9-2015

Game Theory and the Surgeon

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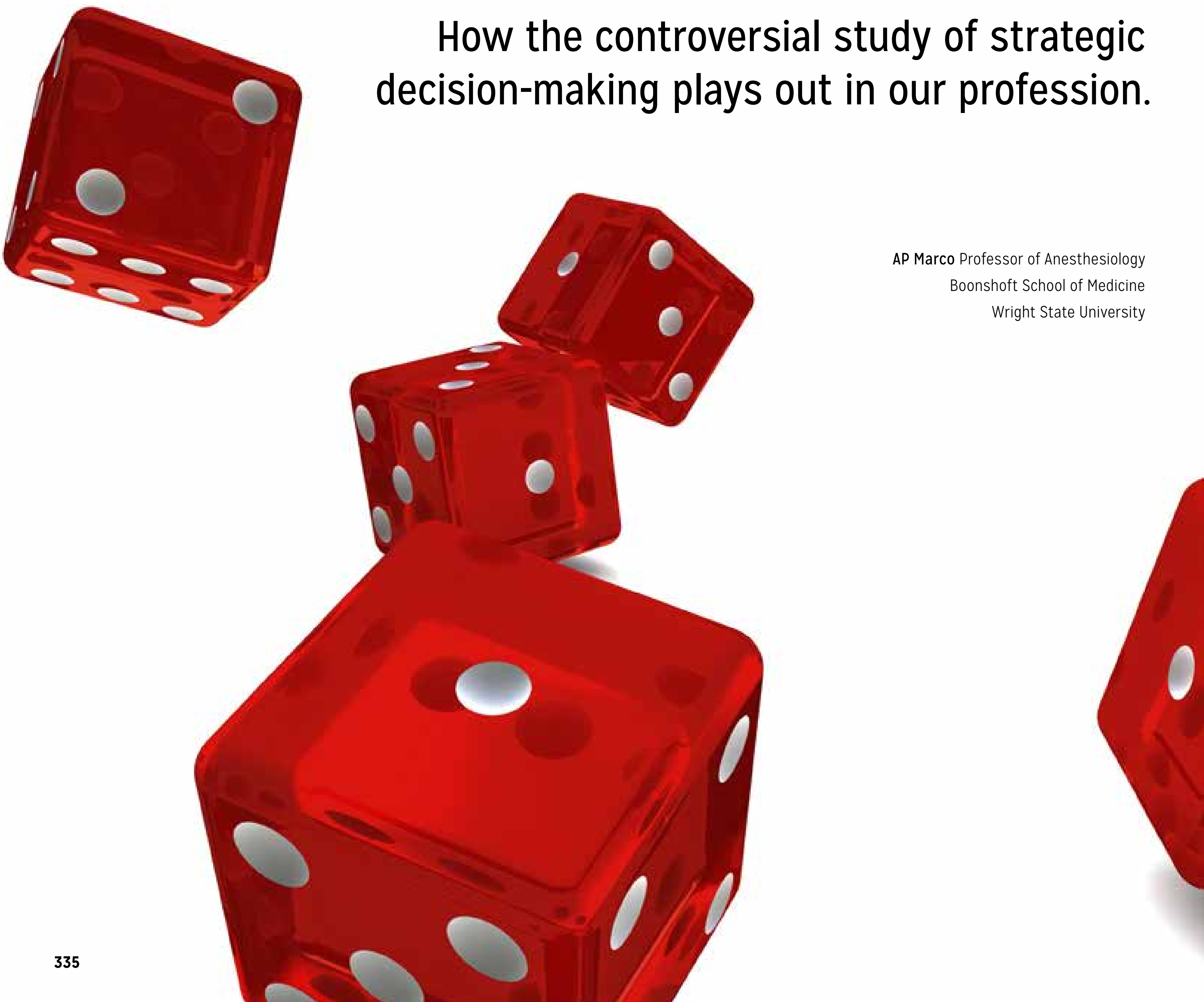
DOI: 10.1308/rcsbull.2015.335

Game theory and the surgeon

How the controversial study of strategic decision-making plays out in our profession.



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The first thing that people think when they hear the term 'game theory' is most likely to be 'What is it?', followed by 'Why should I care?'. Game theory is a way of analysing the choices we make when we interact with others and how their choices affect ours. If you interact with anyone, you are playing a game.

Take the following instance. You and your partner are deciding where to go for dinner and you think that your vegetarian partner is likely to choose the vegan Dendrophilia's Delights. However, your partner is flexible and, as you are a committed carnivore, you suggest Bob's Burger Barn (even though you would prefer Steve's Steakhouse) because Bob's has that black-bean burger for your partner and you can get the BBQ Bacon Deluxe Burger. You have just played a game where you tried to optimise the outcome for the two of you (cooperative behavior), instead of insisting on the big win for yourself.

We will discuss four scenarios where game theory applies to surgeons on a personal level, a hospital/clinic level, in the regional market, and in interactions with the public. These scenarios illustrate the prisoner's dilemma game, the tragedy of the commons, motivation for cheating in a cartel, and the effect of asymmetric knowledge in surgical markets.

Let's look at a common situation in operating theatres. A surgeon wants to add a patient to the schedule but there isn't enough time left for his case. He wants the team to agree to post the case but the team may not agree. This is a classic example of what is known as the prisoner's dilemma game (PG). In the classic PG, two prisoners are arrested for a petty crime, but suspected of a much more serious one. They know that the police only have evidence of the minor crime and that they face only a short time in jail if convicted (assuming they both cooperate and keep silent). However, if one of them testifies against the other (defects), that one will get a much lighter sentence and the other will get a heavy sentence. Knowing this, each prisoner weighs up his options and thinks that his best solution is to defect and testify, resulting in both prisoners ending up with worse outcomes than had they cooperated by remaining silent.

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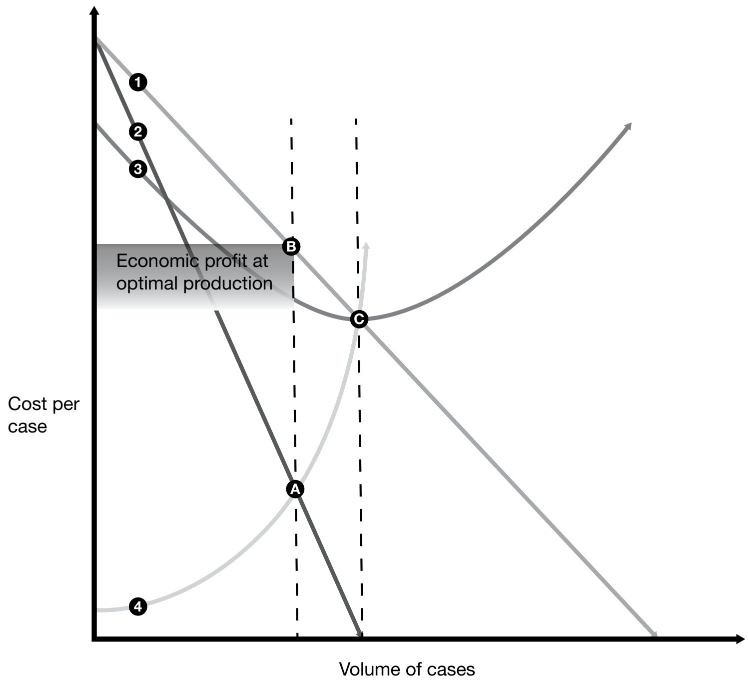
In the operating theatre setting, the surgeon may 'defect' by misleading the team about the time needed, or complain to hospital management to pressure the team. Or, the operating theatre team can simply say 'no', instead of looking for ways to accommodate the surgeon. If both the surgeon and the team defect, the patient gets delayed and neither side is happy. If there was more cooperation from both sides, they may have been able to work out an arrangement that would benefit all concerned. In real life, we find that people tend not to act as rationally as required in the mathematical analysis of game theory, partly because we value social interactions and the benefit to others.[1,2]

On a broader scale, a surgeon might ask for an additional assistant for his or her clinic. Should the clinic manager provide the extra staff or not? Ultimately, the resources are finite and need to be allocated in some rational way. Even if the costs of that extra staff are somehow charged back to the surgeon, it is a small cost relative to the gain if that surgeon sees more patients. However, each additional request for help or extra equipment erodes the financial status of the clinic and makes it less able to engage in strategic investments. As the profit margin goes down, the return on investment to parent corporation becomes so small that the clinic is closed. In game theory, this is known as the 'tragedy of the commons'. When sheep-herders add one more to their flock grazing on the commons, there is an incremental benefit – another fattened sheep or a bit more wool to sell – for that individual. However, the commons is degraded a bit by the additional grazing. As more families add that extra sheep, the commons is degraded more and more until nothing is left. Although the individuals initially benefit by getting that extra bit from the commons, overuse eventually leads to the downfall of all.

In many markets there may be two or more hospitals or health systems that are competing for patients in a specific service line. There is a finite market for those services and the costs of providing care are similar if the facilities are of a similar age, have similar supply costs, and have similar labour costs. They could have an agreement to evenly split the market (ignoring the legal aspects of collusion). In Figure 1 we see the market demand for services and the average total cost at various levels of demand. The optimal production is where the curve for marginal revenue intersects the curve for marginal cost of production. If the two hospitals were to collude and agree to split the market share at this level of production, they would maximise the profit of the system.

But what if one hospital were to cheat and cut its price a bit to attract a few more patients? It would make a bit less on average, but still increase its total revenue. The other hospital would try to do the same and revenue per case would continue to go down until there was no margin left. As multiple providers enter the marketplace (eg the growth of ambulatory surgery centres), the likelihood of cheating increases because 'in small groups reputation balances the urge to cheat but, as players become more numerous, reputation is less important and the prospective gain from cheating becomes larger'.[3,4] Cheating can drive the market price down to where there is no margin left for anyone.

Another aspect of game theory that applies to surgeons is the role of asymmetric information and its effect on quality. This is particularly relevant to discretionary surgical procedures such as vision correction and aesthetic procedures. Pricing to achieve the desired volume and market share involves game theory, as your choices depend on the choices of others and how they respond. Top-notch surgeons might be willing to perform a procedure for $12,000, whereas a so-so surgeon would be willing to take $6,000. If consumers can't tell the difference between the high- and low-quality surgeons, they might seek each out in roughly equal numbers, leading to an average market price of $9,000. However, at that price, the higher-quality surgeons are less likely to offer the procedure, so there will be more lower-quality surgeons in the market.



1.) Market demand curve
2.) Market marginal revenue curve
3.) Average total cost for market
4.) Marginal cost for market

A.) Optimal production where marginal revenue intersects marginal cost for market.
B.) Volume demand at the price point of optimal projection market
C.) No profit point

Suppose that at the price point of $9,000, three-quarters of the procedures were offered by the lower-quality surgeons and one quarter by the high-quality ones. If the public eventually figures this out, they might only be willing to pay $7,500 for the procedure (the weighted average of the $12,000 and $6,000). But at that price, even fewer of the top-quality surgeons would be willing to offer the procedure, decreasing both the number of providers offering the procedure and the fraction of high-quality providers willing to offer it. The trend is for lower-quality products to force out high-quality ones in a market where there is asymmetric information. Only if consumers have information on quality can they make the informed decision on pricing and value. Unfortunately, many of the publicly reported quality measures fail to portray true clinical quality (in part because of the lack of risk-adjustment) so price-setting for these discretionary procedures involves both game theory and wild guesses as to public reaction to available information.

Game theory plays an integral part in our actions on a day-to-day basis. By understanding some of the basic principles, we can guide our actions to optimise our outcomes on many levels. This can have an impact on our relationship with our partners, our coworkers, employers, and the general public.

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