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LHSC MULTI-ORGAN TRANSPLANT PROGRAM: Pooling Ontario's kidney transplant wait-lists

Felipe Rodrigues and Fredrik Odegaard wrote this case solely to provide material for class discussion. The authors do not intend to illustrate either effective or ineffective handling of a managerial situation. The authors may have disguised certain names and other identifying information to protect confidentiality.

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It was June 26, 2017, and Henry Rogers’s first day of work at London Health Sciences Centre (LHSC) began with a surprise. Rogers had a graduate degree in Management Science and had taken the job as an analytics specialist at LHSC at the beginning of the summer. Dr. Vivian McAlister, an experienced surgeon and researcher at this internationally acclaimed hospital in Southwestern Ontario, Canada, knew that analytics could be a powerful decision tool for the health care industry. When Rogers accepted the job, McAlister knew he could put Rogers’s expertise to effective use right away. McAlister invited Rogers to a meeting with Dr. Tony Jevnikar, director of the hospital’s Multi-Organ Transplant Program. The meeting was about a subject Roger knew little about: kidney transplants.

“Henry, we have very little time to take a decision that could impact a lot of people’s lives—a lot!” said Dr. McAlister. Saving lives was not what Henry expected on his first day. Being in unfamiliar territory made him rather nervous. He hoped he could meet McAlister’s expectations.

**THE MULTI-ORGAN TRANSPLANT PROGRAM meeting**

After the usual round of introductions, Jevnikar went directly to the point: “Vivian, as you know, I just got back from Toronto. I presented our current numbers to the health ministry’s transplant team regarding our kidney transplant program.”

“I bet they are impressed, Tony,” said McAlister. “After all, we managed to keep the wait time for kidney transplantation to a little less than a year.”

Rogers began to sense where this conversation was going. He knew that transplant wait-lists were a delicate issue that involved not only medical efficiency but also social fairness and politics. Waiting one year for a transplant, though, seemed like a long time.

“Yes, they are, Vivian. The big problem is, the rest of the province is not doing so well. They showed their numbers and it seems that they have been having trouble reducing their wait time to a little less than four years.”

Precipitately, Rogers jumped into the conversation: “Wow, can the patients handle from one to four years for a transplant? Really?”

The looks from McAlister and Jevnikar showed that they were a little surprised by the question. After all, if Rogers was going to work at the hospital, he needed to be better acquainted with its reality. The wait time of one year was in fact a relatively good number, considering the reality of the transplantation procedure in North America.

“Henry, you are right, it is a long time. But it could be worse,” said McAlister. From the other side of the table, Jevnikar nodded approvingly.

Rogers thought it would be better to admit his lack of knowledge now than fall into a trap later. “I’m sorry for my ignorance, but can you go through the basic procedure for a kidney transplant?”

McAlister replied:

When kidney patients are diagnosed with end-stage renal disease, or ESRD, they are immediately put into dialysis treatment. Therein lies the first problem: dialysis is only supposed to be temporary. Patients take a heavy toll taking dialysis many times a week, and it is not an ideal situation for the patients, or the family, or the health care system. At the time of their diagnosis, we run some tests and we establish whether the patients are suitable for transplantation. If we find that they are, then their place is confirmed on the wait-list. Patients then take dialysis until we find a good match for a transplant. Keep in mind that not only is dialysis palliative, it is also expensive, and the survival rate adjusted for five years is less than 45 per cent. Transplants however, have a survival rate ranging from 80 to 90 per cent, depending on the type of the patient.

“So the sooner patients receive transplants, the better?” asked Henry.

Jevnikar responded:

Precisely, Henry. The demand is not so much the problem; supply is the real problem. Donors are a rare breed. Most of the organs come from what we call deceased donors. These are usually other patients who died, usually suddenly, for other reasons. We have them tested with consent of their families to see whether they can be donors of multiple organs—in this case, kidneys. We perform the surgery to extract the suitable organs and tissues, and transplant these to the patients on the wait-list. The donors are the real heroes, and we make sure to show our appreciation. You should come by to one of our donor appreciation events and see how meaningful this is for all the families involved.

McAlister agreed and, feeling he needed to explain further, said, “Kidneys have a particularity. Unlike livers, for example, we have two kidneys per donor, which helps a great deal with managing the wait-list.”

Rogers’s expression revealed that he had never thought about that fact before. He pondered how little he remembered from his high school human biology classes, and felt a bit out of place. Both doctors saw Rogers’s face at that moment of realization and glanced at each other as if saying, “This never gets old.”

McAlister continued, “We do not have enough deceased donors. And I suppose that the rest of the province is in worse shape that we are in this matter.”

“It seems the system is not stable,” Rogers said, hoping to sound knowledgeable. The result was a concerned face from both the doctors.

“What do you mean?” they asked in unison.

Rogers continued, “Well, if you have more patients arriving than donors, the queue will keep growing indefinitely.” More concerned faces, he noticed.

Jevnikar continued where McAlister had stopped, explaining, “We have many programs to help increase the number of donors, but our main alternative is living donors. Whenever new patients enter dialysis, if they or their families feel like the wait time is too long, they make an effort to find a family member willing to donate one of their kidneys.”

Jevnikar paused, then added, “And yes, you can live rather well with only one kidney,” anticipating Henry’s question. Again, the doctors glanced at each other, knowing that it was a familiar question.

McAlister added:

At the end of the day, the longer the wait time, the higher is the incentive to find a family member willing to donate. Here in London, because the wait is approximately one year, we do not rely so much on living donors. But in the rest of the province, living donors are the best way to bring the wait down. Isn’t that right, Tony?

“Does each hospital have its own wait-list?” asked Rogers.

Jevnikar replied:

No, Henry. For the sake of simplicity, let’s say that the Ontario is divided into regions. Western Ontario is attended by London, and Eastern Ontario, by Toronto. Occasionally, we share donors, but it does not happen on a consistent basis. And here is the catch. The Ministry of Health is considering the possibility of pooling the two wait-lists—in other words, merging the two independent wait-lists that we have today into one single program. We would still make the transplants in both London and Toronto, but the wait-lists would be unified and both patients and organs would be transported on a need basis.

“How does the transportation work? Does that affect the organ or the transplantation at all?” asked Rogers curiously.

Jevnikar responded:

Preferably, the organs are transported. That minimizes the hassle for the patient and the family. But you are right, the longer the organ takes to be transplanted, the higher the likelihood that it might be wasted. Unfortunately, every now and then we have a kidney that is not transplanted. This is usually due to difficulties finding a match, or either the patient or the organ does not arrive at the operating room in time. This is a problem that could increase if the wait-lists are pooled. Not to mention potentially high transportation costs. Fortunately those cases are still rare here.

“I’m a bit concerned about this merger,” said McAlister. “We have a one-year wait time, but in terms of donors, our program is roughly one-third the size of the program in Toronto. I fear that if we merge, Toronto will have just a bit of an improvement since they are so much bigger than us, and we will increase our wait time enormously.”

“I agree, Vivian. My instincts say that our patients will be worse off, and Toronto’s patients will not even notice the change,” Jevnikar agreed, concerned. “But I guess this is the reason Henry is here, isn’t it? What can you do to help us understand the impact this merger might have?”

By now, Rogers knew this was a typical queuing problem and that, as with all things related to queues, he was very cautious: “From what you have told me so far, this situation can indeed impact the lives of many patients. One thing is for sure: I need two kinds of data to help you.” As he thought about the problem at hand, he added, “To begin with, I need the arrival dates for patients on both wait-lists. And I also need the transplant dates for those patients.”

“I am sure you can find all that in our database. We are very meticulous about details,” said McAlister.

Rogers cautiously, but excitedly, replied:

With that information, I would be able to know the rate of arrivals of the patients on the wait-lists. Also, the intervals between the transplants will give me the information I need for the service rates. Since it has not been an issue yet, I will assume that no organs are wasted and that the wait-list approximates a first-come, first-serve basis.

“Because supply and demand are so tight, I suppose you can make those assumptions,” said McAlister.

Rogers continued, “Give me a few days to get acquainted with the database, retrieve the data, and run some rough numbers, then we can meet again, say next week, and I would be able to show you a rough analysis.”

Jevnikar said:

I have to meet the Ministry of Health’s team in a couple of days. Vivian, you are coming with me to help with the clinical side. Henry, please crunch your numbers and let me know by tomorrow what you think we should do in terms of this merger. What will happen to our wait time and to the size of the wait-list? Should we pool the wait-lists? What if the number of patients increases? What if the number of donors increases?

Rogers replied nervously, “Tomorrow?”

McAlister looked at Rogers as if saying, “I told you we had very little time.”

“And by the way,” said Jevnikar, “Welcome to the team.”

**BACKGROUND INFORMATION**

End-stage renal disease (ESRD) was a condition in which the kidneys were permanently impaired and could no longer function normally to maintain life. Once diagnosed with ESRD, a patient had only two treatment options: dialysis, and renal replacement therapy (RRT), commonly known as a kidney transplant. Most often, ESRD was a condition caused by glomerulonephritis, diabetes, or renal vascular disease, but it could have other origins. It did not discriminate on the basis of age, gender, or race. Transplanting of kidneys, on the other hand, had a much higher five-year survival rate, ranging between 80 and 90 per cent, depending on the population group.[[1]](#footnote-1) Thus, RRT was the preferred treatment for ESRD.

From 1991 to 2010, the prevalence of ESRD in Canada had increased 77.38 per cent. Measured in rate per million population (RPMP), the prevalence of ESRD had jumped from 93.3 in 1991 to 165.5 RPMP in 2010, and was expected to keep growing. More than 39,000 Canadians had been diagnosed with ESRD, of which more than 16,000 were living with a functioning kidney transplant. The province of Ontario had Canada’s largest share of ESRD patients, totalling more than 16,000. Of this total, 37 per cent were living with a functioning transplanted kidney.

Despite advancements in medicine, transplantation was not a straightforward procedure. Several difficulties were inherent in the treatment, the most notorious being the scarcity of suitable organs for donation. Low supply and high demand for organs quickly generated a longer than ideal wait-list.

In Canada, the average wait time for a kidney transplant was approximately three and a half years for the more than 3,363 patients awaiting the procedure—and the demand was growing. Since all patients on the wait-list underwent routine dialysis sessions, such long wait times resulted in a costly and lower quality of life. The long wait might also have a morbid side effect: 82 patients died in 2010 as they waited for transplantation. Patients, the medical community, and policy-makers alike considered a three-and-a-half-year wait to be far too long for such a serious condition.[[2]](#footnote-2)

While the majority of transplanted kidneys came from deceased donors, a growing number of transplants had taken place due to living donations, meaning both donor and recipient lived with only one functioning kidney. Such hardships implied that living donors tended to be the patient’s willing family members, who realized the potential threat to the patient as a result of a prolonged wait time.

Often, the living donor’s decision was triggered by a higher than acceptable wait time. If the wait time was seen as acceptable, the patient underwent dialysis while waiting for an available donation from a deceased source. The longer the wait time, the more likely was the push to provide for a living donation. As expected, the wait time had a significant effect on the mix of deceased and living donations. This effect was most notable in Ontario, where close to 40 per cent of transplants were from living donors.[[3]](#footnote-3) By the end of 2010, the province of Ontario had 1,105 patients awaiting RRT, with new arrivals to the wait-list growing every year. Although the province was able to conduct between 450 and 550 kidney transplants each year, this might not be sufficient if demand continued to grow.

**THE ANALYSIS**

Rogers left the meeting feeling like he could never produce the data in time. But if he managed to show the queuing analysis for the kidney transplant wait-lists, he knew he would make the best impression. With the help of co-workers at the health information management department, he was able to compile estimates for both the patient arrivals on the wait-lists and the transplants (see Exhibit 1). As these data represented estimates, and both patient arrivals and transplants varied greatly, the data suggested considering a variation from the mean within 100 per cent to 150 per cent.

**Exhibit 1: a comparison of End-stage renal disease patients in london and toronto**

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| **Location** | **Average Number of Patients per Year** | **Average Number of Donors (Surgeries) per Year** | **Estimated Coefficient of Variation\* of Donors (Surgeries) per Year**  **(Lower and Upper Bound)** |
| **London** | 109.025 | 110.047 | 1.0 to 1.5 |
| **Toronto** | 327.259 | 327.514 | 1.0 to 1.5 |

Note: The information has been simplified to better suit the educational purposes of the case; \*Coefficient of variation: , or the standard deviation divided by the mean service time.

Source: Created by the case authors.

1. Canadian Institute for Health Information, “Canadian Organ Replacement Register Annual Report: Treatment of End-Stage Organ Failure in Canada, 2001 to 2010,” Ottawa: Canadian Institute for Health Information, 2012, accessed November 17, 2018, <http://ghdx.healthdata.org/record/canadian-organ-replacement-register-annual-report-treatment-end-stage-organ-failure-canada>. [↑](#footnote-ref-1)
2. Ibid. [↑](#footnote-ref-2)
3. Ontario Trillium Gift of Life, accessed November 2013, www.giftoflife.on.ca/en/stats.htm#transplant10. [↑](#footnote-ref-3)