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MODELING SUCCESSFUL INFUSION STRATEGIES

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ABSTRACT

This case study explores the use of Discrete Event Simulation (DES) to optimize resource planning and patient flow management in a high-volume oncology infusion center anticipating a five-year surge in demand. Conducted at HonorHealth Cancer Center, the simulation model, built with MedModel software (BigBear.ai) incorporated empirical data and subject matter expertise to evaluate several strategic initiatives, including extended hours of operation, inter-clinic chair sharing, optimized patient and pharmacy scheduling, and front office staffing adjustments. The five-year planning scenarios revealed that, without intervention, the center would experience severe capacity limitations. However, the integration of targeted improvements significantly enhanced chair availability, reduced patient queue times, and increased overall operational efficiency. This study highlights the transformative role of DES as a decision-support tool, underscoring the importance of DES consultants joining planning teams.

1 INTRODUCTION

Infusion therapy, the delivering of powerful, life-sustaining medications such as chemotherapy, immunotherapy, and targeted biologics, is a cornerstone of modern cancer treatment. As of 2025, the outpatient infusion market is projected to exceed $94 billion, growing annually at a rate of 10.6% (Pawar 2025). Factors fueling this growth include the rising incidence of cancer, the advent of cutting-edge therapies like CAR T-cell therapy and checkpoint inhibitors, and a healthcare-wide shift toward outpatient care. CAR T-cell therapy modifies a patient's T cells to attack cancer, while checkpoint inhibitors enable immune cells to detect and destroy tumors that previously evaded the immune system (National Cancer Institute 2023; American Cancer Society 2023). With escalating demand, efficient utilization of infusion chairs has become critical. This study is distinct in that DES served as a central decision-support tool to answer a myriad of sequential research questions as new information and questions unfolded for a cross-disciplinary planning team enabling data-driven decisions for a five-year phased expansion plan.

2 METHODS

The study was conducted at the HonorHealth Cancer Center and Research Institute in Scottsdale, Arizona. An internal DES consultant joined the team comprising nursing leadership, administrators, pharmacists, physicians, and analysts charged with optimizing a two-phase consolidated infusion center construction project. In phase one (the subject of this paper), an existing cancer center building will be expanded to accommodate up to 48 chairs and beds on one floor and 27 chair/beds on another floor. In phase two, five years into the future, construction will start on a new building that meets patient needs at that time.

The simulation used MedModel (BigBear.ai) software because it gave clients desired visual representation of interaction among the model's six entities, 104 locations, and 10 categories of resources which characterized a pharmacy and four infusion clinics: Medical Oncology (MedOnc), Gynecologic Oncology (GynOnc), Bone Marrow Transplant (BMT), and the Research Institute (HHRI). Validation was performed by comparing empirical data from the actual system to data produced by the model, where variables *Mean Arrivals per Day* and *Mean Process Lead Time* were compared for all four clinics, and samples indicated no statistical differences. During experimentation, Y variables such as *Vacant Chairs*, *Time in Queue*, *Time in Check-in Queue*, *Mean Closing Time*, and *Hood Process Lead Time* provided leaders with the prescriptive analytics necessary to make decisions among options that included 60 scenarios. Seven key experiments were conducted: 1) Consolidating MedOnc, GynOnc, and HHRI on the 4th floor confined to 40 chairs and 8 beds while placing BMT on the 3rd floor with 20 chairs and 7 beds. 2) Simulating 7% annual patient volume growth over five years. 3) Extending operating hours by two hours per day for each growth year. 4) Allowing limited inter-clinic chair sharing. While each clinic had dedicated chairs within the model, this experiment allowed for sharing of a limited number of chairs between clinics when a clinic reached capacity (for each growth year). 5) Determining the optimal number of front office (FO) staff needed on both floors for each growth year. 6) Testing efficient patient scheduling (e.g., longer infusions in the morning) for each growth year. 7) Estimating the optimal number of pharmacy hoods (where chemotherapy drugs are compounded) for each growth year.

Flow mapping was conducted for all clinics. Entities included patients, drug orders, and cleaning tasks; resources included registered nurses, medical assistants, front office staff, and pharmacy technicians. Arrival tables, containing empirical distributions, simulated the variation found in weekday-specific patient inflow between 6:00 AM and 3:00 PM. Activity times were derived from empirical time stamps and expert validation, with stochastic variation modeled using fitted distributions.

3 RESULTS

The baseline model showed sufficient performance for current volumes, but by year five, all clinics experienced decreased chair availability and prolonged queue times. Combining extended hours and limited chair sharing improved system efficiency markedly. Furthermore, efficient scheduling strategies yielded earlier clinic closing times and ensured more predictable end-of-day operations (See Table 1). Optimal front office staffing significantly reduced delays, with mean *Time in Check-in Queue* falling from 8.3 min to 0.3 min with two and four staff respectively. Regarding pharmacy operations, adding a fifth compounding hood reduced year five mean *Hood Process Lead Time* from 15.0 min to 9.1 min.

Table 1: Results.

Scenarios	Evaluative Criteria															
	Vacant Chairs				Mean Queue Time (Min)				Mean Chair Utilization				Mean Closing Time			
Clinic*	MO	GO	RI	BMT	MO	GO	RI	BMT	MO	GO	RI	BMT	MO	GO	RI	BMT
Base Case	3.7	3.5	8.7	14.7	6.1	6.7	3.9	3.5	50%	33%	33%		16.4	16.4	18.0	
Volume Increase	2.0	2.5	3.9	11.3	20.2	11.6	11.3	3.4					16.9	17.1	18.27	
Chair Sharing	2.1	1.5	3.8	14.3	11.0	11.0	11.0	3.4								
Add Extended Hours	3.1	3.0	4.3	14.7	5.9	5.9	5.9	3.4								
Efficient Scheduling	0.0	0.0	1.0		5.0	5.0	5.0	N/A	76%	80%	61%		15.5	16.8	17.3	

4 CONCLUSION

This case study demonstrates the strategic value of DES in healthcare planning, especially for high-demand environments like oncology infusion centers. The ability to simulate future growth and operational improvements provided the planning team with strong, visualized evidence to support investment decisions. Keeping the expanded patient volumes in house through tested strategies earned an estimated $21M in net profit. Incorporating DES into early planning stages enabled rapid experimentation, helping adapt facility design and staffing to projected needs. This work highlights how interdisciplinary collaboration and simulation can align healthcare operations with patient care demands.

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