

Smith Hager Bajo, Inc. Simulation Modeling Case Study

The Problem:

A 2,000 birth hospital in New York planned a new obstetric unit in 1996. Market research completed in conjunction with the planning indicated that the most important feature of the new unit should be private post-partum rooms. A bed need analysis for 2,200 annual births was completed using a statistical probability model. It indicated the need for 7 LDR's, 3 triage/testing/recovery beds, 7 antepartum/GYN beds and 19 post-partum beds.

The new unit opened in mid-October 2000, and experienced post-partum overflow issues the first week. Significant staffing problems existed prior to opening the unit and continued following the opening. The problems were compounded because several targeted rates and volumes used as assumptions for planning the new unit did not match actual practices. Smith Hager Bajo was asked to complete a thorough operational analysis of both the quantity of beds and staffing and recommend appropriate solutions.

The Analysis:

Computerized simulation modeling was used to complete the analysis for several reasons:

- Ability to include key variables such as the impact of scheduled procedures, seasonal variability and discharge times (could not be evaluated with former bed need prediction model)

- Allows the evaluation of staffing levels for each type of caregiver involved in the care process

- Flexibility to compare/contrast the results of a variety of scenarios

The analysis indicated significant differences between five key assumptions developed in 1996 and actual practice in 2000.

| | 1996 Assumptions | 2000 Actual Practice |
|--|--|---|
| LDR Average Length of Stay (ALOS) | .38 day - vaginal deliveries/ .45 day - unscheduled C/S | .50 day - non-induction vaginal .67 day - inductions |
| Postpartum ALOS | 1.38 days - vaginal deliveries 3.45 days - unscheduled C/S 3.00 days - scheduled C/S | 2.5 days - vaginal deliveries 4.34 day - all C/S |
| NST Annual Volume | 617 projected tests | 1,069 actual tests (42% ↑) |
| Scheduled vs. Unscheduled C/S | 20% scheduled 80% unscheduled | 50% scheduled 50% unscheduled |
| C/S Rate | 20% Projected | 28.6% Actual |

The Results:

Each of these assumptions was analyzed using simulation to determine which variable impacted the bed and staffing needs. Surprisingly, the results were much more sensitive to the change in post-partum average length of stay than to the change in Cesarean birth rates. The ability to include scheduled procedures by time of day and day of week significantly increased the validity of the model. Finally, the ability to program a prescribed discharge time (and to see whether adherence to it impacted bed need) made the results much more valid to the physicians and nursing staff.

The model generated three types of results. They include:

- Bed need by type of bed
- Patient overages and days all beds full
- Staffing requirements by position

Predicted Bed Need Results Summary

| BED TYPE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | 2000 Births | 2000 Births | 2000 Births | 2000 Births | 2200 Births | 2200 Births | 2200 Births | 2200 Births |
| | 3.03 ALOS | 2.7 ALOS | 3.03 ALOS | 2.7 ALOS | 3.03 ALOS | 2.7 ALOS | 3.03 ALOS | 2.7 ALOS |
| | 28.7% C/S | 28.7% C/S | 25% C/S | 25% C/S | 28.7% C/S | 28.7% C/S | 25% C/S | 25% C/S |
| LDR | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 |
| Postpartum | 22 | 21 | 22 | 21 | 24 | 23 | 24 | 23 |
| Triage | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| Antepartum | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 3 |
| TOTAL | 34 | 33 | 34 | 32 | 36 | 36 | 36 | 36 |

Predicted Bed Need Results by Scenario

| Scenario 1 - 2000 Annual Births - ALOS 3.03; C/S 28.7% | | | | | | | |
|--|-----|-------|----------------|--------------------------------------|---------------------------------------|---|--|
| Room Type | Max | Mean | Std. Deviation | 1 Std. Deviation (87% Confidence) | 2 Std. Deviations (95% Confidence) | 3 Std. Deviations (99.5% Confidence) | |
| LDR | 10 | 2.19 | 1.59 | 3.78 | 5.37 | 6.96 | |
| Post-partum | 26 | 13.24 | 4.23 | 17.47 | 21.7 | 25.93 | |
| Triage | 4 | 0.59 | 0.73 | 1.32 | 2.05 | 2.78 | |
| Antepartum | 6 | 1.1 | 1.1 | 2.2 | 3.3 | 4.4 | |

| Scenario 2 - 2000 Annual Births - ALOS 2.7; C/S 28.7% | | | | | | | |
|---|-----|-------|----------------|--------------------------------------|---------------------------------------|---|--|
| Room Type | Max | Mean | Std. Deviation | 1 Std. Deviation (87% Confidence) | 2 Std. Deviations (95% Confidence) | 3 Std. Deviations (99.5% Confidence) | |
| LDR | 11 | 2.26 | 1.59 | 3.85 | 5.44 | 7.03 | |
| Post-partum | 24 | 12.35 | 4.06 | 16.41 | 20.47 | 24.53 | |
| Triage | 5 | 0.59 | 0.75 | 1.34 | 2.09 | 2.84 | |
| Antepartum | 4 | 1.13 | 1.02 | 2.15 | 3.17 | 4.19 | |

| Scenario 3 - 2000 Annual Births - ALOS 3.03; C/S 25% | | | | | | | |
|--|-----|------|----------------|--------------------------------------|---------------------------------------|---|--|
| Room Type | Max | Mean | Std. Deviation | 1 Std. Deviation (87% Confidence) | 2 Std. Deviations (95% Confidence) | 3 Std. Deviations (99.5% Confidence) | |
| LDR | 8 | 2.21 | 1.57 | 3.78 | 5.35 | 6.92 | |
| Post-partum | 27 | 13.5 | 4.3 | 17.8 | 22.1 | 26.4 | |
| Triage | 5 | 0.57 | 0.72 | 1.29 | 2.01 | 2.73 | |
| Antepartum | 6 | 1.08 | 1.16 | 2.24 | 3.4 | 4.56 | |

Scenario 4 - 2000 Annual Births - ALOS 2.7; C/S 25%

| Room Type | Max | Mean | Std. Deviation | 1 Std. Deviation (87% Confidence) | 2 Std. Deviations (95% Confidence) | 3 Std. Deviations (99.5% Confidence) |
|-------------|-----|-------|----------------|--------------------------------------|---------------------------------------|---|
| LDR | 9 | 2.26 | 1.57 | 3.83 | 5.4 | 6.97 |
| Post-partum | 22 | 12.12 | 4 | 16.12 | 20.12 | 24.12 |
| Triage | 5 | 0.6 | 0.72 | 1.32 | 2.04 | 2.76 |
| Antepartum | 4 | 0.91 | 0.82 | 1.73 | 2.55 | 3.37 |

Scenario 5 - 2200 Annual Births - ALOS 3.03; C/S 28.7%

| Room Type | Max | Mean | Std. Deviation | 1 Std. Deviation (87% Confidence) | 2 Std. Deviations (95% Confidence) | 3 Std. Deviations (99.5% Confidence) |
|-------------|-----|-------|----------------|--------------------------------------|---------------------------------------|---|
| LDR | 9 | 2.51 | 1.74 | 4.25 | 5.99 | 7.73 |
| Post-partum | 29 | 15.19 | 4.41 | 19.6 | 24.01 | 28.42 |
| Triage | 5 | 0.66 | 0.79 | 1.45 | 2.24 | 3.03 |
| Antepartum | 4 | 1.1 | 0.96 | 2.06 | 3.02 | 3.98 |

Scenario 6 - 2200 Annual Births - ALOS 2.7; C/S 28.7%

| Room Type | Max | Mean | Std. Deviation | 1 Std. Deviation (87% Confidence) | 2 Std. Deviations (95% Confidence) | 3 Std. Deviations (99.5% Confidence) |
|-------------|-----|------|----------------|--------------------------------------|---------------------------------------|---|
| LDR | 9 | 2.52 | 1.67 | 4.19 | 5.86 | 7.53 |
| Post-partum | 27 | 13.8 | 4.64 | 18.44 | 23.08 | 27.72 |
| Triage | 5 | 0.64 | 0.77 | 1.41 | 2.18 | 2.95 |
| Antepartum | 5 | 1.35 | 1.05 | 2.4 | 3.45 | 4.5 |

Scenario 7 - 2200 Annual Births - ALOS 3.03; C/S 25%

| Room Type | Max | Mean | Std. Deviation | 1 Std. Deviation (87% Confidence) | 2 Std. Deviations (95% Confidence) | 3 Std. Deviations (99.5% Confidence) |
|-------------|-----|-------|----------------|--------------------------------------|---------------------------------------|---|
| LDR | 9 | 2.52 | 1.66 | 4.18 | 5.84 | 7.5 |
| Post-partum | 27 | 14.91 | 4.17 | 19.08 | 23.25 | 27.42 |
| Triage | 5 | 0.63 | 0.74 | 1.37 | 2.11 | 2.85 |
| Antepartum | 4 | 0.85 | 0.9 | 1.75 | 2.65 | 3.55 |

Scenario 8 - 2200 Annual Births - ALOS 2.7; C/S 25%

| Room Type | Max | Mean | Std. Deviation | 1 Std. Deviation (87% Confidence) | 2 Std. Deviations (95% Confidence) | 3 Std. Deviations (99.5% Confidence) |
|-------------|-----|-------|----------------|--------------------------------------|---------------------------------------|---|
| LDR | 11 | 2.55 | 1.79 | 4.34 | 6.13 | 7.92 |
| Post-partum | 31 | 13.05 | 4.64 | 17.69 | 22.33 | 26.97 |
| Triage | 5 | 0.64 | 0.76 | 1.4 | 2.16 | 2.92 |
| Antepartum | 4 | 0.96 | 0.93 | 1.89 | 2.82 | 3.75 |

Patient Overages and Days All Beds Full

| Scenario | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | 2000 Births | 2000 Births | 2000 Births | 2000 Births | 2200 Births | 2200 Births | 2200 Births | 2200 Births |
| | 3.03 ALOS | 2.7 ALOS | 3.03 ALOS | 2.7 ALOS | 3.03 ALOS | 2.7 ALOS | 3.03 ALOS | 2.7 ALOS |
| | 28.7% C/S | 28.7% C/S | 25% C/S | 25% C/S | 28.7% C/S | 28.7% C/S | 25% C/S | 25% C/S |

Patient Overages

| | | | | | | | | |
|-------------|-----|----|-----|----|-----|-----|-----|-----|
| Triage | 21 | 20 | 23 | 26 | 37 | 30 | 25 | 28 |
| LDR | 10 | 14 | 4 | 6 | 20 | 21 | 20 | 29 |
| Post-partum | 130 | 67 | 127 | 47 | 223 | 175 | 173 | 140 |
| Antepartum | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Days All Beds Full

| | | | | | | | | |
|-------------|----|----|----|----|----|----|----|----|
| Triage | 16 | 16 | 18 | 20 | 29 | 20 | 15 | 19 |
| LDR | 6 | 6 | 3 | 4 | 11 | 10 | 9 | 12 |
| Post-partum | 31 | 18 | 28 | 15 | 52 | 40 | 43 | 34 |
| Antepartum | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Staffing Results By Scenario

| Scenario | Mean | Std. Dev. | Mean + 1 | Mean + 2 | Mean + 3 | | | |
|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| | | | Std. Dev. | Std. Dev. | Std. Dev. | 1 | 3 | 5 |
| 1 - 2000 Annual Births - ALOS 3.03; 28.7% C/S | 5.65 | 2.68 | 8.33 | 11.01 | 13.69 | | | |
| 2 - 2200 Annual Births - ALOS 3.03; 28.7% C/S | 6.42 | 2.74 | 9.16 | 11.9 | 14.64 | | | |
| 3 - 2000 Annual Births - ALOS 2.7; 28.7% C/S | 5.49 | 2.55 | 8.04 | 10.59 | 13.14 | | | |
| 4 - 2200 Annual Births - ALOS 2.7; 28.7% C/S | 6.18 | 2.90 | 9.08 | 11.98 | 14.88 | | | |
| 5 - 2000 Annual Births - ALOS 3.03; 25% C/S | 5.7 | 2.61 | 8.31 | 10.92 | 13.53 | | | |
| 6 - 2200 Annual Births - ALOS 3.03; 25% C/S | 6.24 | 2.68 | 8.92 | 11.6 | 14.28 | | | |
| 7 - 2000 Annual Births - ALOS 2.7; 25% C/S | 5.34 | 2.49 | 7.83 | 10.32 | 12.81 | | | |
| 8 - 2200 Annual Births - ALOS 2.7; 25% C/S | 5.83 | 2.84 | 8.67 | 11.51 | 14.35 | | | |
| Mean + 1 Standard Deviation | | | | | | 1 | 3 | 5 |
| Daily Caregiver Hours Required | 199.92 | 192.96 | 199.44 | 187.92 | 219.84 | 217.92 | 214.08 | 208.08 |
| Weekly Caregiver Hours | 1,399.44 | 1,350.72 | 1,396.08 | 1,315.44 | 1,538.88 | 1,525.44 | 1,498.56 | 1,456.56 |
| Caregiver Hours Annualized | 72,771 | 70,237 | 72,596 | 68,403 | 80,022 | 79,323 | 77,925 | 75,741 |
| Caregiver FTE's Required | 34.99 | 33.77 | 34.90 | 32.89 | 38.47 | 38.14 | 37.46 | 36.41 |
| Fixed FTE's | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 |
| Fixed Management FTE's | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| TOTAL FTE'S REQUIRED | 51.39 | 50.17 | 51.30 | 49.29 | 54.87 | 54.54 | 53.86 | 52.81 |
| Mean + 2 Standard Deviations | | | | | | 1 | 3 | 5 |
| Daily Caregiver Hours Required | 264.24 | 285.60 | 254.16 | 287.52 | 262.08 | 278.40 | 247.68 | 276.24 |
| Weekly Caregiver Hours | 1,849.68 | 1,999.20 | 1,779.12 | 2,012.64 | 1,834.56 | 1,948.80 | 1,733.76 | 1,933.68 |
| Caregiver Hours Annualized | 96,183 | 103,958 | 92,514 | 104,657 | 95,397 | 101,338 | 90,156 | 100,551 |
| Caregiver FTE's Required | 46.24 | 49.98 | 44.48 | 50.32 | 45.86 | 48.72 | 43.34 | 48.34 |
| Fixed FTE's | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 | 12.4 |
| Fixed Management FTE's | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| TOTAL FTE'S REQUIRED | 62.64 | 66.38 | 60.88 | 66.72 | 62.26 | 65.12 | 59.74 | 64.74 |

The Recommendations:

- Reduce the mean cesarean birth post-partum length of stay. (Physicians agreed to focus on this recommendation based on their review of the results).
- Offer the option that obstetric patients from special religious populations having extended post-partum stays would either double up, using the two-bed antepartum rooms, or choose a shorter post-partum length of stay in a single bed room.
- Eliminate the use of the antepartum/GYN rooms for GYN patients and use two-bed antepartum rooms for overflow of post-partum patients (analysis indicated that only three antepartum rooms are needed). GYN inpatients would be accommodated in the medical surgical unit rather than in the obstetric facility.
- Continue to use the three multi-purpose rooms for triage, testing, cesarean section prep and recovery since this practice has been very successful and requires no change.
- Flex staffing levels up through overtime, per diem staff, on call staff and other means to fill current gaps. The unit is currently staffing between the 90% and 95% confidence levels, which means that 5-10% of the time there will be inadequate staffing for the volume at that time. Since experience has demonstrated that there is the ability to flex up, then actual staffing levels are adequate for the current volume.
- Revise processes that are contributing to the staffing problems experienced since the new unit opened and implement the revised processes in conjunction with the above recommendations.