Patient volume and facility risk

MMA §623e: ESRD Bundled Payment Demonstration

Problem statement

The use of resources varies substantially from patient to patient. This variation may, for analytic purposes, be attributed to three sources:

- Variation in a patient's need for and response to treatment.
- Variation in treatment patterns, i.e., the way in which a provider responds to a patient's need.
- Random or unexplained variation, i.e., the variation that remains after taking into account (as best one can) patient needs and provider practices.

The primary goal of case mix adjustment is to 'control for' variation attributable to patients' need for treatment. After adjustment for case mix differences, a certain amount of variation will remain. The extent to which this variation reflects treatment patterns or is simply random or unexplained variation can seldom be determined with a substantial degree of certainty. This 'residual' or 'unexplained' variation generally is ignored in the design of payment systems for two related reasons:

- First, it is assumed that the 'random' variation in gains and losses on individual patients will tend to offset one another over the entire population of patients treated by a provider.
- Second, it is assumed that any systematic or consistent differences in resource use (however measured) after adjustment for case mix can be attributed to differences in practice patterns or provider 'efficiency'.

These assumptions are valid only when a provider treats a 'large' number of patients in a statistical sense. As the number of patients treated by a provider increases, random differences will tend to offset one another and the variation in gains and losses across providers attributable to chance (i.e., good luck or bad luck) will be small. However, as the number of patients treated declines, the variation attributable to chance will increase.

Random variation and patient volume

The level of (non-systematic) risk under which a facility operates is largely a function of the number of patients the facility treats during a month. Statistically, as the population of patients treated rises, the month-to-month variation in *average* resource use across all of the facility's patients will decline.

When payment amounts are based on the resource use of the average patient (after adjustment for case mix) the month-to-month variation in the average gain or loss across all of the facility's patients will similarly decline as its census rises and as the residual or unexplained variation declines.

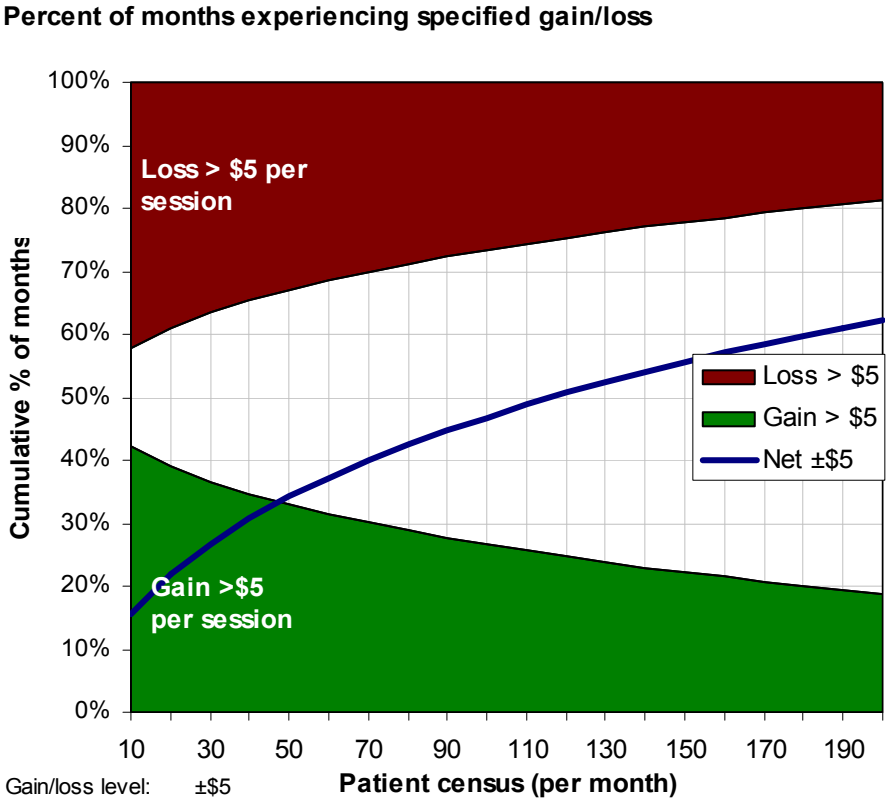
The question of how much risk a facility will operate under as census varies can be answered in two ways. The first approach focuses on the likelihood that a facility will experience a gain or loss of a specified magnitude in any given month. That is: how

frequently will a facility experience a gain or loss that exceeds a specified dollar amount?

The likelihood of a specified gain or loss

Figure 1A depicts the relationship between patient volume and the risk of experiencing a gain or loss that exceeds $5 per session for a bundle of services with an average value of $100 and a standard deviation of $80 across all patients. These values are approximately equal to the value of the bundle (1C) that was used in the case mix analyses discussed in the paper in tab 4. Figure 1A, therefore, can be interpreted as depicting the situation that facilities would face if they were paid under a system that included no case mix adjustment.

Figure 1A: Likelihood of a $5 per session gain / loss during a month— Base case (no case mix adjustment)



In Figure 1A, the dark area at the bottom of the chart represents the percent of months in which the gain exceeds the specified $5 per session threshold. The white area (in which the gridlines are visible) represents the percent of months in which net income is between a $5 gain and a $5 loss per session. The dark area at the top of the figure represents the percent of months in which the loss exceeds the specified $5 per session threshold. These three groups are stacked on top of one another. The solid line displays the percentage of months in which net income ranges from a loss of $5 to a gain of $5.

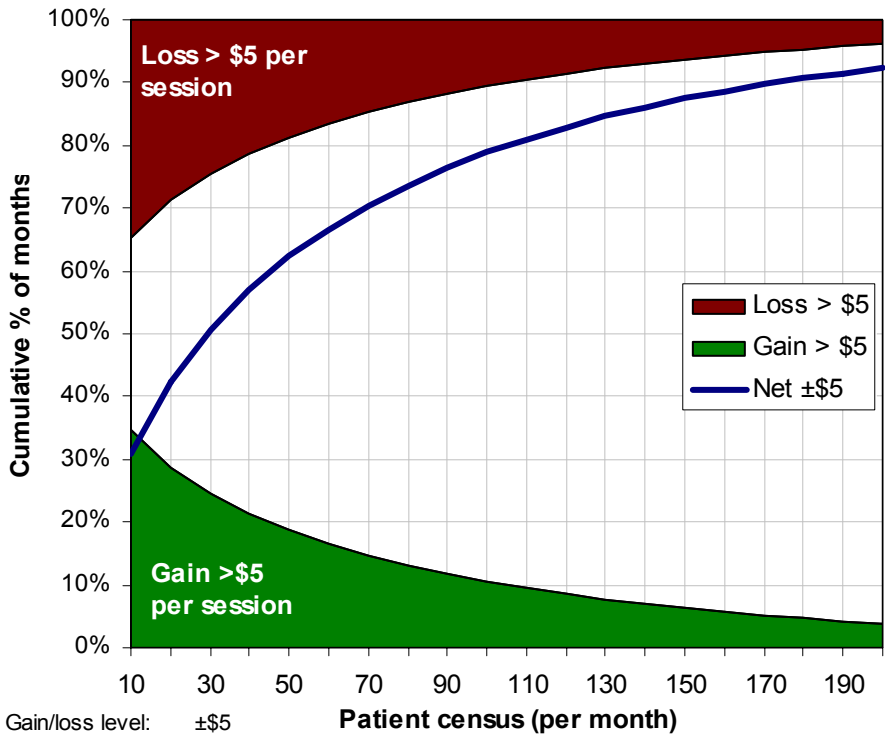
A facility with a census of 30 patients would experience a gain of $5 per session or more in about 37 percent of months. It would experience a loss of $5 or more in another 37 percent of months. And in just under 27 percent of months it would achieve a net income ranging between a loss $5 and a gain of $5.

At a census of 50, a facility would experience a gain or loss within the range of ±$5 per session in 34 percent of patient months. It would experience gains of more than $5 in 33 percent of months, and losses of more than $5 in 33 percent of months.

At a census of 90, a facility would experience a gain or loss within the range of ±$5 per session in about 45 percent of months. It would experience gains of more than $5 in about 28 percent of months, and losses of more than $5 in about 28 percent of months.

Figure 1B depicts the situation facing facilities if case mix adjustment can account for about half of the patient-to-patient variation in resource use. Statistically, case mix adjustment has the effect of reducing variation in per session resource use. Figure 1B depicts the probability of a facility experiencing a gain or loss of ±$5 per session for a bundle of services with an average value of $100 and a standard deviation of $40 (half the level of variation assumed in Figure 1A).

Figure 1B: Likelihood of a $5 per session gain / loss during a month—Moderately effective case mix adjustment



Under these conditions, a facility with a census of 30 patients would achieve a net income ranging from a gain of $5 per session to a loss of $5 per session in 51 percent of months. In a quarter of months it would experience gains of more than $5 per session, and in another quarter of months it would incur losses of more than $5 per session.

At a census of 50, a facility would experience a comparable gain or loss in 62 percent of months. In about 19 percent of months it would experience gains of more than $5 per session, and in another 19 percent of months it would incur losses of more than $5 per session.

At a census of 90, a facility would experience a gain or loss in the range of ±$5 per session in 76 percent of months. In about 12 percent of months it would experience gains of more than $5 per session, and in another 12 percent of months it would incur losses of more than $5 per session.

The size of likely gains or losses at specified risk levels

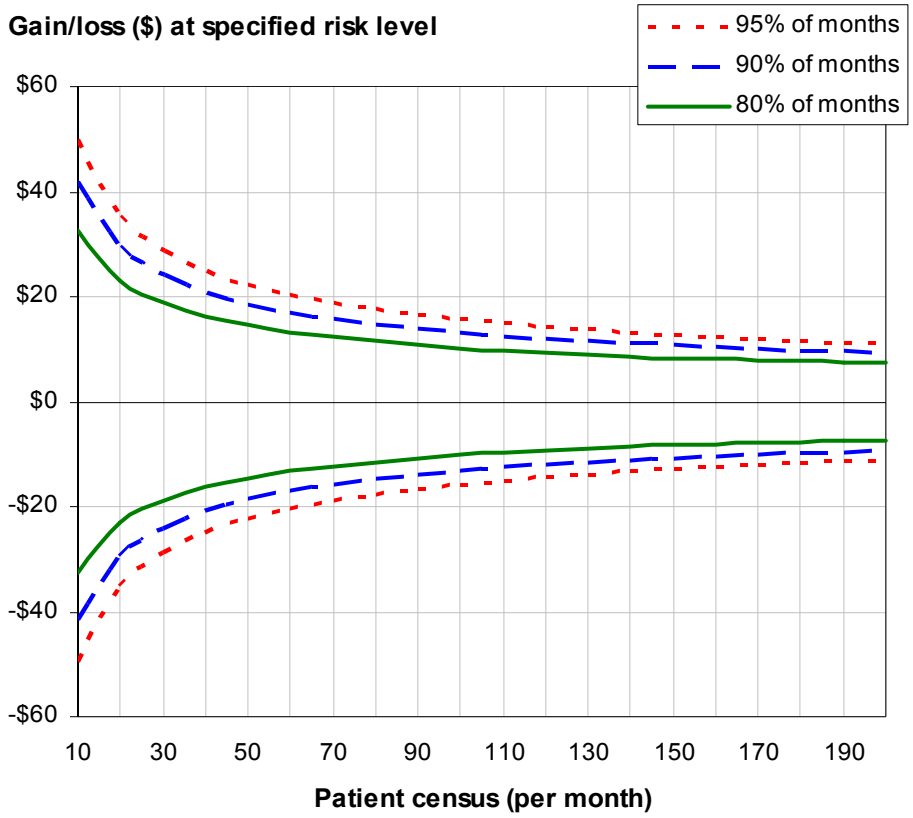
A somewhat different way of looking at the problem focuses on the range of gains and losses that a facility will experience month-to-month at a specified level of likelihood. That is: what is the range of gains and losses that a facility will experience in a specified percentage of months?

Figure 2A (on the next page) depicts the answer to this question for the situation used in Figure 1A. It shows the relationship between patient volume and the range of gains or losses within which a facility can expect to operate in 80 percent, or 90 percent, or 95 percent of months for a bundle of services with an average value of $100 and a standard deviation of $80 across all patients.

A facility with a census of 30 patients is likely to achieve a net income ranging between a gain of about $18.72 to a loss of about $18.72 per session in 80 percent of months. In 90 percent of months net income is likely to range between a gain of $24.02 and a loss of $24.02 per session. In 95 percent of months net income is likely to range between a gain of $28.63 and a loss of $28.63 per session. (These results can also be expressed in terms of the percentage of months in which gains and losses will *exceed* the specified limits. In 20 percent of months, a facility with a census of 30 will experience gains or losses larger than ±$18.72 per session. In 10 percent of months, it will experience gains or losses larger than ±$24.02 per session. And in 5 percent of months it will experience gains or losses larger than ±$28.63 per session.)

The range of likely gains and losses narrows as facility size increases. A facility with a census of 50 patients is likely to achieve a net income ranging between a gain of $14.50 to a loss of just under $14.50 per session in 80 percent of months. In 90 percent of months net income is likely to range between a gain of $18.61 and a loss of $18.61 per session. In five percent of months net income is likely to range between a gain of $22.17 and a loss of $22.17 per session.

Figure 2A: Dollar magnitude of likely gain / loss during a month— Base case (no case mix adjustment)



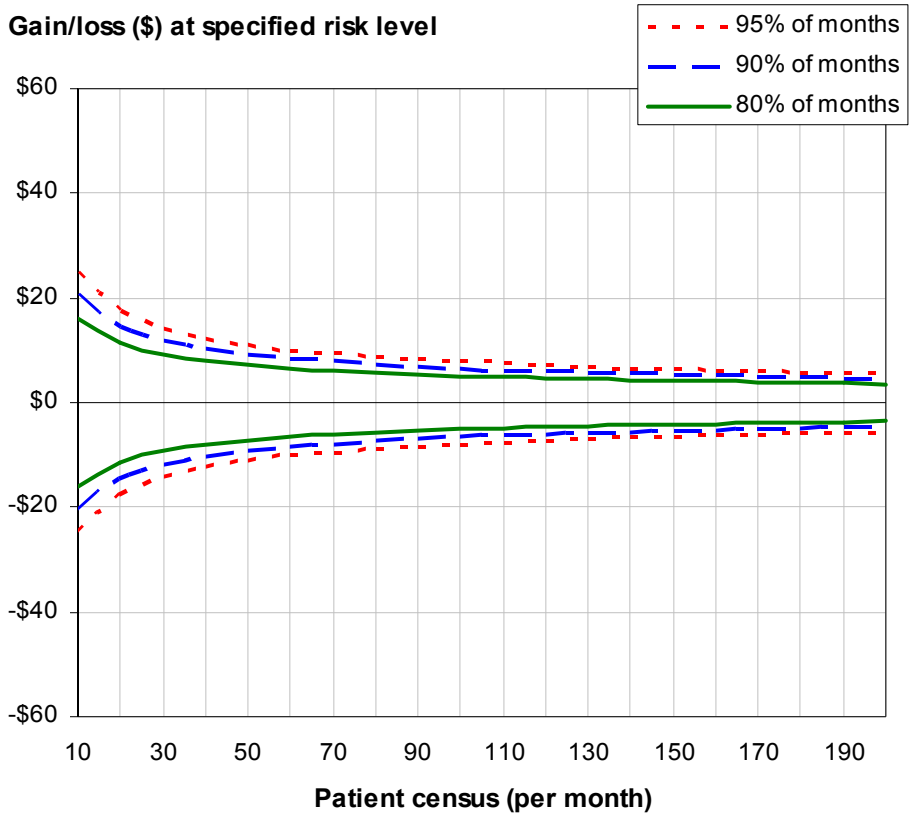
A facility with a census of 90 patients is likely to achieve a net income ranging between a gain of $10.81 to a loss of $10.81 in 80 percent of months. In 10 percent of months net income is likely to range from a gain of $13.87 to a loss of $13.87 per session. In five percent of months net income is likely to range from a gain $16.53 to a loss of $16.53 per session.

Figure 2B depicts the situation facing facilities if case mix adjustment can account for about half of the patient-to-patient variation in resource use. This is the same situation depicted in Figure 1B, i.e., a bundle of services with an average value of $100 and a standard deviation of $40 (half the level of variation assumed in figure 2A).

In general, under these assumptions, the size of the gain or loss that a facility is likely to experience is half those shown in Figure 2A.

A facility with a census of 30 patients is likely to achieve a net income ranging between a gain of $9.36 per session to a loss of $9.36 per session in 80 percent of months. In 10 percent of months net income is likely to range between a gain of $12.01 and a loss of $12.01 per session. In five percent of months net income is likely to range between a gain of nearly $14.31 and a loss of nearly $14.31 per session.

**Figure 2B: Dollar magnitude of likely gain / loss during a month—
Moderately effective case mix adjustment**



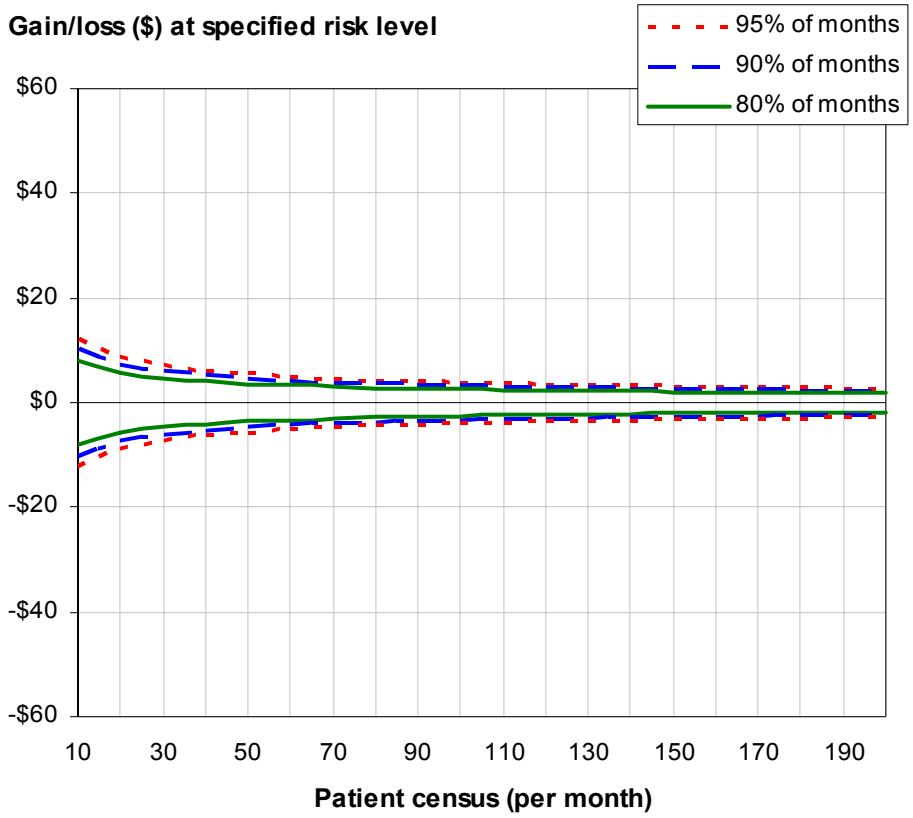
A facility with a census of 50 patients is likely to achieve a net income ranging between a gain of $7.25 to a loss of $7.25 in 80 percent of months. In 10 percent of months net income is likely to range between a gain of $9.30 and a loss of $9.30 per session. In five percent of months net income is likely to range between a gain of $11.09 and a loss of $11.09 per session.

A facility with a census of 90 patients is likely to achieve a net income ranging between a gain of $5.40 to a loss of $5.40 in 80 percent of months. In 10 percent of months net income is likely to range between a gain of $6.94 and a loss of $6.94 per session. In five percent of months net income is likely to range between a gain of $8.26 and a loss of just over $8.26 per session.

Figure 2C depicts the situation facing facilities if case mix adjustment can account for about three quarters of the patient-to-patient variation in resource use. This is the same situation depicted in Figures 1B and 2B, i.e., a bundle of services with an average value of $100 and a standard deviation of $20 (half the level of variation assumed in figure 2B and one quarter the level of variation assumed in figure 2A).

In general, under these assumptions, the size of the gain or loss that a facility is likely to experience is half those shown in Figure 2B and one quarter the size of those shown in figure 2A.

Figure 2C: Dollar magnitude of likely gain / loss during a month— Highly predictive case mix adjustment



A facility with a census of 30 patients is likely to achieve a net income ranging between a gain of $4.68 to a loss of $4.68 in 80 percent of months. In 80 percent of months, the net income of a facility with a census of 50 will range between a loss of$3.62 and a gain of $3.62 per session. The facility with a census of 90 will have net income that ranges between a loss of $2.70 and a gain of $2.70 per session in 80 percent of months.

Monthly vs. annual results

The analysis and discussion up to this point has focused on financial results for a single month. Figures 1A and 1B depict the likelihood that a facility with the specified patient census will experience a gain or loss of the specified magnitude during a single month when financial results are averaged over all the patients it treats. Figures 2A and 2B depict the range of the gains and losses that a facility is likely to experience at specified levels of risk in a single month.

Month-to-month gains or losses may not be as important as the gain or loss that a facility is likely to experience over the course of a year. Month-to-month gains and losses will cancel each other out to some degree. Assuming that gains and losses are independent across months, the likelihood of an annual gain or loss is substantially smaller than the likelihood of a monthly gain or loss, particularly for smaller facilities. Aggregating results over an entire year has the same effect as increasing the census

of the facility by a factor of 12. That is, for a single month a facility with a census of 30 has financial results that reflect the average experience over 30 patient-months. Over the course of a year, the facility's financial results reflect the average experience of 360 patient months.

Figure 2D: Dollar magnitude of likely gain/loss during a year—Moderately effective case mix adjustment

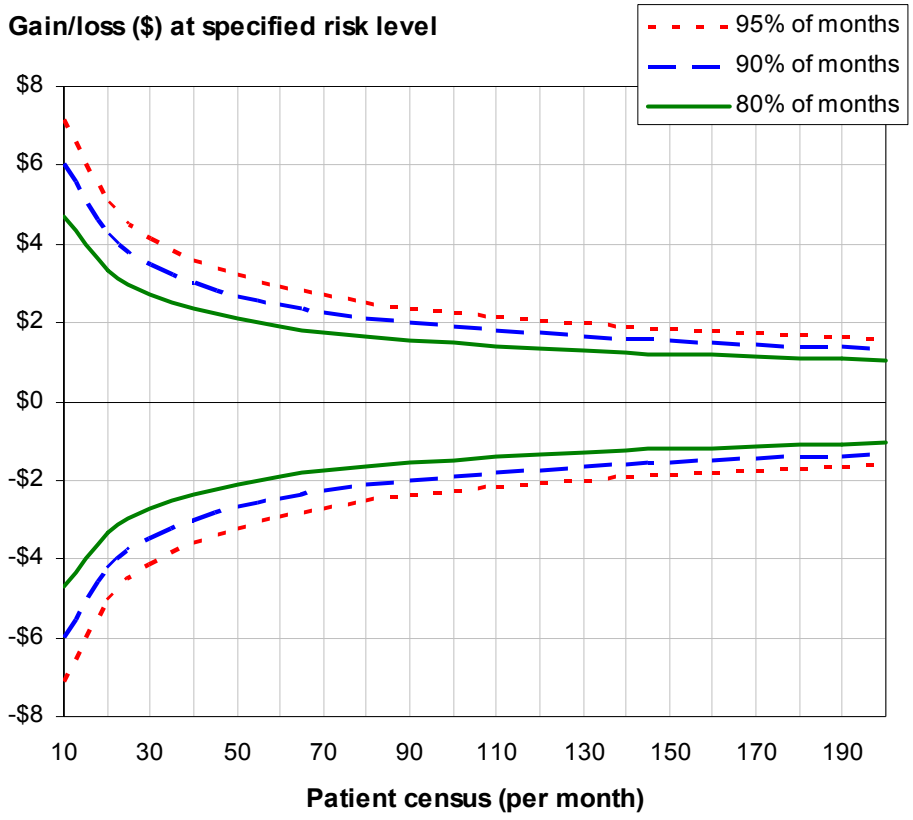


Figure 2D depicts the 'annualized' analysis of the situation facing facilities if case mix adjustment can account for about half of the patient-to-patient variation in resource use. This is the same situation depicted in Figure 1B, i.e., a bundle of services with an average value of $100 and a standard deviation of $40 (half the level of variation assumed in figure 2A).

The twelve-fold increase in the number of patient months whose results are being averaged results in a substantial narrowing of the range of likely gains and losses.

A facility with a monthly census of 30 patients (an annual 'census' of 360 patient months) is likely to achieve a net income ranging between a gain of $2.70 per session to a loss of $2.70 per session in 4 out of five years. In one out of ten years net income is likely to range between a gain of $3.47 per session and a loss of $3.47 per session. In one out of every 20 years, net income is likely to range between a gain of $4.13 and a loss of $4.13 per session.

As in the monthly analysis, as facility census rises, the range of likely gains and losses narrows. At a monthly census of 90 (an annual 'census' of 1080 patient months) net income will range between a gain of $1.56 and a loss of $1.56 per session in one year out of five. In one year out of 20, net income is likely to range between a gain of $2.39 and a loss of $2.39.

To extrapolate from a monthly analysis to an annual analysis of likely gains and losses, the assumption that months are independent is critical. It is not, however, entirely unjustified. The purpose of case mix adjustment is to control for systematic differences among patients that account for variation in resource use. To the extent that an effective method of measuring case mix is available, the month-to-month gains and losses for a single patient should be more-or-less independent of one another. Having said that, however, it is acknowledged that any practical case mix adjustment is unlikely to fully achieve this result. The question is how close any actual case mix adjustment comes to achieving it.

Implications

The relationship between patient volume and variability of resource use has two principal implications for the design of a bundled payment system.

First, the relatively low census of dialysis facilities reduces the extent to which the 'law of large numbers' can be relied upon to even our gains and losses across patients. The variability of month-to-month gains and losses increases rapidly as the facility census falls below 50.

Second, the small size of many (or most) facilities places greater demands on case mix adjustment. A case mix adjustment may need to account for a substantial amount of the patient-to-patient variation in resource use to avoid creating significant risk for individual facilities.

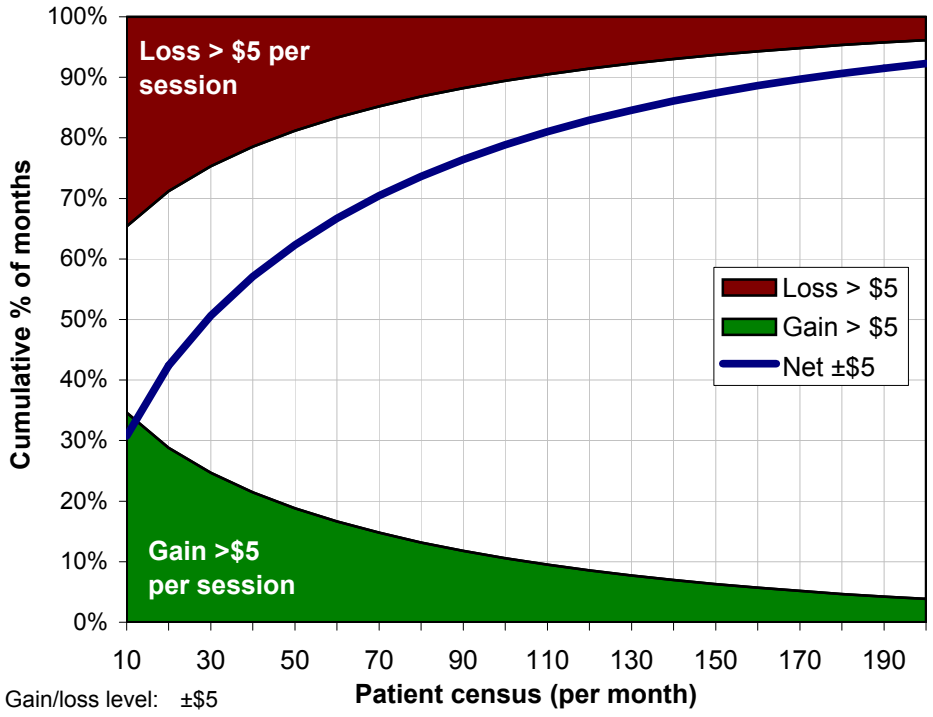
Patient volume and facility risk

Likelihood of specified gain/loss for facility month

Figure/Table 1B: Moderately effective case mix adjustment

Size	Mean	Std. Dev.	Gain/loss: % Below	±5% % Within	% Above
10	$100	12.6	34.6%	30.7%	34.6%
20	$100	8.9	28.8%	42.4%	28.8%
30	$100	7.3	24.7%	50.6%	24.7%
40	$100	6.3	21.5%	57.1%	21.5%
50	$100	5.7	18.8%	62.3%	18.8%
60	$100	5.2	16.6%	66.7%	16.6%
70	$100	4.8	14.8%	70.4%	14.8%
80	$100	4.5	13.2%	73.6%	13.2%
90	$100	4.2	11.8%	76.4%	11.8%
100	$100	4.0	10.6%	78.9%	10.6%
110	$100	3.8	9.5%	81.0%	9.5%
120	$100	3.7	8.5%	82.9%	8.5%
130	$100	3.5	7.7%	84.6%	7.7%
140	$100	3.4	7.0%	86.1%	7.0%
150	$100	3.3	6.3%	87.4%	6.3%
160	$100	3.2	5.7%	88.6%	5.7%
170	$100	3.1	5.2%	89.7%	5.2%
180	$100	3.0	4.7%	90.6%	4.7%
190	$100	2.9	4.2%	91.5%	4.2%
200	$100	2.8	3.9%	92.3%	3.9%
Population	$100	40.0		±$5	

Percent of months experiencing specified gain/loss



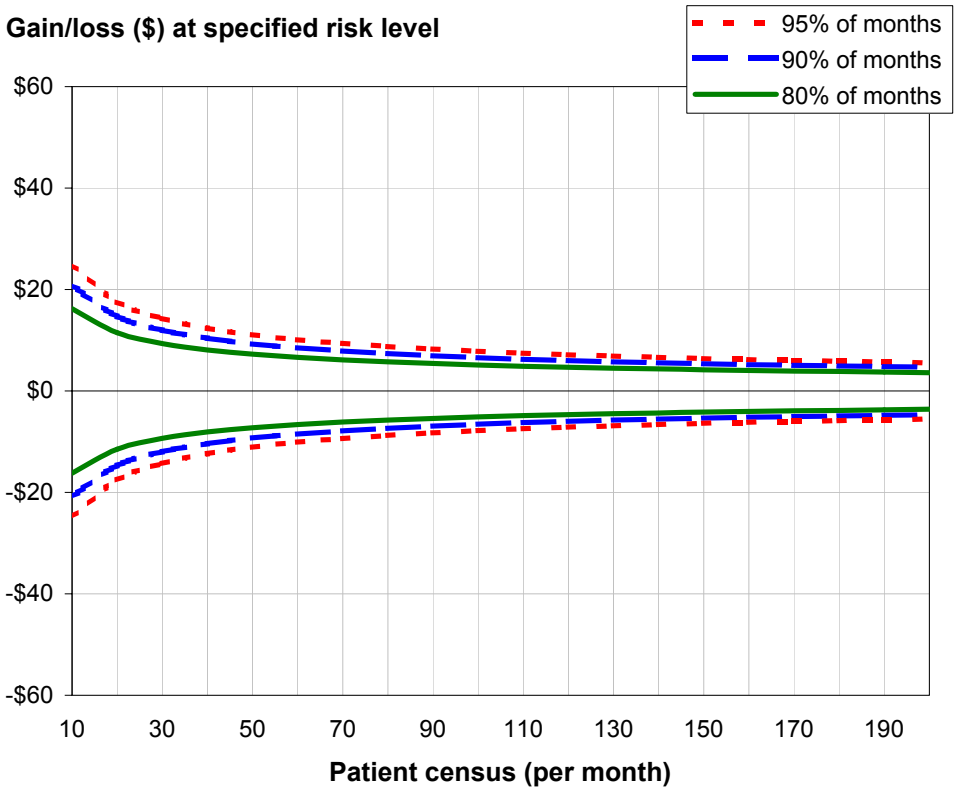
Gain/loss level: ±$5

Patient volume and facility risk

Dollar range of gain/loss for facility month at specified risk levels

Figure/Table 2B: Moderately effective case mix adjustment

Size	Mean	Std. Dev.	Tolerance range at risk level of: 95.0%	90.0%	80.0%
10	$100	12.6	±$24.79	±$20.81	±$16.21
20	$100	8.9	±$17.53	±$14.71	±$11.46
30	$100	7.3	±$14.31	±$12.01	±$9.36
40	$100	6.3	±$12.40	±$10.40	±$8.11
50	$100	5.7	±$11.09	±$9.30	±$7.25
60	$100	5.2	±$10.12	±$8.49	±$6.62
70	$100	4.8	±$9.37	±$7.86	±$6.13
80	$100	4.5	±$8.77	±$7.36	±$5.73
90	$100	4.2	±$8.26	±$6.94	±$5.40
100	$100	4.0	±$7.84	±$6.58	±$5.13
110	$100	3.8	±$7.48	±$6.27	±$4.89
120	$100	3.7	±$7.16	±$6.01	±$4.68
130	$100	3.5	±$6.88	±$5.77	±$4.50
140	$100	3.4	±$6.63	±$5.56	±$4.33
150	$100	3.3	±$6.40	±$5.37	±$4.19
160	$100	3.2	±$6.20	±$5.20	±$4.05
170	$100	3.1	±$6.01	±$5.05	±$3.93
180	$100	3.0	±$5.84	±$4.90	±$3.82
190	$100	2.9	±$5.69	±$4.77	±$3.72
200	$100	2.8	±$5.54	±$4.65	±$3.62
Population	$100	40.0			



Patient volume and facility risk

Dollar range of gain/loss for facility year at specified risk levels

Figure/Table 2D: Moderately effective case mix adjustment

Size	Mean	Std. Dev.	Tolerance range at risk level of: 95.0%	90.0%	80.0%
120	$100	3.7	±$7.16	±$6.01	±$4.68
240	$100	2.6	±$5.06	±$4.25	±$3.31
360	$100	2.1	±$4.13	±$3.47	±$2.70
480	$100	1.8	±$3.58	±$3.00	±$2.34
600	$100	1.6	±$3.20	±$2.69	±$2.09
720	$100	1.5	±$2.92	±$2.45	±$1.91
840	$100	1.4	±$2.71	±$2.27	±$1.77
960	$100	1.3	±$2.53	±$2.12	±$1.65
1080	$100	1.2	±$2.39	±$2.00	±$1.56
1200	$100	1.2	±$2.26	±$1.90	±$1.48
1320	$100	1.1	±$2.16	±$1.81	±$1.41
1440	$100	1.1	±$2.07	±$1.73	±$1.35
1560	$100	1.0	±$1.98	±$1.67	±$1.30
1680	$100	1.0	±$1.91	±$1.61	±$1.25
1800	$100	0.9	±$1.85	±$1.55	±$1.21
1920	$100	0.9	±$1.79	±$1.50	±$1.17
2040	$100	0.9	±$1.74	±$1.46	±$1.13
2160	$100	0.9	±$1.69	±$1.42	±$1.10
2280	$100	0.8	±$1.64	±$1.38	±$1.07
2400	$100	0.8	±$1.60	±$1.34	±$1.05
Population	$100	40.0