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## Rational Rationing

### Allocating scarce resources in uncertain conditions

Based on the Research of Sarang Deo And Charles Corbett

Scarcity is something many of us can plan for. If the electricity goes out, we have flashlights and candles at the ready. If there is a drought, we can take shorter showers or let the lawn wither under the summer sun. But these examples pale in comparison to the hardship shortages impose on HIV/AIDS clinics in sub-Saharan Africa. There, scarcity fairly often means death. The clinics rely on outsiders whose donations and supplies may be delayed due to poorly developed infrastructure, logistical problems, and even corruption. In the past, doctors, directors, and practitioners had to guess at the most effective way to allocate or ration those scarce resources. But new research from Sarang Deo (Assistant Professor of Managerial Economics and Decision Sciences at the Kellogg School of Management) shows how to make more rational decisions about rationing.

"If you run an HIV/AIDS clinic in a place like rural Malawi or rural Zambia, you have problems on all sides," Deo says. "You depend absolutely on a scarce resource: antiretroviral drugs [ARVs]. But you have no control over the size of the shipment of drugs you will get [or] when you will get it. There are thousands more people who need ARVs than you can hope to treat, but to start someone on ARV treatment and then stop can be worse than not starting treatment at all."

Stopping and starting HIV treatment, Deo explains, is deadlier and costlier than never starting treatment at all because this process breeds new, drug-resistant strains of HIV, which makes future infection even more difficult and expensive to treat.

Clinics in the developed world can order drugs today and know exactly when they will receive the shipment. Clinics in sub-Saharan Africa, on the other hand, do not enjoy such reliable supply chains. With no control over the supply of ARVs, clinics there are faced with the unenviable situation of rationing drugs between two groups of patients: those who are new and those whose care is ongoing.

#### Rationing is a Common Business Challenge

Allocating scarce products is the norm in the business world, Deo says. An airline can offer only a certain number of seats on each route. The most popular routes, such as New York to London or Madrid to Barcelona, have more would-be travelers than airlines can accommodate.

Like most businesses, airlines ration by price. Air carriers adjust ticket prices up and down to depress and stimulate demand. The lower the price, the more people are likely to buy tickets; the higher the price, the fewer people will be willing to fly. An airline wants to maximize its yield by filling every available seat at the highest possible price.

Airlines use yield-management software to change ticket prices quickly, depending on factors such as expected demand, weather forecasts, and the number of unsold seats on a specific flight. But what if the airline did not know how many seats would be available for sale? And what if passengers could not afford to pay but knew that getting on that airplane could mean the difference between life and death? Who decides who will get a ticket and live? How do those decision makers reach their choices?

Like airline executives before the advent of yield-management programs, many HIV/AIDS clinicians use experience to

fine-tune their best guess about future supply and demand to ration scarce supplies. Deo and colleague Charles Corbett (Professor of Operations Management and Environmental Management at the Anderson School of Management, University of California, Los Angeles) have devised a mathematical model that takes the guesswork out of rationing for businesses and nonprofits alike.

### **Working with Dynamic Models**

The model looks at the thorny issue of rationing in a way that differs significantly from existing approaches. Rather than consider rationing in a static sense, this new model takes a dynamic approach. This is important because both supply and demand constantly change over time—the former because of the uncertainties in the supply chain and the latter because of deaths, dropouts, and previous enrollment decisions.

Many business ventures give in to the temptation to grow too quickly, leaving them unable to provide consistent quality of service to their existing customer base. If an entrepreneur expands the customer base too quickly, demand outstrips supply, which can sink the company.

In medicine, the primary goal is to provide maximum good for the maximum number of patients, to maximize the survival of patients, and to bring the greatest improvement to their quality of life.

But medical needs may not match political or social needs. There is tremendous pressure, Deo notes, to maximize the number of people being treated for HIV in sub-Saharan Africa. Treating more people today offers immediate benefits to political leaders, drug makers, and patient-interest groups. As the number of HIV-positive people receiving ARV treatment increases, all of these groups can claim success. But when delivery of ARV supplies to HIV clinics falters, Deo says, no one takes responsibility for the resulting increase in illness, deaths, and drug-resistant HIV strains.

“We can now quantify just how suboptimal that policy [maximizing the number of patients] is and how it depends on the level of supply uncertainty,” Deo says.

Deo decided to study HIV because it has two important qualities. First, it is a major disease that is almost invariably fatal if left untreated. When the disease is treated appropriately—which requires patients to take the proper dose of ARVs at the same time, every day, for life—patients can expect to live long and enjoy normal activities.

Second, processes ensuring that patients receive regular doses of drugs are vital to successful treatment. A reliable supply chain that provides years, or even decades, of ARVs is as important as the drugs themselves.

Of the similar trade-offs that exist between uncertain resources and growth in both the business and nonprofit sectors, Deo says, “You have to keep your ambitions and your expansion under control. Our work provides a model to help optimize the rationing of scarce resources in a more rational manner.”

### **About the Kellogg Researcher**

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### **About the Research**

Deo, Sarang and Charles J. Corbett. 2008. Dynamic Allocation of Scarce Resources under Supply Uncertainty. Working paper.

### **About the Writers**

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