Go With the Flow: Improving Red Cross Bloodmobiles Using Simulation Analysis

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The Red Cross worried that long waiting lines and the time to donate blood might affect donors’ willingness to repeat.

In response, we developed a computer simulation model to study customer service and productivity issues for Red Cross bloodmobiles.

We tested several strategies to alleviate this problem.

Initial implementation experience indicated positive results.
The American Red Cross collects over 6 million units of blood per year in the U.S.

- There are 52 blood services regions
- There are over 400 fixed and mobile collection sites
- Mobile sites are in business, school, and community locations or in modified buses or trucks
- About 80% of Red Cross blood is collected at mobile sites
More Background I

- Donation time is said to be one hour, but is often 1½ to 2 hours
- Arrival at blood drives is random
- Donor scheduling (i.e., appointments) is largely avoided by the Red Cross
- The belief is that imposing appointments will alienate donors
- A key factor that has increased donation time is AIDS and hepatitis
AIDS has affected the donation process in two ways:

- Donor screening procedures have become more rigorous
- Staff must take additional precautions

Red Cross blood centers have limited budgets

There is a severe shortage of nurses nationwide
The Red Cross relies heavily on repeat donors

Donors are volunteers

The Red Cross, therefore, wants satisfied (happy) donors

They seek to minimize time spent in line and at the donation site

Blood drive sponsors also want to minimize donation time

If a drive sponsor is dissatisfied, The Red Cross may not be invited back
System Description

- See Figure 1 for the seven steps

- Figure 2 shows a typical physical set-up for a six-bed drive

- This set-up is common when 50 to 75 donors are expected in a five to six-hour period

- Significant delays occur in registration, taking vital signs, obtaining donor’s health history, and in the donor room
The Blood Collection Model

- We have a typical queuing system
  - Donor arrivals are random
  - Servers are limited
  - Handful of decision points
- We used the six-bed unit as a basis for our model
- We were able to obtain data from historical records
Blood Donor Arrivals

- We examined the operations records for 76 blood drives
- We then modeled arrivals as a nonstationary Poisson process
- Three dominant patterns emerged
- See Figure 3
Service Times

- We collected service times for each of the major steps in the blood donation process.

- We fit probability distributions to the observed data for each step.

- We used a chi-square goodness of fit test.

- We chose parameters using maximum likelihood estimation.

- The results are summarized in Table 1.
Model Development and Testing I

- We developed the blood collection model using GPSS/PC on an IBM PS/2 Model 60 computer
- We debugged, verified, and validated the model
- The Red Cross confirmed that it was intuitively valid
- We performed a variety of sensitivity analyses
The results indicated that waiting and transit times were not overly sensitive to any one step in the process.

Increasing throughput at any one point (by adding servers or reducing service time) would have little beneficial impact.

Waiting time would simply increase at the next step.
Increasing throughput at the last constraining step (the donor room) would produce some benefit.

But, adding servers here would be costly in terms of personnel and space.

These tests indicated that any modifications had to balance the throughputs at the various steps to avoid bottlenecks.
We saw three possibilities for changing the collection process

1. Combine some or all of the donor screening steps into a single functional work station

2. Abandon the three-bed unit concept in the donor room in favor of having two phlebotomists share responsibility for 6, 7, or 8 beds

3. Develop formal work rules for floating staff who would assist in screening and in the donor room
The first alternative would

- Result in reduced service time since some tasks could be performed simultaneously
- Make available more servers
- Reduce the psychological cost of waiting

This alternative obtains a 5% reduction in mean transit time and a 12% reduction in mean waiting time
Modeling Analysis III

- The second alternative would increase the likelihood that a phlebotomist is available to start or disconnect a donor
  - This reduces the time a donor spends on a bed
  - This alternative obtains a 13% reduction in mean transit time and a 51% reduction in mean waiting time
Modeling Analysis IV

- We did not model the third alternative by itself
- Rather, we modeled the three alternatives in various combinations
- Four scenarios are compared against the control scenario in Table 2
- Time saved (in minutes) over the control scenario is shown in Table 3
Implementation of Results I

- We conducted field trials of the strategies developed
- We modified one of the promising scenarios due to limited staff availability (see Figure 4)
- We collected detailed time data
- We surveyed donors to get their impressions
- We tried the new scenario on five blood drives
Implementation of Results II

- The new scenario was fine-tuned on the first and second blood drives
- We collected data only on the last three of the five drives
- The detailed results are shown in Table 4
- In the first two drives (at Duke and Lundy), mean transit times were much improved
- In the Easco drive, more donors arrived than expected
On the customer satisfaction side, the results were also positive.

- Of repeat donors, 62% felt the donation process was shorter.
- 73% felt that waiting time was reduced.

For specific comments, see page 11.

Within a year or two, 20% of Red Cross regions had implemented at least some of our recommendations.
Conclusions

- Simulation was used to identify strategies to make the blood donation process easier on donors
  - Decrease donor waiting times
  - Decrease donor transit times
  - Improve the queuing environment

- In the future, the Red Cross will need to also develop an effective donor scheduling system
- The Red Cross considered this study to be a major success