. Equally, among the 12 hospitals with an RIP of 0.60 or more, only three hospitals (25%) had a favorable financial balance in 2004. If the RIP of a hospital is more than 0.60, then this value indicates a hospital with heavy debts. On the other hand, if the RMP of a hospital is less than 0.3, and therefore it is also difficult to move into the black. **b** Relationship between RMP, RIP and medical profit in 73 hospitals (2007). *Closed circle* hospitals with financial balance in the *black*. *Open circle* hospitals with financial balance in the *red*. ① demonstrated 95% line of brake-even ratio (BER): y=0.95x−0.05 induced by the formula: RIP=BER(RMP+1)−1. ② demonstrated 90% line of BER: y=0.90x−0.10. The size of the *circle* indicates the medical account rate (percentage) in each hospital. The financial balance was gradually improved but 18 hospitals were still in the *red* in 2007. The minimum point of the RMP in hospitals with financial balances in the *black* was (0.31). The hospitals with an RMP less than 0.30 in 2004 (12 hospitals) improved management efficiency, however, nine hospitals had still an unfavorable balance

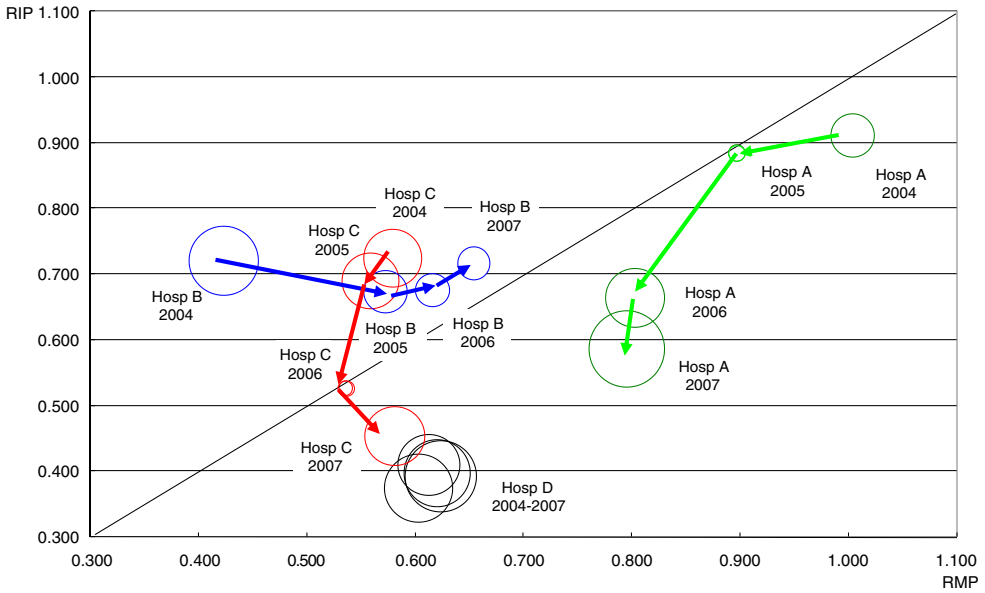


Fig. 6 Characteristic changes of RMP and RIP in four hospitals. Hospital A had very high RMP and RIP but was still in the *black* in 2004. Both the RMP 1.0 and RIP 0.9 were the highest in the HNO. The data suggested insufficient number of staff and over work. The hospital tried to increase the staff which was demonstrated by a decreasing RIP in 2006 and 2007. The RMP in 2007 decreased in comparison to 2004, however, OPP improved which resulted in marked improvement of the financial balance. Hospital B reconstructed the hospital a few years ago and still had high depreciation cost which was shown as high RIPs. They tried to improve the efficiency of medical care, which was demonstrated by a continuous increase in the RMP and an improvement in OPP over 4 years. Hospital C had a high RIP and a large deficit in the financial balance in 2004. The depreciation cost (investment) decreased in 2006 and 2007 which was demonstrated by the decreasing of RIP and the financial balance turned to the black in 2007. Hospital D was consistently operated for 4 years and showed no remarkable changes in either the RMP or RIP. The hospital has a plan to reconstruct the hospital building

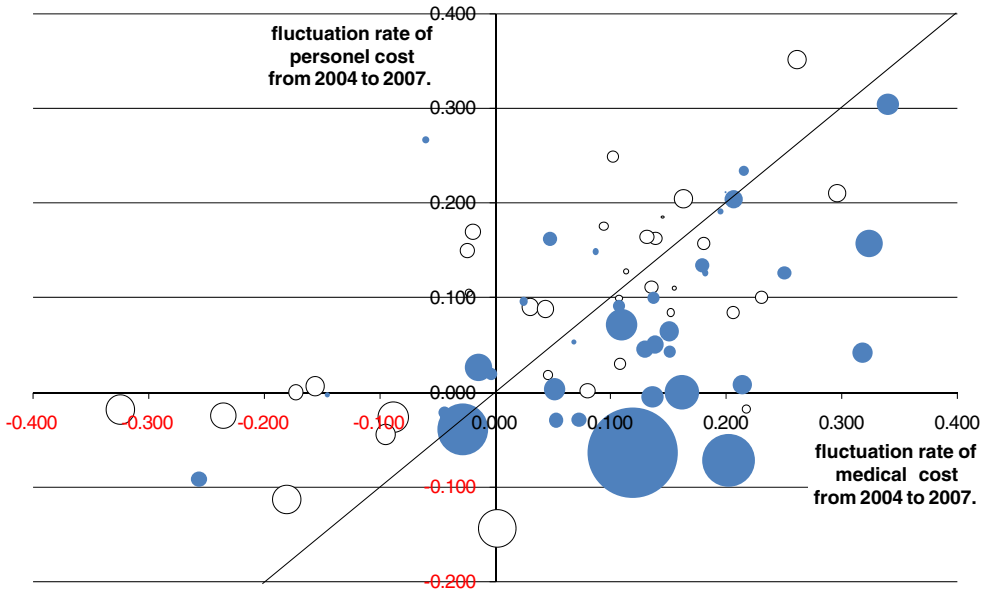


Fig. 7 The factors which resulted in changes of the RMP. *Closed circle* the RMP of hospitals increased through 2004 to 2007. *Open circle* the RMP of hospitals decreased through 2004 to 2007. The size of the *circle* indicates the value of RMP in each hospital. The medical cost includes medical material, drugs and food expense. Twenty-five out of 35 hospitals (71.4%) with a larger fluctuation rate than personnel cost increased the RMP. Only three of 11 hospitals show a decline in both of the fluctuation rate of medical cost and personnel cost improved the RMP. The increase in the fluctuation rate of medical cost with higher RMP reflects an improvement of management efficiency and medical activity

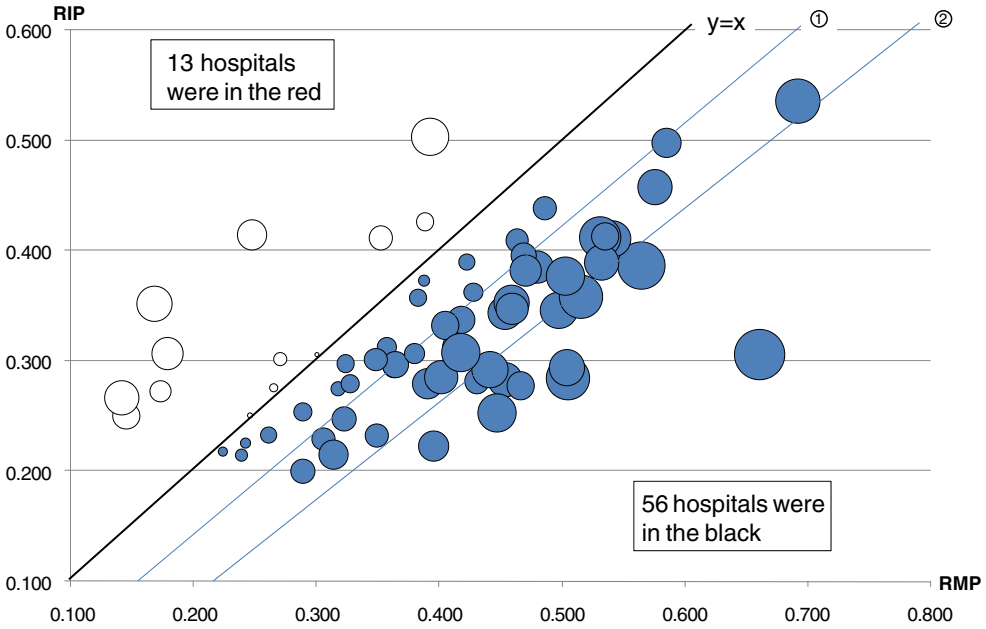


Fig. 8 The new indicators in hospitals offering chronic medical care in 2007. *Closed circle* hospitals with financial balance in the *black*. *Open circle* hospitals with financial balance in the *red*. ① demonstrated 95% line of brake-even ratio (BER): $y=0.95x-0.05$ induced by the formula: $RIP=BER(RMP+1)-1$. ② demonstrated 90% line of BER: $y=0.90x-0.10$. Significant differences between hospitals offering acute care and chronic care was clearly demonstrated. The minimum point of RMP in hospitals with financial balances in the *black* was 0.224. The value of RIP in more than 95% of the hospitals with favorable balances was less than 0.45. Four hospitals out of 15 (30%) which have an RIP 0.40 or more were in the read. (Two hospitals were outside the scale because of lower RMP less than 0.100.) Therefore, if the RIP of a hospital is more than 0.40, then this value indicates a hospital with heavy debts in a hospital offering chronic medical care in the NHO. Furthermore, among the 15 hospitals with an MRP 0.25 or less, only six hospitals (40%) had a favorable financial balance

Medical financial analysis, RMP, RIP, OPP and BER in clinical departments

The RMP of each clinical department reflects the individual management efficiency and medical activity of each department (Table 1).

Eight departments operated in the black (OPP>0.0). On the other hand, total medical revenues in departments F, G and H were higher than those of departments I, K or M. However, the OPPs of the departments were less than 0 (minus). On the other hand the OPPs of department I, K and M were more than 0. The OPPs of the department F, G and H and low RMP demonstrated that despite the total medical revenue of the department was high, thus indicating that either the medical efficiency or management of the department was insufficient.

Medical financial analysis, RMP, RIP, OPP and BER in DPC groups

RIP, RMP, OPP and BEP in ten selected DPC groups was computed and demonstrated in Table 2. The best five and worst five groups of net profit were selected from among those DPC groups which include more than ten patients. The management efficiency and financial balance in each DPC group was clarified by comparisons between the RIP of the hospital and individual RMP.

Discussion

In industry, a manager can control the volume of products and can decide the price of the products by himself. However, a hospital manager cannot control the number of patients or the contents of medical service. The number of patients in hospitals is easily influenced by circumstances in the surrounding environment, the weather and temperature, prevalence of disease such as influenza, and the variable physical condition of each patient [21]. Every patient is a so-called independent product. Therefore, a hospital manager cannot always utilize the same protocol or method applied in industry to evaluate the medical cost. Furthermore, in contrast to the fact that the manager of an industry can decided the cost of their product by themselves, the price of medical care is usually controlled by the Government, or some other official organization. About 70% of all hospital expenses are fixed costs including depreciation cost, maintenance cost for a hospital and

Table 1 Medical financial analysis, RMP, RIP, OPP and BEP in clinical departments

Clinical department	Medical revenue	Medical re venue/patient/day	RMP	RIP	OPP	BEP
A	$8,810,546	$1,415	0.595	0.411	0.183	$7,797,378
B	$7,881,827	$425	0.610	0.411	0.199	$6,906,797
C	$5,566,362	$432	0.542	0.411	0.131	$5,093,088
D	$5,352,584	$454	0.644	0.411	0.233	$4,593,712
E	$5,227,279	$590	0.613	0.411	0.202	$4,572,829
F	$2,322,023	$576	0.290	0.411	−0.121	$2,540,667
G	$1,343,712	$444	0.215	0.411	−0.196	$1,560,849
H	$1,258,035	$583	0.251	0.411	−0.161	$1,419,673
I	$1,152,544	$525	0.708	0.411	0.296	$952,530
J	$1,005,218	$896	0.122	0.411	−0.289	$1,263,932
K	$898,724	$548	0.473	0.411	0.062	$860,860
L	$713,421	$418	0.204	0.411	−0.207	$835,936
M	$631,275	$326	0.454	0.411	0.043	$612,540
N	$582,566	$522	0.254	0.411	−0.158	$655,841
O	$303,285	$524	−0.023	0.411	−0.434	$437,868
P	$42,975	$347	−0.699	0.411	−1.111	$201,674

The dates demonstrated on the table refer to DPC patients. The RIP of the hospital is 0.411. The same value of RIP can be adapted to each department. Eight departments operated in the black (OPP>0.0). Total medical revenues in departments F, G and H were higher than that of departments I, K or M. However, OPPs of the departments were less than 0. On the other hand OPPs of department I, K and M were more than 0. The OPPs of the department F, G and H and low RMP demonstrated that despite the total medical revenue of the department was high, the medical efficiency or management of the department was insufficient

BEV break-even volume

personnel costs. The depreciation cost and maintenance cost for a hospital are also classified as indirect costs in a hospital. On the other hand, personnel cost, cost of medical materials and food expenses are classified as direct cost. These factors led us to develop a new concept for the allocation rules of personnel cost and the new indicators RMP and RIP were developed. In industry, there is a similar economical indicator, "labor's relative share" but this is completely different from the new indicators. RMP is a variable because of the components including variable cost (cost of medical material and food expenses). On the other hand, the ratio of investment (indirect cost; depreciation cost and maintenance cost for a hospital) per personnel cost (RIP) is defined as fixed. Fortunately, it is

Table 2 Medical financial analysis, RMP, RIP and OPP in DPC groups

DPC code	Medical revenue/pt./day		Medical cost/pt./day		MAP	RMP	RIP	OPP
	Blanket portion	FFS	Personnel cost	Materials				
11012XXX040XXX	$245.6	$834.0	$191.7	$32.7	$855.3	4.463	0.411	4.052
050070XX01X00X	$292.3	$2,637.5	$219.1	$2,043.1	$667.6	3.047	0.411	2.636
040200XX01X0XX	$277.3	$693.4	$260.2	$38.6	$671.8	2.581	0.411	2.170
060035XX03X0XX	$290.3	$361.1	$179.4	$11.9	$460.2	2.565	0.411	2.154
060100XX02XXXX	$269.3	$320.8	$180.5	$11.4	$398.2	2.206	0.411	1.795
120010xx99x30x	$568.0	$125.9	$257.3	$331.7	$104.9	0.408	0.411	−0.003
070340xx97x0xx	$217.8	$341.5	$332.9	$97.1	$129.3	0.388	0.411	−0.023
120020xx99x30x	$486.6	$156.1	$260.7	$291.1	$90.8	0.348	0.411	−0.063
120170xx99xxxx	$238.6	$55.6	$204.4	$36.8	$53.0	0.259	0.411	−0.152
050130xxxx00xx	$263.7	$194.6	$278.5	$113.3	$66.6	0.239	0.411	−0.172

Materials include cost of medical materials, drugs and food expenses

FFS fee for service, *MAP* marginal profit after personnel cost

not difficult to compute the personnel cost per patient or personnel cost per DPC/DRG group, not only every year, but also every month using the previously reported accounting system. When the personnel cost per patient or DPC/DRG group is computed, the RMP and RIP will be automatically calculated.

A hospital manager can use the new indicators to compare his hospital to other hospitals and easily recognized the condition of his hospital in comparison to a similar hospital group like the NHO. He/she can also evaluate the management efficiency and activity of each clinical department and DPC group. A high RMP with a high RIP does not indicate a high quality of management efficiency. The balance between the RMP and RIP is the most important indicator to efficiently operate a hospital.

BEP and OPP are simple and intelligible methods to evaluate the management efficiency and is practically used in industry. Both concepts were well known, however, it was not usually used in the medical field except for a single clinic or a disease [22, 23]. A business in industry is somewhat standardized and uniform. However, in medical care the variety of products (disease and diagnosis, inpatient and outpatient) and has not been standardized. One of the problems is how to allocate the indirect cost to each product (DPC group and patient). Therefore, a new device was necessary to use BEP as an evaluation method for hospital management. On the other hand, the following prerequisite conditions may be necessary in order to utilize the break-even point as an indicator in a hospital. 1. The medical cost per patient or diagnosis group is constant. 2. The fixed cost of a hospital in one period is constant. 3. Variable cost and expenses are changed in proportion to the number of patients. 4. When there is a variation of disease or Diagnosis group, the rate of the combination of a disease or Diagnosis group is invariable in a hospital or department. 5. The amount of medical cost corresponds to the medical revenue. New ideas were necessary to fulfill the prerequisite conditions. One of the solutions is the allocation of the fixed cost into the sections for outpatients and inpatients. The other was some exchange rate or method (or allocation rule) which can change complicated medical services into one indicator. The two indicators, RIP and RMP developed based on personnel cost, were the ideal device. The cost accounting system, which we previously reported, primarily divided the personnel cost into the sections of outpatient and inpatient. Next, the personnel cost could be allocated to each patient according to the allocation rule. On the other hand, the medical revenue of each patient or DPC group can be also computed by the system. Therefore, after allocating and calculating the personnel cost, then the RMP can be automatically computed. RIP is fixed value in a single hospital and it can also be adapted to each patient, clinical department and DPC group (Tables 1 and 2). Furthermore, the occurrence rate of the disease, the rate of patients who receive medical service and the rate of severity of illness are not markedly changed in an area such as a city or a prefecture. Therefore the above prerequisite conditions may be fulfilled in a hospital operated under the system of DPC or DRG [24].

The lack of an adequate medical cost analytic method has been another problem. The main problems have been allocation rules or methods for personnel cost and indirect cost. The indirect cost such as depreciation cost and maintenance costs for the hospital has been allocated in accordance with the rate of occupancy space, the floor space or machine time in the traditional cost accounting method such as the ratio-of-cost-to charge method (RCC), the relative value unit method (RVU) and the activity-based costing method (ABC). However, such an allocation rule does not usually reflect the practical condition of medical care. Recently, new accounting systems such as ABC (Activity-Based Costing) or ABM (Activity-Based Management) were developed and the allocation rule or method for personnel cost and indirect cost was steadily developed [10, 13–17]. One of the merits of ABC and ABM is the concept of medical resource. The cost accounting system reported previously was based on personnel cost for calculating medical cost and financial balance [19]. The personnel cost was divided to an individual patient according to the medical service which each patient received. Next, the indirect cost of a whole hospital was allocated according to the personnel cost of each patient. The advantage of this system is that the indirect cost is primarily allocated to each patient, clinical department and DPC group (Tables 1 and 2). On the other hand, the weak point of the new indicators (RIP and RMP) is about the lack of data regarding medical resources [13–17]. However, the combination of the new indicators thus made it possible to demonstrate BEP, BER and OPP on a single graph (Fig. 4).

The characteristics of the new indicators reported in this study were discussed at three points. First, both RMP and RIP are based on personnel costs, which is the largest expenditure item in hospital management. A cost analysis for a DSU (Day surgery unit) revealed that the undeniable problem was not calculation of medical revenue but the allocation rule of personnel costs and the depreciation cost within the total costs of the whole hospital [25]. The cost drivers for personnel costs have been established individually depending on the number of patients, length of stay and the medical treatment, but the allocation of costs for routine work without medical treatment is not considered. In other words, they can be comprehended from a managerial viewpoint and make one consider the appropriateness of the details of treatment, such as the utilization of ICU, radiological sections, laboratory, pharmacy, operative

room, rehabilitation clinics and restaurants etc. If the personnel cost can be appropriately allocated, the new indicators can be a motivating indicator for optimizing the individual section and their activities. Therefore, the evaluation of management efficiency or hospital management was made possible by comparing these two indicators as described in Fig. 4. The RMP, is only loosely associated with depreciation cost and hospital expenses. However, it indicates the ratio of marginal profit after personnel cost per one US Dollar of personnel cost. On the other hand the RIP reflects the ratio of investment (=indirect cost) per one dollar (or yen) of personnel cost. Therefore, the difference after the subtraction of RMP from RIP which demonstrates the operating profit per personnel cost (OPP), not only in a hospital but also each clinical department, may therefore yield very useful data for a hospital manager (Table 1).

Secondly, the theoretical break-even point (BEP) and break-even ratio (BER) can be directly expressed by using these indicators. Only by comparing the RMP and RIP does the correlation between the revenue from treatment and the amount invested (fixed costs) become clear. Using the BEP and BER as a criterion indicates that the value of the RMP needs to be greater than that of the RIP or BER in order to maintain a surplus or stability in the current account. Furthermore, because the RIP indicates the ratio of investment (=indirect cost) per one US Dollar of personnel cost, this value can indicate not only the BEP of the hospital but also the BEP in each medical department and DPC group. If another accounting system such as ABC can be used, and individual depreciation cost and maintenance cost can be obtained from each department, the RIP of an individual department can be calculated in the same way. Therefore, the ideal values for stabilized hospital management would be values in which the RMP of each medical department exceeds the RIP (Fig. 4). Efforts to either increase the RMP or to decrease the RIP are required to improve hospital management. The conditions for increasing the RMP include reducing the personnel costs by reducing the number of staff members, or to relatively reduce the personnel costs per person by securing a larger number of patients and increasing the profit for treatment. On the other hand, the RIP does not decrease unless reductions in the indirect cost or increasing in the personnel costs are implemented. If only the personnel costs are reduced, the RIP should increase. In other words, in the event of the closure of a medical department, it is necessary to efficiently write off the funds that were invested in the department and facilities, etc. in other departments. It is important to consider the balance between the RMP and the RIP when planning management in the future by including new investments as well.

Third, the RMP and RIP were calculated using the data format of the DPC system, which has been designated by the Health, Labor and Welfare Ministry [7]. Thereafter, all computed data are similar to that of cost accounting, so not only is the evaluation of an entire hospital possible, but it can also be applied for the evaluation of each medical department, each classification of DPC groups, and patients (Tables 1 and 2). The new indicators can be utilized in the same way in every hospitals operated by DPC, even if the hospital is operated by DRG/PPS [6, 26–28]. One of the problems confronting hospital managers is that there are often cases where the rate of return is low even when the medical practice revenue is large. However, it is possible to highlight each medical department's problems more accurately by evaluating each medical department based on the RMP and referring to each indicator that has traditionally been used. If one can pinpoint the problems in this way, a new idea or innovative methods that can increase the RMP can be inferred. Furthermore, if the managers of the hospital are thinking about future investment, based on the RIP of his hospital and considering the relationship with the RMP value, it is useful to determine which medical department should have priority for receiving further resources. This would be a department in which the RMP is higher than the RIP. The use of these indicators should facilitate evaluation from both aspects of activity and management efficiency for each medical department, allowing hospital managers to more accurately assess which medical department should improve their administrative efficiency, or which medical department should have priority for receiving resources.

The new indicators should provide good benchmarking, not only for comparisons between hospitals but also for evaluations of the activity per department and the management efficiency from the perspective of management.

Conclusion

Two types of indicators RIP and RMP were developed, based on personnel cost, as new indicators for management evaluation of a hospital and each medical department and DPC (DRGs).

The difference between RMP and RIP demonstrates operation profit per one US Dollar of personnel cost (OPP). A turning point in profitability similar to the break-even point (BEP) and break-even ratio (BER) could be also defined by the combination of the RMP and RIP. The merits of the two indicators are not only related to the elucidation of medical efficiency in a hospital, but also the ability to demonstrate such indicators as BEP, BER and OPP on a single graph. These two indicators were applied to 144 hospitals of the National Hospital Organization (NHO) and one acute care hospital. The use of these two indicators was proven to accurately determine the management efficiency and medical activity of not only an entire

hospital, but also in each department and DPC/DRG group. This will be of use for hospital managers in checking the management efficiency of his/her hospital despite the variations that exist among hospitals, departments and divisions.

References

1. Cleverley, W. O., The hospital cost index: a new way to assess relative cost-efficiency. *Healthc. Financ. Manage.* 56 (7)36–42, 2002.
2. Schuhmann, T. M., Hospital financial performance trends to watch. *Healthc. Financ. Manage.* 62 (7)59–66, 2008.
3. Nakagawa, Y., Noguchi, M., Takemura, T., and Yoshihara, H., Change of the management strategy before and after DPC introduction.—Influence on the hospital profit caused by improvement of sickbed turnover ratio. *J Jpn Soc Health Care Manage*. 9 (4)511–518, 2009.
4. Balicki, B., Kelly, W. P., and Miller, H., Establishing benchmarks for ambulatory surgery costs. *Healthc. Financ. Manage.* 49 (9)40–46, 1995.
5. Melony, W., Benchmarking to improve financial performance. *Health Manag. Technol.* 16 (2)10–12, 1995.
6. Diagnosis Related Groups (DRGs) and the Medicare Program: Implications for Medical Technology—A Technical Memorandum. US Congress Office of Technology Assessment, Washington DC, OTA-TM-H-17, 1983.
7. Fushimi, K., Hashimoto, H., Imanaka, Y., Kuwabara, K., Horiguchi, H., Ishikawa, K., and Masuda, S., Functional mapping of hospitals by diagnosis-dominant case-mix analysis. *BMC Health Serv. Res.* 7:50, 2007. (http://www.biomedicentral.com/1472-6963/7/50).
8. Yasunaga, H., Ide, H., Imamura, T., and Ohe, K., Impact of the Japanese diagnosis procedure combination-based payment system on cardiovascular medicine-related costs. *Int. Heart J.* 46 (5)855–866, 2005.
9. Yasunaga, H., Ide, H., Imamura, T., and Ohe, K., Influence of Japan's new diagnosis procedure combination-based payment system on the surgical sector: does it really shorten the hospital stay? *Surg. Today.* 36 (7)577–585, 2006.
10. West, T. D., Balas, E. A., and West, D. A., Contrasting RCC, RVU, and ABC for managed care decisions. *Healthc. Financ. Manage.* 50 (8)54–61, 1996.
11. Canby, J. B. 4th, Applying activity-based costing to healthcare settings. *Healthc. Financ. Manage.* 49 (2)50–2, 54–6, 1995.
12. Tanaka, K., Sato, J., Guo, J., Takada, A., and Yoshihara, H., A simulation model of hospital management based on cost accounting analysis according to disease. *J. Med. Syst.* 28 (6)689–710, 2004.
13. Cooper, R., and Kaplan, R., Activity-based systems: measuring the cost of resource usage. *Account. Horiz.* 6 (3)1–14, 1992.
14. Kaplan, R., Flexible budgeting in an activity-based costing framework. *Account. Horiz.* 8 (2)104–109, 1994.
15. Chan, Y. C. L., Improving hospital cost accounting with activity-based costing. *Health Care Manage. Rev.* 18 (1)71–77, 1993.
16. Player, S., Activity-based analyses lead to better decision making. *Healthc. Financ. Manage.* 52 (8)66–70, 1998.
17. Biorn, E., Hagen, T., Iversen, T., and Magnussen, J., The effect of activity-based financing on hospital efficiency: a panel data analysis of DEA efficiency scores 1992–2000. *Health Care Manage. Sci.* 6:271–283, 2003.
18. Peden, A. L., and Baker, J. J., Allocation physicians' overhead costs to service: an econometric/accounting-activity based-approach. *J. Health Care Finance*. 29:57–75, 2002.
19. Nakagawa, Y., Noguchi, M., Takemura, T., and Yoshihara, H., New accounting system for financial balance based on personnel cost after the introduction of a DPC/DRG system. *J. Med. Syst.* 2009. (http://www.springerlink.com/content/k1141r4312263602/).
20. Nakagawa, Y., Noguchi, M., Takemura, T., and Yoshihara, H., The construction of the medical profit analysis system and verification before and after induction of DPC system. *Jpn J Med Inform*. 28 (2)61–72, 2009.
21. Tanaka, K., Sato, J., Guo, J., Takada, A., and Yoshihara, H., Cost accounting by diagnosis in a Japanese University Hospital. *J. Med. Syst.* 28 (5)437–445, 2004.
22. Mooney, S. E., Russell, M. A., Prairie, B., Savage, C., and Weeks, W. B., Group preanatal care: an analysis of cost. *J. Health Care Finance*. 34 (4)31–41, 2008.
23. Gandjour, A., and Lauterbach, K. W., A method for assessing the cost-effectiveness and the break-even point of clinical practice guidelines. *Int. J. Technol. Assess. Health Care*. 17 (4)503–516, 2001.
24. Gee, P., DRG do over the need for a service-line strategy. *Healthc. Financ. Manage.* 60 (8)52–55, 2006.
25. Nakagawa, Y., Takemura, T., Shirakami, G., and Yoshihara, H., The cost analysis and problems of Day Surgery Unit in the University Hospital-Second Report: study of the performance improvement. *J Jpn Soc Hosp Admin*. 44 (3)263–272, 2007.
26. Schreyogg, J., Stargardt, T., Tiemann, O., and Busse, R., Methods to determine reimbursement rates for diagnosis related groups (DRG)—a comparison of nine European countries. *Health Care Manage. Sci.* 9:215–223, 2006.
27. Bellanger, M. M., and Tardif, L., Accounting and reimbursement schemes for inpatient care in France. *Health Care Manage. Sci.* 9:295–305, 2006.
28. Fattore, G., and Torbica, A., Inpatient reimbursement system in Italy: how do tariffs relate to cost? *Health Care Manage. Sci.* 9:251–258, 2006.
29. Makie, T., Miyazaki, M., Kobayashi, S., Yamanaka, T., Kinukawa, N., Hanada, E., and Nose, Y., A simple method for calculating the financial balance of hospital based on proportional dividing. *J. Med. Syst.* 26 (2)105–112, 2002.