Game Theoretic Approaches to Operating Room Management

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All interactions between people can be considered games with rules and outcomes. However, modern business practices demand that the players in the game go beyond traditional game theory and look at new ways to improve the outcome of the game. Choosing the right strategy is important to a player's success. A new business strategy, "co-opetition," can be used to increase the value of the game ("create a bigger pie") through cooperative behavior, whereas competition is used to divided the "pie." By looking at how the players adopt simultaneous roles such as complementor and competitor the stakeholders in the operating room (managers, surgeons, anesthesiologists, and nursing staff) can apply the principles of co-opetition to improve the overall success of their facility. Such stakeholders can utilize knowledge of how populations act in games to enhance cooperative play. Adopting such a perspective may lead to increases in the satisfaction and morale of those involved with the operating rooms. Increased morale should increase productivity and staff retention and reduce recruiting needs.

ANY SET OF INTERACTIONS can be modeled as a game between the players involved. Game theory tries to formalize these models to predict behavior. If a player can more accurately predict the actions of other players in the game, he or she can improve the chance of a satisfactory outcome. Zero-sum, non-zero-sum, and ultimatum games can be seen in the operating room environment and have previously been described.[1] The value of the outcome in non-zero-sum games (a classic is the Prisoner's Dilemma) varies depending on what strategies are chosen by the players, whereas in zero-sum games no new value can be created. In this article, new approaches to the concepts of cooperative behavior are described. This framework may be used to develop more favorable approaches to interactions in the operating room (OR) and to improve the overall outcome.

As the competition for resources in medicine becomes more frenzied the need to develop a broader view of the interactions among players becomes ever more important. Business models have begun to acknowledge that players typically play several roles, and these roles can change in different circumstances. If this is true a competitor is not always competing and the simple win-lose mindset limits one's ability to predict the best strategy. The best way to ensure success is not by fighting over how big one's slice of pie is but rather by growing the pie so that there is enough for all to have a good-sized piece. A successful OR must change its thinking from a win-lose perspective to a win-win one.

To change our perspective aspects of competition and cooperation must be brought together and joined with game theory so that the best strategy can be chosen. Modern business uses non-zero-sum game theory to choose the best strategies for making decisions. Identifying and analyzing the roles that various players in the game hold is the first step in developing a strategy.

Players in the Game

A typical breakdown of players is customers and suppliers. However, a player may take on either or both these roles. For example, a manufacturer may buy components for electronic equipment from another firm, assemble them, and sell the finished product back to the original firm. That company may also sell the finished product under its own label and therefore act as a competitor in some areas. In health care, physicians are customers of hospitals but also their suppliers because they supply the expertise needed to accomplish the health care found at the hospital.

Another way to look at the players is as competitors and complementors. Complementors make your product more valuable to the customer when both are available. For example, Windows 2000 is a complementor

This work was supported by the Department of Anesthesiology, Medical College of Ohio (Toledo, OH).

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to Pentium chips. The advanced operating system is more valuable when running on fast hardware than when not and the fast and powerful chip is more valuable when coupled with powerful software. Another example of complementors is General Motors Acceptance Corporation and General Motors. Having more credit available makes selling cars easier and selling more cars increases the need for credit. An important aspects of complementors is that the lack of complementors can cause a business to suffer as surely as stiff competition can. The lack of convenient parking in downtown areas hurts shopping; the value of Comair was decreased when pilots were not available during a strike.

What then are some of the complementors seen in health care? Surgeons and anesthesiologists are complementors—each is more valuable if the customer also has the other. Physicians and hospitals complement each other. The high-technology services and support available from a hospital is more valuable when there is a physician to interpret and coordinate the information and the physician is more valuable when the patient can go to a hospital for the things that the physician cannot provide directly. Physicians and insurance companies are also complementors. Without health care there would be no reason to have health insurance, and without insurance the availability of physicians is less valuable. Similarly physicians and pharmaceutical companies are complementors. Without drugs physicians are less valuable; without physicians to prescribe them drugs are less valuable.

The Value Net

The mix of customers, suppliers, competitors, and complementors when viewed from the perspective of the company/individual can be modeled as a network. Brandenburger and Nalebuff termed this the Value Net[2] (Fig. 1). Although it is easy to see that there are competitors and complementors from the customer's perspective it is not so obvious that the same idea can be applied toward suppliers. If it is more attractive to supply resources to you when also supplying resources to another player the supplier is a complementor. Similarly if it is less attractive to do so then the supplier is a competitor. For a hospital the makers of high technology equipment such as MRI scanners are complementors. The presence and supplying of other players makes it more likely that the technology company will invest the resources needed to improve their devices than if a single hospital was the only player. Compaq and Dell may be competitors to each other, but they are complementors relative to Intel, which is more likely to build a new fabrication plant with both the other players in the game.

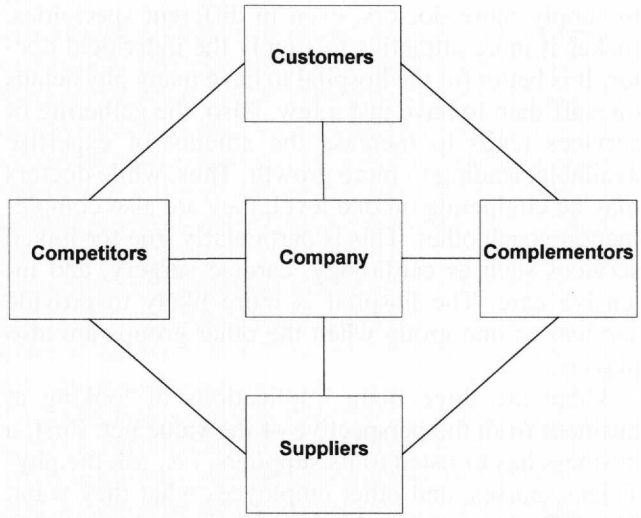

FIG. 1. The value net. The company is in the center while the traditional customer-supplier relationship is supplemented by the competitor-complementor relationship. Individual entities may occupy any or all of these positions relative to the company as circumstances warrant. Adapted from Brandenburger and Nalebuff,[3] Bantum Doubleday Dell Publishing Group, Inc. (New York, NY). Used with permission.

Employees supply expertise, labor, and time to the organization. In health care, hospitals, ambulatory surgery centers, and physician offices typically see themselves as competing for nursing staff. However, using contingency staff can convert this competition into "co-opetition." Many organizations cover peak needs with such staff. The stable base of steady employment helps create a market where the supplier (nurse) will provide services on an as-needed basis, because the supplier has benefits through the primary employer. Having the option to work when desired and the security of steady employment increases the value of both employers to the employee. The use of exclusive contracts between physicians and hospitals can fit into this schema. While not technically employees physicians can be viewed as such in game theory. Exclusive contracts are meant to provide predictable and dependable services to the hospital in exchange for protection from competition. An exclusive contract between a hospital and physician group may work similarly. The exclusive contract provides the groups with some financial security and makes it more attractive for them to provide the hospital with services. At the same time, it makes the group less likely to "poach" on another hospital's turf. However, the arrangement may offer the opportunity to "cherry-pick" short-term assignments to provide services to other hospitals. Thus the physician group gets stability and selective opportunities, the hospital gets consistency in its services, and the other hospitals get short-term coverage without poaching: a win-win-win situation.

Hospitals supply services to doctors and being able

to supply more doctors, even in different specialties, makes it more attractive to supply the individual doctor. It is better for the hospital to have many physicians on staff than to have just a few. Also, the gathering of services tends to increase the amount of expertise available, leading to more growth. Thus, while doctors may be competing on one level, they are also complementing each other. This is particularly true for linked services such as cardiology, cardiac surgery, and intensive care. The hospital is more likely to provide services to one group when the other groups are also players.

There are three main implications of looking at business from the perspective of the value net. First, a business has to listen to its suppliers, *i.e.*, ask the physicians, nurses, and other employees what they want. The OR may not be able to give it to them, but it should listen to their perspectives. Second, the OR can't really put anyone first. The customer isn't always right, partly because of the intertwining of the roles as customer and suppliers. Although in medicine the patient (customer) is placed before business practices that does not mean that patients' wishes are always fulfilled. For example although a patient may demand antibiotics for viral pharyngitis it would not be medically appropriate to say "the customer is always right" and prescribe them. Always putting the customer ahead of suppliers may damage the relationship with the suppliers, as can be seen with the use of mandatory overtime for nursing staff. Third, the ultimate goal of using the value net is to create a bigger pie. Developing a perspective where all players are integrated into a greater whole may lead to better satisfaction, rapport, and efficiencies.

The Operating Room Value Net

In an attempt to apply business practices to the OR many people talk about the issue of customer service. For the OR an emerging perspective is that the surgeons are the customers, since they bring in the patients. The idea of the surgeon as the only customer of the OR is a limited one. Instead a value net for the OR (Fig. 2) can be drawn.

Customers

In addition to surgeons several groups are customers to the OR. Anesthesiologists obtain support for their endeavors from the OR. It gives them a place to practice, equipment, and support staff in an arrangement that lets them both prosper. Particularly at the present time when anesthesiologists are in short supply the anesthesiologists could obtain these things elsewhere, reducing the amount of "health care" that the OR supports. At one hospital the OR schedulers were asked to schedule off-site cases (for MRI and the like) that did not involve OR nurses or surgeons. This is a service that the OR provides to its anesthesiology customers just like a department store would provide valet parking so that its customers could shop more easily. Surgeons are clearly customers of a given OR, because they too obtain needed support from it. Nurses parallel the anesthesiologists' situation. With the shortage of qualified OR nurses, they can choose where to practice to a certain extent. The patients are the ultimate cus-

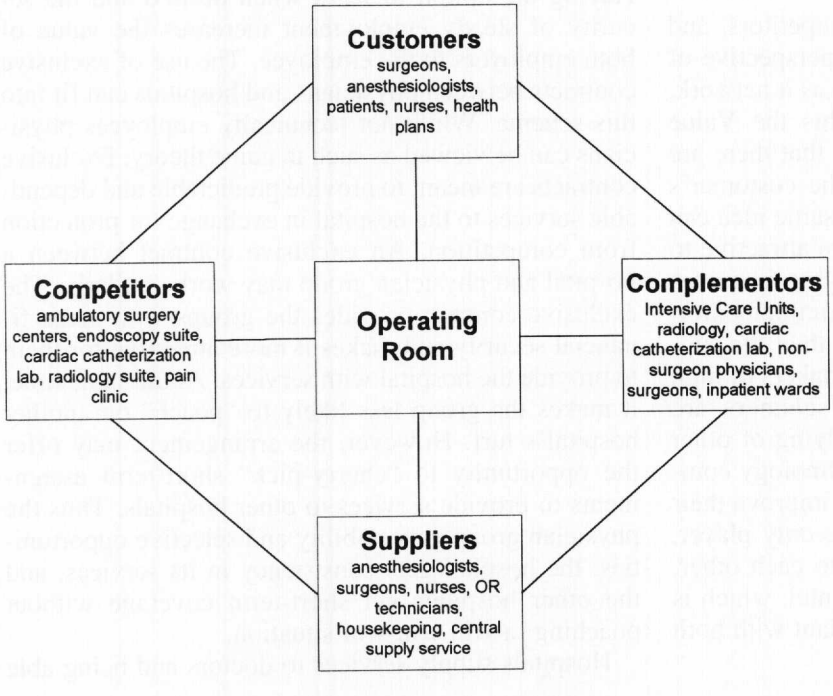

FIG. 2. The value net for the OR. Surgeons can take on three of the possible roles. They can be suppliers of services to the OR, customers of the OR, or complementors to the OR.

tomers because without them there would be no need for the rest. However, because some health plans control where patients may obtain care the insurers too are customers of the OR.

Suppliers

Some of the more apparent OR suppliers include housekeeping and surgical support services (central supply). However, the people who work in the OR are also suppliers of labor, skills, and knowledge. These include hospital-employed workers such as nurses and technicians as well as the physicians working in the OR.

The OR must consider the concerns of its suppliers and customers. For example, using mandatory overtime to satisfy surgical wishes may damage morale among the nursing and ancillary staff, which are suppliers. Recently a cardiac surgeon was observed at a walk-in hair salon. It was late in the day, and they were getting ready to close but had a number of clients waiting. The surgeon was patiently waiting his turn even though only two of the seven chairs were in use. Unlike what can be seen in the OR when rooms close down in the afternoon, the surgeon was not clamoring for the salon to call in more stylists so he wouldn't have to wait. He recognized that the salon had determined that the average utilization at that time of day only warranted the scheduled staff and that the marginal cost of calling in a team exceeded the marginal value received. Since the next haircut or cardiac surgery would take place whether or not another stylist/team was called in, calling in extra staff only erodes the profit margin of the business or hospital. This business decision is accepted outside of health care, but in the OR it is not. If surgeons (a typically high-profile OR customer) can incorporate the concepts of the value net into their perspectives they may realize that the OR has many customers who may have conflicting desires and that the good of the whole system may require compromise by the individuals. At the least this understanding may allow surgeons to be more comfortable with the decision-making process leading to better morale.

Competitors

The OR also has competitors. Some of these are obvious, such as ambulatory surgery centers (ASCs) and office-based surgery. Because some surgeons and anesthesiologists may have a financial interest in these centers surgeons can be competitors as well as suppliers and customers (Surgery and Anesthesiology may also compete with each other for patients in areas such as pain management and for hospital support for new programs or equipment). Within the hospital there are also competitors. The cardiac catheterization lab and the radiology suite are both competitors in relation to the OR (in the larger system of the hospital this may not be an issue). With the increase in percutaneous procedures such as angioplasty and aortic aneurysm stenting these locations compete for customers (patients and physicians) as surely as the ASC does. In an underutilized OR endoscopy can help fill space, but the opening of a separate suite will compete for cases. These non-OR procedure sites also compete with the OR for the personnel that staff them and for capital dollars from the institution's budget.

Complementors

The complementors of the OR are those who are more valuable to the customer when both they and the OR are available. Intensive care units (ICUs) complement the OR. While each is useful in its own right the presence of both expands the types of patients that can be cared for. While radiology and cardiac catheterization labs can compete for patients they also complement the OR. Many surgical procedures require intraoperative radiology, so again the availability of both expands the value of each. In fact the presence of a strong cardiology program requires a strong OR and surgical program because the need to have across-the-board services at one location is critical to survival in the external marketplace. The surgeons and anesthesiologists are complementors with respect to the OR. When the patient (customer) has access to both physicians and ORs each is valued more than they are separately.

Changing Players

In games we tend to look at new players as competitors. But these new players may also complement some of the other players in the game. The goal is to look for complementary opportunities as well as competitive threats. For the OR a radiology suite can be both a competitor and a complementor. At one hospital encouraging the trauma surgeons to use the cardiac catheterization suites to place vena cava filters led to higher customer (surgeon) satisfaction because it reduced waiting time for OR suites, strengthened the utilization numbers of the other sites, and improved the care of the patient by minimizing wait times for the procedure. It also reduced global charges, making the hospital more competitive in the external marketplace. In addition shifting these procedures to a "competitor" allowed better utilization of the OR for more equipment and personnel-intensive cases. Although the cardiac catheterization suites were competing with the OR for some cases they also served as complementors by giving surgeons more flexibility to do their cases.

The proximity of superficially competing services can also lead to complementary behavior. Just as art

galleries or antique shops cluster in the same area to draw more people the juxtaposition of competing service lines can make them complementors, too. Angioplasty competes with the OR for the treatment of coronary artery disease. However, having the OR suite close by adds value to both in the event that emergency surgery is needed. The OR gets a stream of patients and the catheterization suite has the backup it needs. Similarly cardiologists, although competing on some levels with cardiac surgeons, benefit from having such services close by. In fact it is easier to recruit skilled surgeons and cardiologists when the complementors are strong. In this manner we can see that a player can take one or more of the roles described in the value net. The idea of looking at other players only as customers or suppliers unnecessarily limits a player's view of the game and the interactions need to maximize the outcome.

Added Value

Once the value net is determined the player can examine his or her role(s) in the game and then must determine his or her value to the game. A player's value is the size of the pie with him or her minus the size of the pie without the player. The best example is the movie *It's a Wonderful Life*. In it George Bailey (played by Jimmy Stewart) sees what his world would have been without him. The difference between the two was his added value.

A classic card game also demonstrates the concept of added value. Let us suppose that some of the hospital staff decide to play a card game and the president of the hospital puts up $2600 in prize money. Bob, a hospital administrator, has a deck of cards. He keeps the black cards and distributes the red cards to hospital staff. Anyone who turns in a pair (one red and one black) of cards gets $100. At first glance it appears that Bob has the strongest position. However, let us look at this from the perspective of the other players. Bob offers one of them $20 for a red card, but the other player declines. Eventually Bob makes deals with all the other players and the lone holdout who initially refused the $20 is re-approached. At this point that player's position seems stronger because for either of them to gain they must come to an agreement. What typically happens is that the bargain is struck close to a 50-50 split. So by waiting the individual player can improve his or her position. Now, each player knows this and in real life the initial offer and settlement ends up being much closer to 50-50 right from the start.

Chuck gets to play a second game. He replaces Bob and has the 26 black cards. However, he burns three of the black cards in front of the hospital staff. How does this change his position? Each pair of cards is still worth $100. However, if the other players attempt the strategy of turning down an initial low-ball offer, there is no guarantee that Chuck will come back with a counteroffer because there are three "extra" red cards. In this situation Chuck can offer $20 or even $10 and the other players would consider it a good return on an otherwise useless card. Although the size of the pie is smaller ($2300 *vs* $2600) Chuck can get 90 per cent of the smaller pie, making "losing" the three cards a smart move (Fig. 3).

In these games Bob and Chuck have added value. Bob's added value is $2600 and Chuck's is $2300. In Bob's game the other players' added values are $100 each because each holds one-half of a pair of cards worth $100 as a pair. What about the players in Chuck's game? As a group their added value is $2300, but as individuals they each have an added value of $0! That is because with the excess of red cards no individual player has an essential element that adds value to the game.

This scenario comes up in real life, such as the situation with the National Football League and cities that desire teams. There are more cities that want teams than there are teams available (even with expansion teams). The team owners can use this strong position to leverage concessions from the cities such as tax breaks, new stadiums, and the like. In the health care arena, this also applies. In the past hospitals overbuilt ORs, and in a traditional fee-for-service environment this placed power in the hands of the surgeons who controlled referrals to the ORs. Now in many areas OR utilization is up as a result of closure of some hospitals as well as the increased need from an aging population. Surgeons are lobbying to build more ORs. However, this strategy may not be in the ORs' best interest. While building new ORs may increase the size of the pie other hospitals may also do this and the surgeons will continue to be in a strong position. If ORs were to limit their expansion keeping access tighter when although the pie would be smaller than it could be, the added value of the ORs in the game would increase. As long as there were surgeons looking for OR time the OR would be better able to attend to its own interests.

Limiting supply has advantages and costs. Limiting the supply may get the player a bigger piece of the pie, create a certain desirability because of the cachet of scarce product, generate some free publicity through news coverage and word of mouth of the shortage, and get customers to accept less desirable options that are available such as off-peak OR times. Disadvantages include shrinking the pie (costing business today), damaging relationships and future sales, creating ill will, and leaving gaps in the market that invite entry of new players (such as new ASCs).

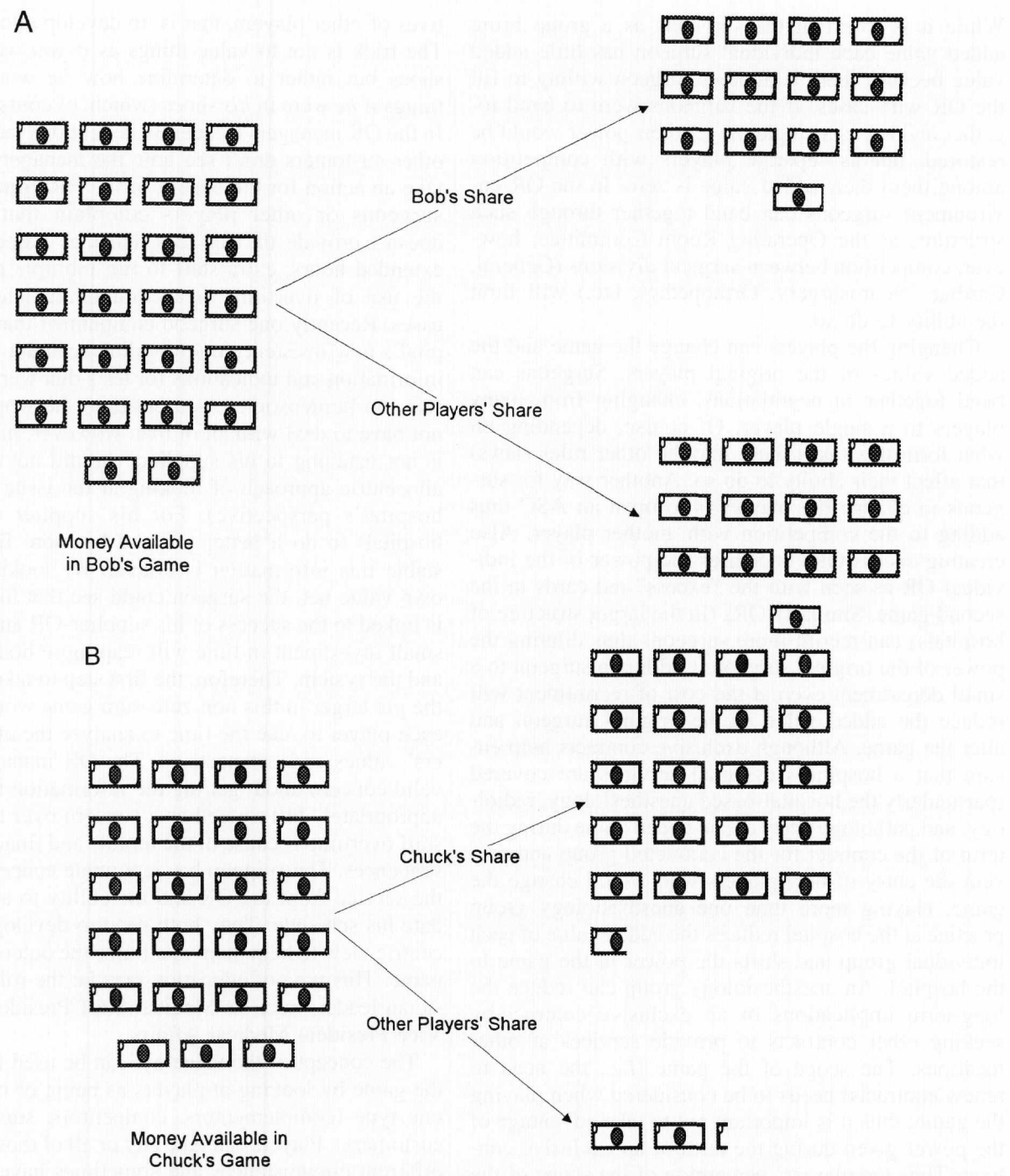

FIG. 3. Two versions of a card game. *A:* In Bob's version with 26 black and 26 red cards, the total cash from the game is $2600. Bob and the other players typically split that amount evenly. *B:* In Chuck's version with only 23 black cards but 26 red cards, the game is only worth $2300, but Chuck could bargain for as much as 90 per cent of the take.

People make typical errors when they try to assess their added values. In the first version of the card game the error is only looking at half of the equation. Although the OR may consider that without the surgeon it would get nothing, it needs to keep in mind that without the OR the surgeon would also get nothing. The surgeon's fallback position is no better than that of the OR, and being aware of this strengthens the negotiating position of the OR. If the supply and demand for ORs are evenly matched the OR has added value because for both players (surgeon and OR) to maximize their return they each need to make concessions (more "fairness") so that no time goes unused nor does any case not get done. When ORs are in short supply (as were black cards in the second version of the card game) the surgeons overplay their hand.

While it is true that the surgeons as a group bring added value each individual surgeon has little added value because there is another surgeon willing to fill the OR with cases. If the surgeons were to band together and act as a single player their power would be restored, but as separate players with competition among them their added value is zero. In the OR environment surgeons can band together through such structures as the Operating Room Committee; however, competition between surgical divisions (General, Cardiac, Neurosurgery, Orthopedics, etc.) will limit the ability to do so.

Changing the players can change the game and the added values of the original players. Surgeons can band together in negotiations, changing from many players to a single player. Of course, depending on what form this takes there may be other rules (laws) that affect their ability to do so. Another way for surgeons to change the players is to open an ASC thus adding to the competition with another player. Also creating excess ORs decreases the power of the individual OR as seen with the "excess" red cards in the second game. Similarly ORs (in the larger structure of hospitals) can recruit more surgeons thus diluting the power of the original surgeons. Adding a surgeon to a small department even at the cost of recruitment will reduce the added value of the original surgeon and alter the game. Although exclusive contracts help ensure that a hospital's essential services are covered (particularly the hospital-based anesthesiology, radiology, and pathology) they create added value during the term of the contract for the contracted group and prevent the entry of new players who would change the game. Having more than one anesthesiology group practice at the hospital reduces the added value of each individual group and shifts the power in the game to the hospital. An anesthesiology group can reduce the long-term implications of an exclusive contract by seeking other contracts to provide services at other locations. The scope of the game (*i.e.*, the need to renew contracts) needs to be considered when playing the game; thus it is important not to take advantage of the power given during the term of an exclusive contract. Thus the players' perception of the scope of the game affects their choice of strategy.

Changing the Game

It is important to understand how the game is linked to other games. Moves in one game may affect how the players move in other games, so changing the scope of the game changes the game itself. The scope of the game may be wider than it appears especially if some players view it as part of a larger game. The key to a successful strategy is understanding the perspectives of other players, that is, to develop allocentrism. The trick is not to value things as if *you* were in *his* shoes but rather to determine how *he* would value things if *he* were in *his* shoes (which, of course, he is!). In the OR managers frequently lament that surgeons or other customers don't see how the managers need to take an action for the benefit of the OR. Similarly the surgeons or other players complain that the OR doesn't provide the services that they value such as extended hours, extra staff to run multiple rooms, or the use of overtime to accommodate late-running cases. Recently one surgeon complained that the hospital's new insistence on providing accurate insurance information and indications for tests that were ordered was too burdensome. As a customer he would rather not have to deal with all of that. However, his mistake is not listening to his suppliers (he did not adopt the allocentric approach of looking at the issue from the hospital's perspective). For his supplier (the OR/hospital) to do a better job and be more financially stable this information is crucial. By looking at his own value net, the surgeon could see that his success is linked to the success of his supplier-OR and that the small investment in time will reap more both for him and the system. Therefore the first step to take to make the pie larger in this non-zero-sum game would be for each player to take the time to analyze the other players' values and perspectives. The OR manager has a valid concern about getting the information needed to appropriately bill as well as a concern over the use of staff overtime because of the morale and financial consequences. The surgeon has legitimate concerns about the service from the OR and the ability to accommodate his schedule. They both need to develop an allocentric view to help them maximize the outcome of the game. This type of education may be the role of physician leaders such as Medical Staff President and/or Vice President Medical Affairs.

The concept of the value net can be used to change the game by looking at players as being of more than one type (complementors, competitors, suppliers, or customers). Players can take any or all of these roles in different circumstances and sometimes have multiple roles at once. Competition from different ORs is not necessarily bad. Having other hospitals be successful makes them less likely to go after each other's customers. In fact their success may be crucial to the individual hospital's success. In many cities the success of a public hospital OR improves the chance of success of other hospitals by providing a place where uninsured or underinsured patients can go. If the hospital is doing well it can absorb this burden thus allowing other ORs to prosper. Also, thriving and busy ORs are neither able nor interested in recruiting each

other's surgeons to fill unused time, which is minimal. Lastly the presence of a higher-priced facility in the area may serve to bolster prices in the local market by reducing the need to compete on price alone.

An OR can expand its customer base. One of the best ways for a business to do this is to become its own customer. Chrysler's stake in Dollar and Thrifty car rentals allowed it to ensure car sales to these companies. Surgeons and hospitals may create joint ventures to open ASCs that can increase the total customers. The surgeons then become their own customers. These newcomer ORs benefit from the fixed price scheme in health care. If the expected market share of a newcomer lower-priced business is small (say, less than 10%), then it is in the existing business's best interest to stand pat (*e.g.*, give up a small amount of market share) rather than compete on price.[3] However, if the market share becomes too large the larger businesses must also compete on price. This has been seen in health care. When ASCs first appeared they were not considered a threat and traditional care settings (hospitals) did not change their strategies to account for the new competition. Now the share in some markets is considerable, and hospitals must respond with lower prices, with their own ASCs, or in other ways.

The OR needs to create loyalty. In the nonmedical market this is best done by saying "thank you" in kind, not cash. Obviously there are legal restrictions to this in medicine, however, an OR can thank its best customers. This may be through the use of the most desirable case times, multiple rooms to enhance the surgeon's throughput, or other benefits.

Another technique to bind customers to a business is the use of "most favored nation" clauses. This means that the customer will be offered the best price that any other customer is offered. In health care this is employed by Medicare to minimize its costs as well as by some commercial insurers. Can the OR use this strategy to more tightly link its customers? In some ways the OR does. Productive surgeons may be offered the best starting times, multiple rooms to minimize turnover times, or extra staff to expedite their cases. However, this can be expensive for an OR and it may create ill will with other customer/surgeons. The OR cannot afford to provide these types of services to all players. The existence of such "understandings" (these are rarely written agreements) may contribute to the OR managers developing the strength to resist requests for extra services, because if services are provided to one surgeon all the others will want them too. This raises the stakes and makes the OR look more carefully at how good a "deal" it offers.

One way that suppliers in industry attempt to reduce their risk is through the use of "take or pay" contracts. In these the customer agrees to purchase a certain amount of product at a set price. If use doesn't meet this floor, he or she still has to pay for the difference between the actual product used and the contracted amount although typically at a lower price. This changes some of the variable costs of production into fixed ones. That makes it easier to reduce the margin on additional activities to offset these fixed costs. In the OR environment surgeons request block time in anticipation of their expected needs. If that time is not used the OR bears the cost. Although various laws prohibit "charging" surgeons for their unused time can other penalties be applied to accomplish the same goal? Deductions from a risk pool might be one way. While in 1999 the Office of the Inspector General ruled that physicians cannot share in the hospital's cost savings more recent opinions suggest that under certain conditions where abundant safeguards against potentially abusive situations exist gainsharing may be possible.[4] In settings where the surgeons have some discretion as to where they send their patients this type of agreement may encourage the surgeons to increase volume at the contracting OR and would reduce the incentive for other ORs to poach by increasing switching costs for the surgeons.

Changing Behavior

Changing the behavior of groups is difficult. However, expectations do change ("evolve") over time through the introduction of new individuals and ideas. In repeated games with replacement of individuals by subsequent generations of players the new players can adopt new strategies or they can mimic their predecessors' strategies.[5] OR managers have to help this evolution along. An aid to this is the fact that OR interactions are repeated. This allows for rewarding desired behavior and punishing undesired behavior. Also, the players have knowledge about past interactions and can make judgments about future plays. Consider the ultimatum game: two players have to divide a sum. The first makes an offer and the second either accepts or declines it. If the second player declines, both players get nothing. When played in populations increasing knowledge about past play drives the system to fairness.[6] In social interactions both altruism and reciprocation affect players' choices of strategy.[7] These points suggest that OR managers can influence the strategies of other players over time by leading by example. Decisions to cooperate may be based on the desire to match cooperation by other players or by the desire to control the play of others by inducing them to cooperate. Control rather than matching is most important when the counterpart's move is in the future.[8] Even in games of chance where

there is no control possible people *act* as if they can control future play, although they do not *believe* they can. For players in the OR, this is important because acting as if one could control other players' moves leads to more cooperative behavior. The matching heuristic (especially when referenced to past moves) may lead to more cooperative behavior. Thus, acting in a cooperative manner may lead to more overall cooperation, even if the player does not believe he or she has influence!

Although in some cases pure self-interest can achieve as good a result in the game as cooperation, in large groups with multiple interactions cooperation is increasingly likely to yield benefit beyond that obtainable with pure self-interest.[9] In the Sequential Prisoner's Dilemma where the first player's choice is revealed to the second player before the second player has to move cooperation is a more likely response if the first player chose cooperation than if he or she chose defection.[10] Even though defection is the dominant strategy for the second player there is some cooperation that is motivated by reciprocation rather than altruism. In a society where reputation effects are important the value of a trustworthy reputation may be high enough that it is rational for even selfish players to resist the temptation to defect and seize short-term advantages.[11]

Two main actions are suggested for the stakeholders in the OR who wish to improve the level of cooperation. First, cooperative play may induce cooperation by others in the OR. Second, they must increase the desirability of cooperative play—or its converse, decrease the benefit of defection. Education and open discussion of these principles may lead to more insightful play. Increasing the reward for cooperative play may also be possible. For example, staff who get high scores when rated for their interpersonal relationships may get preferred shifts or operating times whereas those who score poorly may not. Consistent poor performers may be deselected from medical staffs or panels.

Conclusion

Modern business theory holds that players must adopt multiple contrasting roles such as complementor and competitor, supplier and customer, to be successful. It has never been necessary for others to lose for one player to win: creating win-win situations is easier if one understands the value net and game theory. Building and understanding the complex web of relationships that are the hallmark of modern business practices is vital to the success of organizations. The OR as a microcosm of the hospital must evaluate its position in the value net to develop successful strategies in the current market. Part of this effort must be to encourage other players to develop and study their own intersecting value nets so that mutually beneficial strategies may be developed.

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