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

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Outline of Study

- 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

Background

- 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

More Background II

- 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

Project Motivation

- 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

Model Development and Testing II

- 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

Model Development and Testing III

- 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

Modeling Analysis I

- 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

Modeling Analysis II

- 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

Implementation of Results III

- 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