Editor's Note: This online data supplement contains supplemental material that was not included with the published article by Francois de Brantes and colleagues, "Should Health Care Come With A Warranty?" *Health Affairs* 28, no. 4 (2009): w678–w687 (published online 16 June 2009; 10.1377/hlthaff.28.4.w678)

Technical Appendix 1: *The warranty allowance model – division between flat fee and proportional rate*

Because ECRs are severity-adjusted based on patient and other factors, there are wide variations in the total episode costs per patient. Let's assume that the inpatient portion of the AMI ECR can vary from as low as $16,670 to as high as $71,180. Additionally, let's assume that the average cost of potentially avoidable complications in this example is $15,000. Halving that number to create the warranty allowance pool yields an average of $7,500 per episode. Given the size of this number relative to the lower end of the severity-adjusted ECRs, if equally distributed on all cases, this amount could potentially create a significant incentive for cherry-picking less severe patients. Conversely, while PROMETHEUS recognizes that there is a higher likelihood of having PACs when patients are more severe, thus necessitating a higher allowance, allocating the allowance on a purely proportional basis could lead providers to upcode the severity of all patients to maximize the allowance on each patient. As a result, and in order to mitigate these two potential effects, PROMETHEUS decided to split the allocation of the per ECR warranty using a flat and proportional amount as illustrated in the following figure. While it's unclear that this split will effectively avoid cherry-picking or upcoding, we analyzed the relative size of the per-ECR warranty when the flat fee portion is increased from 0% to 100%.

Modeling the flat and proportional allocations:

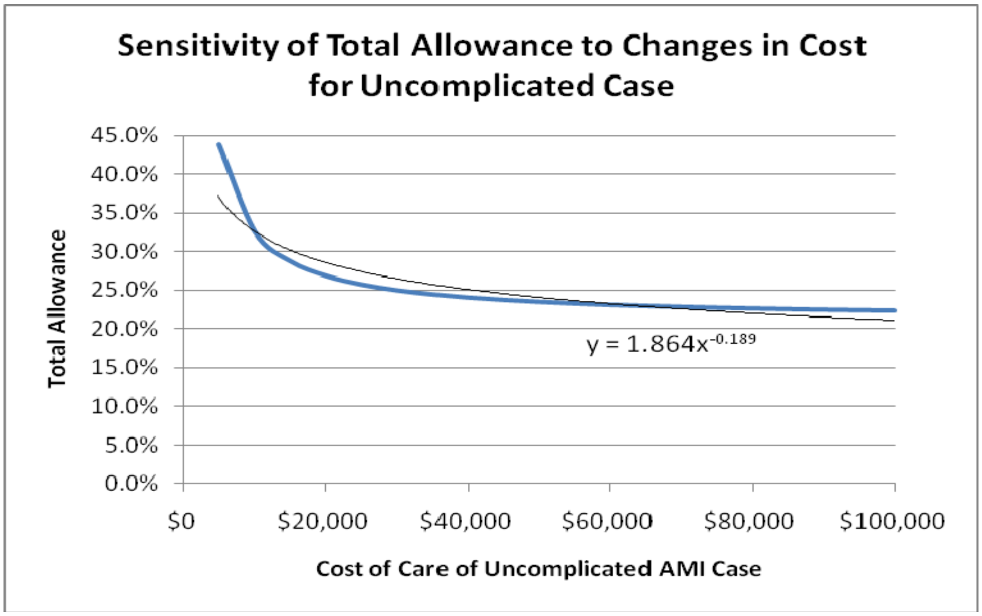
This example illustrates that the total warranty allocation as a percentage of the severity-adjusted ECR decreases as that number increases. Tables 1 and 2 and Figure 1 summarize the results of varying the flat fee portion of the allowance, and modeling its impact as a percent of the base severity-adjusted ECR. The modeling confirms that the slope of the curve becomes increasingly negative as the flat fee portion of the allowance increases, which confirms that the providers would have a strong incentive to select less severe patients when the flat fee allowance is higher than the proportional one. As such, a lower flat fee would have the counter effect and potentially lead to claims upcoding to maximize the severity indicators of every patient. Whether 25% is an appropriate cut-point for the flat fee and will balance out the two potential provider behaviors (patient selection and upcoding) deserves further investigation as the PROMETHEUS model is piloted. Certainly, having 75% of the allowance based on a proportional rate will create a greater allowance for more severe patients, thus compensating the hospital for the greater likelihood that more severe patients might trigger more avoidable complications.

Table 1. Sensitivity of Total Allowance to Changes in Cost for Uncomplicated Case

Cost of Care for Uncomplicated AMI Case	Total Allowance
$5,000	43.8%
$10,000	32.5%
$15,000	28.8%
$20,000	26.9%
$25,000	25.8%
$30,000	25.0%
$35,000	24.5%
$40,000	24.1%
$45,000	23.8%
$50,000	23.5%
$55,000	23.3%
$60,000	23.1%
$65,000	23.0%
$70,000	22.9%
$75,000	22.8%
$80,000	22.7%
$85,000	22.6%
$90,000	22.5%
$95,000	22.4%
$100,000	22.4%

Source: Data analysis and simulation by PROMETHEUS Payment Inc.

Figure 1



Source: Data analysis and simulation by PROMETHEUS Payment In

Table 2. Sensitivity of Total Allowance to Changes in Payment for Uncomplicated Case and Flat Fee Allocation

Cost of Care of Uncomplicated AMI Case	Flat Fee Portion															
	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%
$5,000	36.30%	40.00%	43.80%	47.50%	51.30%	55.00%	58.80%	62.50%	66.30%	70.00%	73.80%	77.50%	81.30%	85.00%	88.80%	92.50%
$10,000	29.50%	31.00%	32.50%	34.00%	35.50%	37.00%	38.50%	40.00%	41.50%	43.00%	44.50%	46.00%	47.50%	49.00%	50.50%	52.00%
$15,000	27.30%	28.00%	28.80%	29.50%	30.30%	31.00%	31.80%	32.50%	33.30%	34.00%	34.80%	35.50%	36.30%	37.00%	37.80%	38.50%
$20,000	26.10%	26.50%	26.90%	27.30%	27.60%	28.00%	28.40%	28.80%	29.10%	29.50%	29.90%	30.30%	30.60%	31.00%	31.40%	31.80%
$25,000	25.50%	25.60%	25.80%	25.90%	26.10%	26.20%	26.40%	26.50%	26.70%	26.80%	27.00%	27.10%	27.30%	27.40%	27.60%	27.70%
$30,000	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%
$35,000	24.70%	24.60%	24.50%	24.40%	24.30%	24.10%	24.00%	23.90%	23.80%	23.70%	23.60%	23.50%	23.40%	23.30%	23.20%	23.10%
$40,000	24.40%	24.30%	24.10%	23.90%	23.70%	23.50%	23.30%	23.10%	22.90%	22.80%	22.60%	22.40%	22.20%	22.00%	21.80%	21.60%
$45,000	24.30%	24.00%	23.80%	23.50%	23.30%	23.00%	22.80%	22.50%	22.30%	22.00%	21.80%	21.50%	21.30%	21.00%	20.80%	20.50%
$50,000	24.10%	23.80%	23.50%	23.20%	22.90%	22.60%	22.30%	22.00%	21.70%	21.40%	21.10%	20.80%	20.50%	20.20%	19.90%	19.60%
$55,000	24.00%	23.60%	23.30%	23.00%	22.60%	22.30%	21.90%	21.60%	21.30%	20.90%	20.60%	20.20%	19.90%	19.50%	19.20%	18.90%
$60,000	23.90%	23.50%	23.10%	22.80%	22.40%	22.00%	21.60%	21.30%	20.90%	20.50%	20.10%	19.80%	19.40%	19.00%	18.60%	18.30%
$65,000	23.80%	23.40%	23.00%	22.60%	22.20%	21.80%	21.40%	21.00%	20.60%	20.20%	19.80%	19.30%	18.90%	18.50%	18.10%	17.70%
$70,000	23.70%	23.30%	22.90%	22.40%	22.00%	21.60%	21.10%	20.70%	20.30%	19.90%	19.40%	19.00%	18.60%	18.10%	17.70%	17.30%
$75,000	23.70%	23.20%	22.80%	22.30%	21.90%	21.40%	21.00%	20.50%	20.10%	19.60%	19.20%	18.70%	18.30%	17.80%	17.40%	16.90%
$80,000	23.60%	23.10%	22.70%	22.20%	21.70%	21.30%	20.80%	20.30%	19.80%	19.40%	18.90%	18.40%	18.00%	17.50%	17.00%	16.60%
$85,000	23.50%	23.10%	22.60%	22.10%	21.60%	21.10%	20.60%	20.10%	19.70%	19.20%	18.70%	18.20%	17.70%	17.20%	16.80%	16.30%
$90,000	23.50%	23.00%	22.50%	22.00%	21.50%	21.00%	20.50%	20.00%	19.50%	19.00%	18.50%	18.00%	17.50%	17.00%	16.50%	16.00%
$95,000	23.50%	22.90%	22.40%	21.90%	21.40%	20.90%	20.40%	19.90%	19.40%	18.80%	18.30%	17.80%	17.30%	16.80%	16.30%	15.80%
$100,000	23.40%	22.90%	22.40%	21.90%	21.30%	20.80%	20.30%	19.80%	19.20%	18.70%	18.20%	17.70%	17.10%	16.60%	16.10%	15.60%

Source: Data analysis and simulation by PROMETHEUS Payment Inc.

Technical Appendix 2: Simulating Warranties in an ECR System

This reviews the use of episode payment to create an implied health care warranty under which providers have an incentive to reduce the rate of avoidable complications. To illustrate the effects of this incentive, we simulated the overall operation of the new payment model and measured the financial impact on providers. The results of the simulation are included in the main body of this paper. In this appendix, we review the technical and practical components of the simulation.

For the simulation, we first built a static model with all the relevant inputs and outputs. As described in detail below, these factors include:

- Individual patient’s propensity to complications (risk index)
- Payment to the provider under the ECR system
- The provider’s probability of complications
- Cost of basic care
- Cost of treating complications when they occur

We then replaced key variables with probability distributions, so that the actual values changed with each iteration. The model simulates a provider system (hospital and physicians) with a covered population that has the overall characteristics described in Table 1. The provider manages 100 AMI episodes within a given time period. Those episodes have a risk profile that follows a normal distribution, truncated at $7,457 minimum and $106,661 maximum, with a mean of $40,712 (same as Table 1) and a standard deviation of $24,618. The shape of this distribution approximates the actual distribution of AMI episode costs in the commercial data used for the analysis.

The baseline model assumes that all providers start with equal probability of treating high-risk patients. However, depending on random factors (i.e., luck), the provider may get more or fewer of these high-risk patients than expected.

The model also assumes that the provider in the simulation perfectly meets expected efficiency. That is, when the model says the ECR for an AMI case with certain risk factors and without complications is $45,000, then the provider spends exactly $45,000 in resources to treat the patient (before any added costs due to complications). In reality, some providers are more efficient than others, and this efficiency will affect their profitability in an episode of care payment environment. However, this assumption is made to focus the analysis on the effects of variations of case mix and complication rate on total margin, not intrinsic provider efficiency.

The model further assumes that the provider has a base complication rate of 50% (similar to the average 48% complication rate observed in Table 1; we later vary the complication rate to test its financial impact). And it assumes that the probability of a potentially avoidable complication is positively correlated with patient severity factors. In other words, a patient with a high severity-adjusted base ECR is more likely to have a potentially avoidable complication.

Finally, and crucially, the model assumes that the provider incurs additional costs when a PAC occurs. These additional costs for an avoidable complication vary for each case, according to the probability distribution derived for PACs. It is a log-normal distribution, truncated at $185 minimum and $210,665 maximum, with a mean of $33,341 and a standard deviation of $47,622. (Log-normal distributions are useful for modeling variables that can be considered the multiplicative mathematical product of many small independent factors. As above, the specific log-normal distribution used for the simulation closely follows the actual observed data for complication costs.) In other words, the PAC cost distribution is defined so that most complications are relatively inexpensive, but there is a long "tail" that includes rare but very expensive complications.

Given these assumptions, the following will be true for any AMI case treated by the provider.

- The provider's costs will be the ECR (by assumption) + Complication Cost. In cases where no complication occurs, the complication cost is $0.
- The provider's revenue will be: ECR + 10% margin + PAC Allowance
- The profit for any single case will therefore be:
  - 10%*ECR + PAC Allowance - Complication Cost
- Profit margin is: Revenue (summed over all cases) ÷ Costs (summed over all cases) – 1.

In the simulation, the provider's total profit margin is affected by several factors. First, there is the actual illness severity of the provider's population. Over the long term, the typical provider's AMI patient population will follow the average risk profile. However, in the short run, the provider may have more or fewer high-risk patients, depending on chance. This is the "probability risk" discussed in the main text of the paper.

Another factor affecting profitability is how well the provider avoids complications. Initially, the model assumes a provider whose technical skills and processes suggest a 50% expected complication rate. But here again, chance may dictate that a provider has more or fewer complications in a given period.

The final influence on financial outcomes is how expensive the provider’s complications are. Since the new payment model’s PAC allowance is based on the average cost of complications, providers prone to more expensive complications may have trouble showing a profit, even if their complication rate is lower than average.

We ran 500 iterations of the model using a Monte Carlo simulation to determine the provider’s probability of different outcomes. The ECR payment system design means that the model was expected to show that providers with higher complication rates would be less profitable. But the model results can provide insight into the patterns and influences that emerge when all the variables interact with each other.

The main text of this paper discusses and interprets the outputs of the model, which are illustrated in Figures 1 through 3.