The Financial Risk to Hospitals Inherent in DRG, Per Diem, and Capitation Reimbursement Methodologies

Louis C. Gapenski, Ph.D., University of Florida; Barbara Langland-Orban, Ph.D., University of South Florida

EXECUTIVE SUMMARY

This study uses Monte Carlo simulation to assess the short-term financial risk to hospitals inherent in three reimbursement methodologies. The results are quite consistent across a wide variety of assumptions concerning utilization and costs. The primary conclusions are as follows:

1. DRG and per diem contracts have similar risk.
2. If the health status of the population is correctly assessed, capitation contracts have less short-term risk than DRG or per diem contracts for fixed cost structures above 70 percent.
3. When hospital managers are unable to assess health status correctly, capitation contracts are significantly riskier than DRG or per diem reimbursement methodologies.
4. Small populations increase the risk of capitation contracts relative to DRG and per diem contracts.

Although the simulation analysis assessed only short-term risk, it is clear that capitation contracts have long-term risks that are not inherent in DRG and per diem contracts. The results have significant implications for hospital managers regarding both information needs and managerial responses to managed care plan contracts.

For more information on this article, you may contact Dr. Gapenski at Louis.hrp@mail.health.ufl.edu

Although some payors still reimburse hospitals on charges or discounted charges, other reimbursement methodologies now dominate the payor mix. Two methodologies that are widely used today are diagnosis related group (DRG), in which a fixed amount is paid for each admission based on principal diagnosis, and per diem, in which a fixed amount is paid for each day of hospitalization. However, many managed care plans, particularly health maintenance organizations (HMOs), are moving toward capitated payment systems in which hospitals receive a fixed amount per enrollee (covered life) per month, usually adjusted for age and gender. Currently, nearly one-quarter of HMOs capitate hospitals (Interstudy 1995), and Fitch Investors Service predicts that 70 percent of hospitals' total revenues could come from capitated payment plans as early as 1999 (*Modern Healthcare* 1994). Although not all predictions are realized, there is a widely held view that hospitals face a future of increasing use of capitation contracts.

Previous studies have argued that hospitals are exposed to more financial risk under capitation than under traditional reimbursement methodologies because capitation forces providers to assume all risks regarding both the utilization of services and associated costs (Benz and Nagelhout 1986; Coyne and Simon 1994; Davis 1990). However, these discussions of the risks inherent in alternative reimbursement methodologies have tended to focus on cost uncertainty, while financial risk is a function of profit uncertainty, which depends on uncertainties in both revenues and costs, and, more important, how these uncertainties interact.

As enrollment in managed care plans increases, and more managed care plans seek capitation contracts with hospitals, hospital managers must identify the implications of capitation on their organization's financial risk. This article uses Monte Carlo simulation to compare and contrast the financial risks to hospitals inherent in three reimbursement methodologies: DRG, per diem, and capitation. Monte Carlo simulation can provide insights into the impact of capitation on hospitals' financial integrity, as demonstrated by its use in assessing primary care physicians' financial risk (Gapenski and Langland-Orban 1996). Additionally, Monte Carlo simulation can identify those factors that contribute to risk differentials among the three reimbursement methodologies, as well as those factors that are critical to hospital executives in managing the risks inherent in capitation.

FINANCIAL RISK

In general, financial risk stems from uncertainties inherent in expected cash flows. If all cash flows associated with a particular reimbursement contract were known with certainty, there would be no financial risk. However, hospitals face uncertainty in either revenues or costs, or both, in all reimbursement methodologies, so financial risk is present.

One of the most commonly used measures of financial risk is standard deviation of net income, which measures the variability of profitability about its mean, or expected, value (Brealy and Myers 1988; Brigham 1995; Gitman 1994). The greater the standard deviation, the greater the probability of realizing a net income well below that expected, and hence the greater the financial risk of the contract.

In addition to standard deviation of net income, hospital managers are very concerned about the prospects of incurring a loss on any reimbursement contract, so we also report the probability that a contract will result in negative net income. The probability of incurring a loss is highly correlated with the net income's standard deviation when expected net incomes are similar, but the probability of a loss is easier to interpret and more useful when net incomes differ.

The analysis begins with a base case that examines the financial risk inherent in three reimbursement methodologies under a very restrictive set of assumptions. For the base case, we assume that the general health status and resulting utilization distribution of a fixed population is known, as are attending physicians' practice patterns. Furthermore, we assume that the cost structure associated with inpatient utilization is known. Finally, we assume that utilization and treatment costs are independent of reimbursement methodology.

Following the base case analysis, many of the assumptions are relaxed to provide a more realistic view of reimbursement risk. It is important to recognize, however, that the simulation analysis measures the riskiness inherent in a single contract period, say, one year. Thus, the analysis focuses on short-term risk. Clearly, the long-term risk of reimbursement contracts could differ from their short-term risk. We discuss some qualitative considerations regarding long-term risk after we perform the quantitative analysis.

AN OVERVIEW OF MONTE CARLO SIMULATION

Monte Carlo simulation, so named because it grew out of work on the mathematics of casino gambling, describes uncertainty in terms of continuous probability distributions. Although it has been used in engineering applications since the 1940s, its first use in financial analysis was described in 1964 (Hertz 1964). More recently, the use of Monte Carlo simulation was advocated to help assess the riskiness inherent in health care capital investment decisions (Gapenski 1990).

The first step in a Monte Carlo simulation is to create a model that requires numerical inputs, such as one that estimates a hospital's net income under different reimbursement contracts. The relatively certain numerical inputs are estimated as single, or point, values in the model, while continuous probability distributions are used to specify the uncertain variables. For example, average length of stay might be represented by a normal distribution with a mean (expected value) of 5.6 days and a standard deviation of 0.3 days.

Once the model has been created, the simulation software automatically executes the following steps:

1. The Monte Carlo program chooses a single random value for each un-

certain variable on the basis of its specified probability distribution. For example, the program might choose 5.1 days for average length of stay.

2. The value selected for each uncertain variable, along with the point values for the relatively certain variables, are combined in the model to estimate net income.
3. A single completion of Steps 1 and 2 constitutes one iteration, or "run," in the Monte Carlo simulation.
4. The Monte Carlo software repeats the above steps many times, say, 10,000. A different net income results from each iteration, because the values selected for the uncertain variables are chosen by random draws on the basis of their specified distributions.

The end result is a net income probability distribution with 10,000 individual "scenarios," and hence one that encompasses virtually all of the likely financial outcomes. Based on the resulting profitability distribution, the simulation software automatically calculates summary statistical data such as expected net income and standard deviation of net income.

THE REIMBURSEMENT RISK ANALYSIS MODEL

The reimbursement risk analysis model is contained in Table 1, along with the assumed base case input values and uncertainty assumptions. The model calculates net income for a one-year hospital contract under three reimbursement alternatives—DRG, per diem, and capitation—assuming a served population of 100,000. The base case data were drawn primarily from a major university-based hospital. Thus, the data reflect a composite hospital with academic health center characteristics. However, the robustness of results gives some confidence regarding the applicability of the findings across a wide range of hospitals.

Note that the number of admissions and average length of stay are assumed to be independent of the type of reimbursement, so the patient population is assumed to be managed in the same way regardless of reimbursement methodology. Also, note that the base case values, which are reported to the nearest dollar, were chosen so that total revenues equal $48,725,000 (except for rounding differences) regardless of the reimbursement methodology.

Costs are also assumed to be independent of reimbursement methodology, so total annual costs are the same in all three cases. Since both revenues and costs are independent of contract type, the resulting net income, $1,475,000, is the same for all contracts. The base case data were chosen so that, assuming a world of certainty, the hospital would realize a 3 percent operating margin, which is consistent with recent hospital operating results (Cleverley 1995).

Table 1 illustrates a cost structure composed of 50 percent fixed costs, which are independent of volume, and 50 percent variable costs, which are directly related to volume. Since operating leverage (the mix of fixed

Table 1
Base Case Model and Uncertainty Assumptions

Input Values	DRG	Per Diem	Capitation
Population served	100,000	100,000	100,000
Number of admissions	6,250	6,250	6,250
Case mix index	1.35	1.35	1.35
Average length of stay (days)	5.6	5.6	5.6
Average DRG payment	$7,796		
Per diem payment		$1,392	
Capitation rate PMPY			$487
Average cost per patient day	$1,350	$1,350	$1,350
Fixed cost ratio	0.50	0.50	0.50
Model Output (Thousands of Dollars)			
Revenues	$48,725	$48,725	$48,725
Fixed costs	23,625	23,625	23,625
Total variable costs	23,625	23,625	23,625
Total costs	$47,250	$47,250	$47,250
Net income	$ 1,475	$ 1,475	$ 1,475

Uncertainty Assumptions

Input Variable	*Standard Deviation*	99.7% of the Distribution Falls Between: *Minimum*	*Maximum*	*Correlation w/Case Mix*
Number of admissions	100	5,950	6,550	N/A
Average case mix	0.02	1.29	1.41	N/A
Average length of stay (days)	0.1	5.3	5.9	0.5
Average cost per inpatient day*	$21	$937	$1,063	0.5

Note: The standard deviations presented here (except for number of admissions) apply to the mean values for each variable, not to the variable itself. For example, the values for length of stay range from one to 137 days, with a variable standard deviation of 5.4 days. The stated standard deviation of 0.1 days applies to the average length of stay.

*Standard deviation applies to variable cost portion only. Also, standard deviation is scaled down proportionally as fixed cost ratio increases from 0.5 to 1.0.

and variable costs) affects financial risk, the analysis was conducted at six different fixed-to-total-cost ratios: 50, 60, 70, 80, 90, and 100 percent. These values were chosen because salaries and capital costs make up about 50 percent of total hospital costs, while general service costs comprise the remainder (Cleverley 1995). For a one-year contract life, salaries and capital costs are essentially fixed. To the extent that some portion of the general services costs also are fixed, 50 and 100 percent fixed costs represent boundary values, with most hospitals having fixed cost ratios that fall within this range.

It is important to recognize that the base case is merely the starting point of the analysis, and no conclusions can be drawn regarding the relative riskiness of the contract types until all of the relaxed assumption analyses have been considered.

RISK ASSUMPTIONS

To make the analysis more manageable, some of the input variables are assumed to be known with certainty, at least initially. The population served (100,000), average DRG payment ($7,796), per diem rate ($1,392), and the PMPY capitation payment ($487) are assumed to be fixed and known with certainty at the beginning of the one-year contract period. Also, within each operating leverage scenario, annual fixed costs are assumed to be certain for the contract period. In reality, these variables would have small amounts of uncertainty, but their uncertainties would be dominated by the uncertainties inherent in the remaining variables. Note that although the average DRG payment is assumed to be known with certainty for a case mix of 1.35, the realized average DRG payment is uncertain because the realized case mix is uncertain.

The uncertainties assumed in the analysis are shown in the bottom section of Table 1. Normal distributions were chosen to proxy input variable risk because, under the central limit theorem (law of large numbers), the distribution of the mean of a large sample is approximately normal regardless of the distribution of the sample itself (Kmenta 1986). The standard deviations chosen reflect the authors' best estimates for the actual, but unknown, uncertainties based on data developed from a commercial Blue Cross/Blue Shield hospital contract. Although there is no assurance that the uncertainties used in the simulation apply identically to every hospital, it is likely that the uncertainties specified are reflective of the uncertainties faced by many hospitals.

Note that the standard deviations contained in Table 1 (except for number of admissions) apply to the mean, or expected value, of each variable, and not to the variable itself. Note also that higher average case mix implies sicker patients and greater use of resources. Therefore, we assumed that the distributions for average length of stay and average cost per inpatient day are positively correlated (correlation coefficient of 0.5) with average case mix. Correlation among these input variables is not perfect, because length of stay and cost depend also on severity within a given diagnosis.

BASE CASE RESULTS

The results of all simulations are summarized in Table 2, which gives the standard deviation of net income and probability of a loss for each reimbursement methodology at each level of fixed costs on the basis of a 10,000 iteration simulation.

Except for a slight reduction of risk at a fixed cost ratio of 0.60, the base case riskiness inherent in DRG and per diem reimbursement increases as the fixed cost ratio increases. Both DRG and per diem payments are highly correlated with utilization, so uncertain utilization results in highly correlated changes in revenues and costs. However, as the fixed cost ratio increases, the ability of decreased utilization—and hence decreased revenues—to be offset by decreased costs declines, and financial risk increases. Conversely, the financial risk associated with capitation contracts decreases continuously as the fixed cost ratio increases, because the fixed revenue stream becomes more closely matched to the fixed cost structure. In fact, at 100 percent fixed costs, under capitation there is zero uncertainty in both revenues and costs, so financial risk is completely eliminated.

The riskiness inherent in DRG and per diem contracts is roughly comparable regardless of the fixed cost structure. The probability of a loss is somewhat higher under per diem reimbursement than under DRG reimbursement, but revenues under both methodologies are highly correlated with utilization and case mix, so their financial risks are similar. Also, at lower levels of fixed costs (50 and 60 percent), capitation is riskier than DRG and per diem methodologies, but at higher levels of fixed costs (70 percent and above), capitation is less risky than either DRG or per diem reimbursement in the base case.

RELAXING THE ASSUMPTIONS

The base case simulation contains many unrealistic assumptions about the hospital's patient mix and its ability to forecast utilization and costs. To extend the results to encompass more realistic conditions, the simulations were rerun with many of the base case assumptions relaxed.

EXPECTED CHANGES IN CASE MIX

Since hospitals can vary in case mix, the simulation was rerun assuming a case mix of 1.0. Here, we assumed that both the hospital and the payor recognize that the covered population requires less intense hospitalization than in the base case. Utilization was left unchanged at 6,250 admissions, the cost per inpatient day was reduced to $1,000, the average DRG payment was reduced to $5,157, and the capitation rate was lowered to $332 PMPY. The new values were chosen to again force a profit margin of 3.0 percent for all three contract types.

Although the financial risk as measured by standard deviation of net income is reduced, as evidenced by the probability of a loss portion of the table, the results with a case mix of 1.0 are comparable to the earlier results with a case mix of 1.35. Thus, changes in case mix do not affect the base case conclusions. As further evidence, if financial risk is measured by the coefficient of variation of net income, financial risk is relatively unaffected by case mix.[1] For example, at 50 percent fixed costs the base case coefficient of variation of net income under DRG reimbursement is 0.46, while at a case mix of 1.0 it is 0.45. As the average case mix declines, both net income and standard deviation of net income decline more or less proportionally.

INCREASED UTILIZATION AND COST UNCERTAINTY

The base case assumed relatively small uncertainties in average utilization and costs. In many situations, information regarding hospital inpatient utilization for a defined population may be unavailable or incomplete, with average utilization and cost data, but

Table 2
Simulation Results (Thousands of Dollars)

	Fixed Cost Ratio					
	0.50	0.60	0.70	0.80	0.90	1.0
Base Case						
Standard Deviation of Net Income:						
DRG	$ 676	$588	$640	$766	$ 917	$1,064
Per Diem	735	659	721	862	1,025	1,172
Capitation	1,171	870	599	374	174	0
Probability of a Loss:						
DRG	1.6%	0.6%	1.1%	2.6%	5.4%	8.3%
Per Diem	2.3	1.2	1.9	4.6	7.6	10.4
Capitation	11.1	4.8	0.5	0.0	0.0	0.0
Case Mix = 1.0, Expected by Hospital						
Standard Deviation of Net Income:						
DRG	$439	$403	$465	$582	$713	$824
Per Diem	526	467	500	597	714	826
Capitation	860	649	456	285	135	0
Probability of a Loss:						
DRG	1.4%	0.6%	1.9%	4.2%	8.3%	11.4%
Per Diem	3.4	1.6	2.4	4.9	8.3	11.6
Capitation	13.5	7.0	1.6	0.0	0.0	0.0
Increased Utilization and Cost Uncertainty						
Standard Deviation of Net Income:						
DRG	$1,892	$1,673	$1,710	$1,923	$2,189	$2,448
Per Diem	1,950	1,719	1,756	1,966	2,227	2,502
Capitation	2,311	1,645	1,097	657	294	0
Probability of a Loss:						
DRG	22.8%	19.3%	19.6%	22.5%	25.0%	27.1%
Per Diem	23.1	19.8	20.1	22.8	25.6	28.2
Capitation	26.2	19.1	9.5	1.4	0.0	0.0
Fixed Cost Uncertainty						
Standard Deviation of Net Income:						
DRG	$851	$841	$953	$1,094	$1,284	$1,446
Per Diem	882	893	1,015	1,167	1,362	1,541
Capitation	1,250	1,055	924	877	918	999
Probability of a Loss:						
DRG	4.1%	4.1%	6.2%	8.7%	12.8%	15.3%
Per Diem	5.0	4.9	7.5	9.9	14.0	17.0
Capitation	12.9	8.3	5.7	4.7	5.4	7.0
Reduced Patient Population						
Standard Deviation of Net Income:						
DRG	$205	$175	$190	$228	$273	$320
Per Diem	218	199	217	256	305	351
Capitation	351	259	182	112	52	0
Probability of a Loss:						
DRG	25.0%	21.9%	22.9%	26.8%	30.5%	32.7%
Per Diem	27.1	24.7	25.9	28.8	32.3	34.5
Capitation	35.2	29.8	21.8	10.3	0.2	0.9
Case Mix = 1.4, Unexpected by Hospital						
Standard Deviation of Net Income:						
DRG	$714	$599	$639	$770	$925	$1,080
Per Diem	765	671	731	867	1,021	1,181
Capitation	1,223	919	635	393	180	0

continued

Table 2
Continued

	Fixed Cost Ratio					
	0.50	**0.60**	**0.70**	**0.80**	**0.90**	**1.0**
Probability of a Loss:						
DRG	65.9%	68.9%	67.2%	64.7%	62.4%	60.5%
Per Diem	65.8	67.2	65.8	63.3	61.2	59.9
Capitation	96.5	99.3	100.0	100.0	100.0	100.0
Population Size Uncertainty						
Standard Deviation of Net Income:						
DRG	$1,427	$1,606	$1,839	$2,106	$2,374	$2,664
Per Diem	1,451	1,635	1,862	2,136	2,408	2,703
Capitation	1,713	1,721	1,837	2,000	2,209	2,436
Probability of a Loss:						
DRG	15.4%	18.3%	21.4%	23.9%	26.9%	29.5%
Per Diem	15.6	18.7	21.5	24.8	27.3	29.5
Capitation	19.6	20.3	20.8	23.1	25.1	27.3
Equal Mix of All Three Contract Types						
Standard Deviation of Net Income	$676	$427	$328	$401	$557	$711
Probability of a Loss	1.7%	0.1%	0.0%	0.0%	0.5%	1.7%

no information regarding variability. Furthermore, it may be very difficult for a hospital to estimate cost structures associated with treatment protocols relevant to the covered population. To examine the impact of increased utilization and cost uncertainty, the simulation was rerun with triple the variability in utilization and variable costs. The standard deviation for the number of admissions was increased from 100 to 300, and the standard deviation of variable costs was increased from $21 to $63. Increasing the uncertainty in utilization and costs significantly increases the financial risk of the contracts, as demonstrated by comparing the increased utilization and cost uncertainty values with the base case values. Still, the overall conclusions remain roughly the same.

FIXED COST UNCERTAINTY

We have assumed that all cost uncertainty resides in variable costs. Now, we introduce uncertainty in fixed costs. The base case simulation was rerun with the addition of fixed cost uncertainty, specified by a standard deviation of $500,000 for a fixed cost ratio of 50 percent (fixed costs = $23,625,000), and rising to a standard deviation of $1,000,000 for 100 percent fixed costs (fixed costs = $47,250,000). The uncertainty in fixed costs depends on uncertainties in wage rates, personnel requirements, interest and rental payments, and the like, which are not directly related to utilization, so fixed cost uncertainty was assumed to be independent of other uncertainties.

With fixed cost uncertainty added, financial risk under capitation does not decrease across the full spectrum of fixed cost ratios; rather, it increases at high fixed cost ratios. Still, under the assumed conditions, capitation remains the least risky reimbursement methodology at fixed cost ratios of 70 percent and above.

REDUCED PATIENT POPULATION

The base case simulation assumes 100,000 covered lives, an amount sufficiently large enough to benefit from the law of large numbers. What if the covered population were only 10,000? Now, the expected number of admissions would be only 625, and the standard deviations would be approximately three times as large. (The square root of 6,250 is approximately 79, while the square root of 625 is 25, for a roughly threefold difference in standard deviation.[2])

Again, the general pattern of results parallels that obtained in the other simulations. However, this situation is significantly riskier than the base case, because expected net income is only 10 percent of the base case value while the standard deviations are roughly 30 percent of the base case values. The increased risk caused by a smaller patient population is borne out by the probabilities of losses. In terms of coefficient of variation, the coefficient of variation of net income under DRG reimbursement at 50 percent fixed costs is 1.52, compared with 0.46 for the base case. Smaller patient populations lead to greater risk, because smaller patient populations benefit less from the law of large numbers, which leads to greater utilization and cost uncertainties.

UNEXPECTED CHANGES IN CASE MIX

A prior scenario examined the effect of a case mix change (from 1.35 to 1.0) assuming hospital managers anticipated the change. In other words, the health status of the population served was assumed to be different, but known. Now, we assume that the true expected case mix of the served population is 1.40, but that hospital managers erroneously believe it to be 1.35. Furthermore, the true expected average length of stay is 5.81 days rather than the 5.6 expected by managers. In this situation, the hospital managers are not able to assess correctly the health status of the population served, so in addition to the riskiness caused by the randomness of the input values, added riskiness results from information deficiencies.

This situation, unlike all the others, produces drastically different results. Failure to assess correctly the health status of the population served drives the true expected net income down under all three reimbursement methodologies (when the population is sicker than anticipated). However, the fact that DRG reimbursement is tied to case mix and per diem reimbursement is tied to length of stay means that these methodologies result in an increase in revenues that partially offsets the increase in costs. Thus, there is roughly a 35 to 40 percent probability that the hospital will still make a profit on these contracts, depending on the fixed cost ratio. However, under capitation, there is almost total certainty that a loss will result.

POPULATION SIZE UNCERTAINTY

In this extension, we address the issue of population size uncertainty. Here, we assumed base case values, but specified population as a normal distribution with an expected value of 100,000 and standard deviation of 5,000. Thus, in addition to the uncertainty of utilization within a fixed population, there is added uncertainty of population size.

Population size uncertainty increases the risk under all contract types, and also reduces the risk differentials between capitation and DRG and per diem reimbursement at higher levels of fixed costs. In essence, the capitation revenue stream is no longer known with certainty (fixed), so revenues no longer match costs as costs become fixed. However, the base case results—which indicate that capitation is the least risky reimbursement methodology at higher fixed cost levels—still hold, although the difference is much less dramatic.

PORTFOLIO EFFECTS

Thus far, we have examined the risk inherent in each reimbursement methodology in isolation. In reality, hospitals have many different payors using many different payment methodologies, and hence have a portfolio of reimbursement contracts. What is most relevant to hospital managers is aggregate risk, as opposed to the riskiness of a single contract. To gain some preliminary insights into aggregate risk, the base case was rerun assuming that the hospital had an equal mix of all three contract types with total revenues at the base case level.

Note that creating a portfolio of reimbursement contracts reduces risk below the base case level at several fixed cost structures, because the profitability distributions of the three contracts are not perfectly positively correlated. At 50 percent fixed costs, DRG reimbursement is slightly less risky than the equal-weighted mix, while at 80, 90, and 100 percent fixed costs, capitation is less risky than the equal-weighted mix. However, at 60 and 70 percent fixed costs, the equal-weighted mix is less risky than a single contract under any of the three methods. Further, the equal-mix portfolio is less risky than a single reimbursement methodology in 14 of the 18 individual fixed cost ratio/reimbursement type scenarios.[3]

MODEL CONCLUSIONS

When all simulations are considered, the overall results regarding short-term risk are relatively consistent:

1. The financial risks embodied in DRG and per diem contracts are similar, so managers, all else the same, should be relatively indifferent between the two reimbursement methodologies regardless of the hospital's fixed cost structure.
2. Assuming that the health status of the population is correctly assessed, capitation contracts are riskier than DRG and per diem contracts for hospitals with less than 60 percent fixed costs. For hospitals with fixed cost structures in the range of 60–70 percent, there is little difference in financial risk among the three reimbursement methodologies. For fixed cost structures above 70 percent, capitation contracts are less risky than DRG and per diem contracts.

3. For all three reimbursement methodologies, financial risk increases with the amount of uncertainty in utilization and costs, including uncertainty in fixed costs and the uncertainty caused by smaller served populations or larger but fluctuating populations. Such uncertainty is reduced, and hence financial risk is reduced, as the contract population increases and size uncertainty is reduced.
4. When hospital managers incorrectly assess the health status of the population served, and the population is sicker than assumed, capitation is significantly riskier than DRG and per diem reimbursement methodologies.
5. Population size uncertainty has a greater negative impact on risk under capitation than under DRG and per diem methodologies.

ADDITIONAL CONSIDERATIONS

Although many initial assumptions were relaxed in the analysis, the conclusions above still depend on several key assumptions. First and foremost, we assumed that hospital managers cannot influence utilization or costs, so these are purely random variables. Clearly, each reimbursement methodology sends prescriptive signals to hospital managers regarding operating decisions. However, the ability of managers to "game" a particular reimbursement methodology has a more or less one-time impact on the contract's profitability but does not change its inherent risk. For example, a hospital may reduce costs in response to a capitation contract or may increase selected utilization under a DRG contract. These actions would have a positive impact on the short-term profitability of the contract, but responses by payors over the long run will mitigate any resulting excess profits, leaving the contract with the risk assessed by the simulation.

Also, the simulation assumed that hospital costs per day were constant across patient stay. To the extent that costs per day decrease across patient stay while reimbursement is fixed per day, reducing length of stay will decrease reimbursement more under per diem contracts than the corresponding decrease in costs.

Of more concern are the long-term risks inherent in the contracts. Most DRG and per diem contracts are awarded by payors to multiple hospitals within a given service area. Thus, the variation of admissions from year to year on a given contract resulting from patients using alternative hospitals is not substantial. Conversely, capitation contracts are typically awarded to a single hospital in a given service area. If a hospital loses a capitation contract, the resulting decrease in utilization can significantly reduce profitability. Additionally, the negotiating power of payors using single-hospital capitation contracts is obviously greater than payors using multiple-hospital contracts with other reimbursement methodologies. This increased negotiating power could lead to situations in which payors offer capitation contracts to hospitals that have lower expected profitability than other reimbursement types. Although lower net income does not increase financial risk as measured by standard deviation of net income, it does increase the probability of a loss as well as the coefficient of variation, which most observers would consider as additional financial risk.

The qualitative factors discussed here clearly raise the anxiety level of hospital managers regarding capitation contracts. Additionally, the long-term risk associated with DRG and per diem contracts is relatively benign, while the long-term risk associated with capitation can lead to catastrophic consequences.

IMPLICATIONS FOR MANAGERS

The analysis has several implications for hospital managers. First, subjective statements about the risk inherent in reimbursement methodologies do not always tell the entire story. The impact of reimbursement methodology on a hospital's financial risk depends on a multitude of factors. Indeed, as shown in this analysis, under certain conditions the short-term financial risk inherent in capitation contracts can be less than under DRG or per diem contracts.

The three most important reimbursement contract risk factors are (1) the hospital's operating leverage (fixed cost ratio), (2) the ability of its managers to assess correctly the health status of the served population, and (3) the size of the population served. According to the American Hospital Association, the average community hospital has a cost structure of about 75 percent fixed costs and 25 percent variable costs (American Hospital Association 1992–93). Hospitals' high reliance on fixed costs can make the short-term financial risk somewhat less in capitation contracts than in DRG and per diem contracts, assuming that the population served is large and its health status is known.

However, when the health status of the population is not known, capitation contracts are riskier than DRG and per diem contracts, because there is no opportunity to recoup any of the increased costs associated with a sicker-than-expected population. It is important for hospital managers to understand the health status of the population served under all reimbursement methodologies, but it becomes critical when reimbursed by capitation. If hospitals do not have the information systems required to develop and merge clinical, actuarial, and financial data, they will be in an especially precarious bargaining position under capitation.

Even when the population's health status is known with some confidence, capitation contract negotiations can be complex and stressful, and each hospital's managers must establish their own standards of acceptance for expected profitability and risk. Furthermore, small populations can increase the risk in capitation contracts, and the long-term risk associated with losing a capitated contract can be substantial.

Although there are many insights to be gained from the Monte Carlo simulation, it does not answer all questions regarding reimbursement methodology and financial risk. More work must be done to understand the impact of portfolio effects and multiyear negotiation on contract risk. Additionally, it would be useful to consider explicitly the impact of differential daily costs.

Finally, hospital managers must deal with the changing incentives created by capitation. Instead of focusing on maintaining utilization, managers must modify behavior to think in terms of creating both cost and utilization efficiencies. This, in turn, requires the establishment of a continuum of cost-effective services that emphasizes prevention, early diagnosis and treatment, and case management. Hospital managers, who historically have focused on inpatient care, must now manage the entire spectrum of care to maximize the benefits and minimize the risks under capitation (Cerne 1994). Until hospital managers have the necessary information to traverse the paradigm shift successfully, the move to capitation will be fraught with concerns.

Acknowledgment

The authors would like to thank William R. Treloar of Shands Teaching Hospital for his assistance in developing data used in this article as well as two anonymous referees who encouraged us to rethink several critical issues.

Notes

1. When expected net incomes vary widely, the coefficient of variation, which is defined as the standard deviation divided by the expected net income, is a better measure of financial risk than standard deviation. The coefficient of variation standardizes the risk measure, and hence removes the impact of scale differences.
2. The standard deviation of a population mean approaches the standard deviation of the observations divided by the square root of the number of observations (Kmenta 1986).
3. This brief examination of portfolio effects raises several interesting questions, including (1) what is the optimal mix of reimbursement types and (2) how much risk does each reimbursement type contribute to the aggregate risk of a hospital. However, these questions are left to follow-on research.

References

American Hospital Association. 1992–1993. *Hospital Statistics.*

Benz, P. D., and R. V. Nagelhout. 1986. "Evaluating Pricing for Health Service Contracts." *Topics in Health Care Financing* Winter: 59–77.

Brealy, R. A., and S. C. Myers. 1988. *Principles of Corporate Finance.* New York: McGraw-Hill, 127–31.

Brigham, E. F. 1995. *Fundamentals of Financial Management.* Fort Worth: Dryden, 155–57.

Cerne, F. 1994. "Shaping Up for Capitation." *Hospitals and Health Networks* August 5: 28–30.

Cleverley, W. O. 1995. *The 1995 Almanac of Hospital Financial & Operating Indicators.* Columbus, Ohio: The Center for Healthcare Industry Performance Studies.

Coyne, J. S., and S. D. Simon. 1994. "Is Your Organization Ready to Share Financial Risk with HMOs?" *Healthcare Financial Management* August: 30–34.

Davis, G. S. 1990. "Introduction: Managed Health Care Primer." *The Insider's Guide to Managed Care: A Legal and Operational Roadmap.* Washington, D.C.: National Health Lawyers Association, 25–28.

Gapenski, L. C. 1990. "Using Monte Carlo Simulation to Make Better Capital Investment Decisions." *Hospital & Health Services Administration* Summer: 207–19.

Gapenski, L. C., and B. Langland-Orban. 1996. "Impact of Capitation Contracts on Financial Risk: A Monte Carlo Simulation." *Health Services Management Research* August: 183–91.
Gitman, L. J. 1994. *Principles of Managerial Finance.* New York: HarperCollins, 220–22.
Hertz, D. B. 1964. "Risk Analysis in Capital Investments." *Harvard Business Review* January–February: 95–106.
InterStudy Publications. 1995. *The Competitive Edge* March 28.
Kmenta, J. 1986. *Elements of Econometrics.* New York: Macmillan, 107–08.
Modern Healthcare. 1994. "Switch to Capitation Means Long-Term Financial Risk for Hospitals, Fitch Reports." July 18: 14.

PRACTITIONER RESPONSE

Gary Strack, CEO, Orlando Regional Health Care System, Orlando, Florida

This article focuses on a very relevant topic to healthcare executives. The ability to objectively assess and quantify the risks inherent in various reimbursement methodologies is critically important to the financial performance and long-term health of providers.

While other authors have talked in generalities about risks in different reimbursement contracts, Drs. Gapenski and Orban have attempted to quantify the risks using Monte Carlo simulation techniques. The drawbacks to their approach are all of the assumptions they had to make to run their model.

I disagree with several of the assumptions, especially that costs are independent of reimbursement methodology. In addition, the model assumes that hospital managers cannot influence utilization or costs and that hospital costs per day are constant across patient stay. However, the authors had to start somewhere. They recognize that many of the assumptions need to be relaxed and, in fact, explored some alternative assumptions in the paper.

However, I believe in Demming's statement "that when there is no theory, there are no questions. And when there are no questions there is no learning, and when there is no learning there is no growth, and when there is no growth there is no change." We obviously need to become more sophisticated in how we measure and manage risk, and this paper represents a solid start in this direction.

In my opinion, the best overall framework for understanding provider risk management is presented by Mulligan, Shapiro, and Walrod in the 1995 edition of the *McKinsey Report on Health Care* entitled "Managing Risk in Health Care." These authors appropriately state "risk must be treated as a core business activity with shared responsibility at the senior level, rather than as a technical skill to be handled by specialists." The authors then build their paper and model around an understanding of the four principal types of risk:

Event risk: The risk associated with the fluctuation in the demand for healthcare in the covered consumer population.

Pricing risk: The risk inherent in setting prices given the unpredictable expense effects of event risk.

Clinical operating risk: The risk of expense fluctuation based on provider behavior in delivering care and variability in patient response to the same treatment regimens.

Financial risk: The basic business risks faced by all companies (e.g., capital, partner insolvency, cash flow, liability, and regulatory risks).

The question I would ask my CFO is this: "After reading the McKinsey and Gapenski and Orban articles, how would your model look, what assumptions would you use, and why?" The issue is progress, not perfection.