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Evaluation of Patient Throughput in an Outpatient Pediatric Hematology, Oncology, and Bone Marrow Transplant Clinic

Presented to the Faculty of the School of Nursing

The George Washington University

In partial fulfillment of the

requirements for the degree of

Doctor of Nursing Practice

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Abstract

Background: Outpatient oncology clinics are complex environments. The multi-step, sequential nature of oncology treatment contributes to delays. Prolonged wait time impacts patient compliance, satisfaction, and staff satisfaction.

Objectives: To assess throughput in the outpatient pediatric oncology clinic and explore staff's assessment of throughput and their opinions of what might be improved.

Methods: Our descriptive-comparative study used retrospective reviews to measure four time intervals for 312 visits at our mid-Atlantic outpatient clinic. Patient and appointment factors were explored. Mean interval times were calculated and differences impacting throughput were analyzed using ANOVA. Prospective survey data were obtained from 22 clinic staff and themes were identified.

Results: The shortest interval was check-in to triage (18.49 ± 18.21 minutes) while the longest was from receiving laboratory results to treatment initiation (136.73 ± 77.98 minutes). Throughput was significantly shorter for appointments consisting of provider visit and laboratory studies only compared to visits involving infusions and blood product transfusions ($p < .001$). Throughput for 8:00-10:00 a.m. appointments was significantly longer than 2:01-6:00 p.m. appointments ($p = .013$). Staff respondents reported throughput was suboptimal. Common problems identified were appointment noncompliance, laboratory workflow, triage and front desk bottlenecks, physician timeliness, fellow workflow, and "saving seats".

Conclusions: Delays occurred at each clinic intersection but were significantly longer with early clinic appointments and infusion and transfusion visits. Staff highlighted problems at each clinic juncture and overarching problems that caused inefficiencies. We identified priority areas to be

addressed via targeted interventions in a structured action plan to improve clinic efficiency and throughput.

Background

There is a clear trend in the current health care system to provide cost-effective oncology care and chemotherapy treatment in the outpatient setting (Hendershot et al., 2005; Reid et al., 2016). Outpatient oncology clinics are complex environments in which many health care professionals must coordinate aspects of medical treatment to provide patients with safe and high-quality care (Suss, Bhuiyan, Demirli, & Batist, 2017). Oncology treatment and chemotherapy administration are multistep, sequential, interdisciplinary processes which involve several activities that must be completed prior to the patient receiving therapy. These include check-in, triage and vital sign assessment, accessing the central venous catheter (CVC) or obtaining peripheral intravenous (IV) access, drawing laboratory studies and awaiting results, assessment by the medical provider, and preparation, delivery, and administration of the chemotherapy, blood product, or other infusion (Belter et al., 2012). These activities occur consecutively and are contingent upon one step being completed before the next. This complex process may cause patients to experience delays and extended wait times in the clinic. Prolonged wait times can influence patients' perception of the quality of care, negatively affect compliance, and impact satisfaction (Davis, Burrows, Khallouq, & Rosen, 2017; Gjolaj, Campos, Olier-Pino, & Fernandez, 2016). Studies have also shown that extended wait times increase emotional turmoil and psychological burden for cancer patients (Gourdji, McVey, & Loiselle, 2003).

Many outpatient cancer centers have conducted research exploring approaches to reduce wait times and improve efficiency in patient throughput. Implementation of new scheduling methods aimed at maximizing resource utilization have shown promise at several institutions (Ahmed, ElMekkawy, & Bates, 2011; Suss et al., 2017; Woodall, Gosselin, Boswell, Murr, & Denton, 2013). Another approach involves drawing laboratory studies the day prior to chemotherapy to expedite treatment the following day (De Pourcq, Gemmel, Trybou, & Kruse, 2018; Dobish, 2003; Suss et al., 2017). Streamlining communication processes through development of standardized practice procedures has also shown success (Belter et al., 2012). Other approaches include implementation of fast track areas to improve efficiency for patients with short infusions or procedures (Kallen, Terrell, Lewis-Patterson, & Hwang, 2012). Each cancer center is structured differently and the chosen method to improve patient throughput must address the specific issues and needs of that clinic. However, the first step to improve patient throughput is to conduct a thorough evaluation of patient flow and identify which areas of the clinic contribute to delays and inefficiency (Belter et al., 2012) so that targeted interventions can be implemented to improve throughput.

Problem Statement

Patients often encounter delays at our outpatient pediatric hematology, oncology, and bone marrow transplant (BMT) clinic. Prolonged wait time was the issue most frequently cited on patient satisfaction surveys at our institution. Patients often reported that they arrived on time for their appointment but waited for an extended period before the visit began. Another common statement was that patients waited a long time for their chemotherapy to be ready. One patient experience survey question specifically asks if patients were kept informed of their wait time. This question was the lowest scoring domain at our pediatric cancer center.

Our nursing staff also identified patient throughput as a major issue that impaired overall clinic functionality. Inefficient processes often lead to disorganized patient flow and congestion, which puts added stress on nursing and support staff to complete tasks for several patients simultaneously. This pressure in combination with managing patient dissatisfaction has been linked to reduced job satisfaction and decreased staff commitment to the organization (Rondeau, 1998). Patient throughput in the pediatric hematology, oncology, and BMT clinic is associated with patient satisfaction, staff satisfaction, and patient outcomes. Further investigation of this topic was warranted to gain an understanding of the specific issues that contributed to throughput delays in our clinic to develop a targeted action plan for improvement.

Purpose

The purpose of our study was to assess patient throughput times in the outpatient pediatric hematology, oncology, and BMT clinic at a large teaching hospital in the mid-Atlantic region. A secondary purpose was to explore the staff's overall assessment of patient throughput and their opinions of what might improve throughput.

Aims

The specific aims of our study were to:

1. Evaluate patient throughput in the pediatric hematology, oncology and BMT clinic using the following time intervals:
    a. Time from check-in to triage.
    b. Time from triage to receiving laboratory results.
    c. Time from receiving laboratory results to treatment initiation.
    d. Total throughput time.
2. Explore clinic staff's overall assessment of patient throughput.
3. Explore clinic staff's opinion of what might improve patient throughput.

Research Questions

We assessed the following research questions:

For patients scheduled at an outpatient pediatric hematology, oncology, and BMT clinic:

1. What is the average time from check-in to triage?

2. What is the average time from triage to receiving laboratory results?
3. What is the average time from receiving laboratory results to treatment initiation?
4. What is the average total throughput time?
5. Is there a difference in total throughput time based on the type of appointment?
6. Is there a difference in total throughput time based on time of the appointment?
7. What is the clinic staff's overall assessment of patient throughput?
8. What are the clinic staff 's opinions about what might be done to improve patient throughput?

Significance

Effective patient throughput is essential to achieve and maintain efficiency in outpatient pediatric cancer centers. Optimizing processes for patient flow is an important initiative for healthcare institutions, as it directly impacts productivity, patient satisfaction, and compliance (Davis et al., 2017; Gjolaj et al., 2016). Patient experience is a top priority, especially since the Centers for Medicare and Medicaid Services (2017) executed the Hospital Value-Based Purchasing Program wherein reimbursement is contingent upon quality measures, one of which is patient experience. Patient satisfaction has been closely tied to wait time which is impacted by throughput (Davis et al., 2017; Matthews, Ryan, & Bulman, 2015). A thorough understanding of patient flow is required to effectively approach throughput issues (Gjolaj et al., 2016).

Our study took the crucial first step of evaluating patient throughput to identify factors and clinic intersections that contribute to significant delays. Based on the findings of the assessment, a targeted action plan was developed to improve throughput in the clinic. The findings from this study will add to the body of knowledge about factors that contribute to extended wait times and inefficiency in pediatric oncology clinics. These findings may also be generalizable to other outpatient centers. Additionally, the process of evaluation, the conclusions, as well as the action plan can help to guide our clinic as well as others in developing process improvement plans to optimize throughput.

Literature Review

Search Strategy

A literature search was conducted between November 2017 and November 2018 to address the research questions. The databases used for the search included CINAHL Plus, Medline Complete, PubMed, and Scopus. These databases were accessed through the Himmelfarb Health Sciences Library through The George Washington University. Keywords used in the searches included *outpatient*, *oncology*, *wait time*, *patient throughput*, *patient satisfaction*, and *simulation*. The Boolean operator “AND” was used with the keywords. Because of limited literature on process mapping and clinic throughput evaluation, the limitation for date range was set at 15 years for each search.

Inclusion and Exclusion Criteria

Inclusion criteria applied included (a) written in the English language, (b) published within the past 15 years, (c) adult and pediatric oncology population, and (d) outpatient setting.

Exclusion criteria included (a) inpatient setting and (b) non-oncology population.

Literature Search Results

A total of 218 articles were identified through literature searches and an additional 39 articles were identified through the reference lists of articles, making a total of 257. After duplicates were identified and removed, there were 137 records available, of which all titles and abstracts were reviewed. Articles were included and excluded based on the outlined criteria.

A recurrent theme in the literature review was that outpatient oncology clinics have a finite number of treatment chairs and resources, which makes patient throughput an essential focus to optimize clinic efficiency. To develop a targeted action plan aimed at improving patient throughput, there must be a thorough patient flow assessment from entry to discharge. The evaluation should analyze each step of the patient visit to identify specific events which contribute to delays (Gjolaj et al., 2016). Many outpatient oncology clinics have implemented initiatives to improve patient throughput based on information obtained from the assessment of clinic flow pre-intervention (Belter et al., 2012; Dobish, 2003; Gjolaj et al., 2016; Gjolaj, Gari, Olier-Pino, Garcia, & Fernandez 2014; Kallen et al., 2012; Skledon et al., 2014). Most assessments have revealed multiple factors that lead to delays.

Hendershot et al. (2015) developed a task force which reviewed the process flow of clinic visits in relation to specific chemotherapy protocols in the outpatient pediatric oncology clinic at the Hospital for Sick Children in Ontario, Canada. Their findings identified several factors that contributed to prolonged wait times including extended registration process, delays in obtaining laboratory studies and preparing chemotherapy, inadequate nursing resources, and space constraints. Based on their assessment, a project studying a nurse-run express chemotherapy clinic was piloted for 76 patients who met outlined criteria. Evaluations were completed by 46 of the 76 enrolled families (61% response rate). Eighty-nine percent of families felt they always or usually received chemotherapy in a timely manner through the express chemotherapy clinic and almost all families reported that the express track improved clinic efficiency.

Kallen et al. (2012) found that extensive wait time was a primary source of patient dissatisfaction within the network of six outpatient oncology treatment centers at the MD Anderson Cancer Center. The team observed all appointment-related events for 1,303 visits over a one-month period using an appointment tracking and measurement system. They also conducted interviews with various staff members to explore their perception of patient throughput. Based on their assessment, an intervention study was implemented which utilized a fast track room to improve efficiency for patients with shorter infusions. A new communication system to obtain chemotherapy orders more quickly from physicians was executed. Additionally, an information technology-based communications application for notification of chemotherapy preparation was created for pharmacy. There was a 26.8% mean reduction in wait time post-intervention based on analysis of 1,224 appointments during the one-month intervention period.

Gjolaj et al. (2014) developed a process flow diagram of their outpatient oncology infusion center, and based on 59 visits over three months, were able to identify that laboratory turnaround time contributed to delays. A root cause analysis was conducted to determine process changes that could optimize laboratory operations. Phlebotomy processes were streamlined by creating a dedicated phlebotomy station in the clinic. The number of process steps were reduced from eight to four, laboratory tubes were upgraded, and the procedure for sending samples to the laboratory was modified. These changes decreased laboratory turnaround time by 53% and total wait time by 17% in a sample of 59 appointments over a nine-week intervention phase.

These outpatient oncology clinics' experiences highlight the importance of conducting a thorough evaluation of patient throughput to develop a targeted action plan to improve clinic efficiency. Baseline data provides a foundation for process improvement projects by identifying areas that contribute to delays and recognizing non-value-added work. The data is used to compare the outcomes post process improvement. The action plan for each cancer center in the literature was unique and based upon the initial evaluation of clinic processes. The evaluation is a critical step that must be carried out to ensure success of the project (Belter et al., 2012).

Most studies in the literature that were conducted with the goal of improving outpatient cancer center efficiency utilized simulation to determine resource utilization, map clinic performance, and find the best scheduling method. Ahmed, ElMekkawy, and Bates (2011) tested several scheduling templates in patients receiving chemotherapy to determine which served the most patients while using resources most efficiently. Woodall et al. (2013) used a simulation-optimization model which indicated that adjustment of nurse schedules according to patient volume and adding part-time nurses would have the largest impact on wait times. Studies by Chabot and Fox (2005) and Cusack, Jones, and Chisholm (2004) focused on creating patient acuity classification systems to guide staffing needs, scheduling, and resource allocation to improve clinic efficiency.

In total, there were 56 studies identified that focused on simulation, scheduling, and staffing modifications to optimize patient throughput. Only 13 studies focused on analysis of the current clinic state without simulation, and subsequent development of an action plan based on the findings. Our study helped to fill this gap in the literature by conducting a systematic assessment of patient throughput to identify patient and clinic factors that contribute to delays and then developing a targeted plan to improve patient throughput and efficiency.

Theoretical Framework

Lean transformation is a framework that focuses on maximizing value and minimizing non-value-added waste (Lean Enterprise Institute, 2018). There is an emphasis on optimization of the flow of services through the entire value stream rather than on individual parts of the system. This strategy was initially developed to improve manufacturing by Toyota Motor Company in the 1980s and has since been applied in many settings including various businesses and industries, government organizations, and healthcare (Lean Enterprise Institute, 2018). In healthcare, this system can be used to eliminate non-value-added steps and streamline patient visits to optimize efficiency, improve safety, and thereby reduce wait times and increase patient satisfaction. Many healthcare organizations have used lean transformation to improve care delivery (Belter et al., 2012; Gjolaj et al., 2016; Wineke, Goedbloed, & van Harten, 2009).

The many steps and departments involved in an outpatient oncology clinic visit create opportunity for errors, corrections, and miscommunication which leads to potential for increased patient wait time, inefficient allocation of staff resources, drug waste, and increased costs (Belter et al., 2012). The goal of using the lean transformation framework in our outpatient pediatric clinic was to evaluate our current processes and identify opportunities to improve coordination of care, eliminate waste, and ultimately improve patient throughput.

There are five principles to guide the implementation of a lean transformation (Figure 1). The first is to identify value from the perspective of the consumer and organization. For our project, value was defined as decreased wait time and improved clinic efficiency. The second phase is to map the value stream and identify non-value-added steps which cause delays and can be eliminated (Lean Enterprise Institute, 2018). Within the framework, the process by which an organization identifies, understands, and responds to challenges begins with gaining a deep knowledge of the situation (Shook, 2010). This is the step upon which our study concentrated.

The third phase is to create flow by implementing changes that add value, increase efficiency, and improve throughput based on findings from our analysis. The next step of the process is to allow the staff and patients to pull value from the new flow. An analysis of the new system will take place and additional areas for improvement will be identified. The process is continuous and repeats with the goal of maximizing value and minimizing waste. Our study was guided by the lean transformation process by evaluating the current state of patient throughput in the pediatric hematology, oncology, and BMT clinic as the first step to improving efficiency (Lean Enterprise Institute, 2018).

Study Variables

The independent variables for our study focused on patient and appointment factors that may impact patient throughput. The dependent variables measured throughput times at each intersection during the clinic visit and total throughput time. Additional qualitative variables measured the clinic staff's overall assessment of patient throughput and what the staff thought might be done to improve throughput. Refer to Table 1 for a full description of study variables.

Methods

Research Design

We conducted a descriptive-comparative study to analyze patient throughput in the pediatric hematology, oncology, and BMT clinic. Four time intervals throughout the clinic visit were measured to identify the intersections that cause delays. Patient information and details about the visit were also collected to determine patient-specific and appointment-specific factors that impact throughput. The data were obtained through retrospective chart reviews. Prospective data were obtained from clinic staff through two survey questions focusing on their opinion of clinic throughput and what may be done to improve throughput.

Study Sample

The target sample was children, adolescents, teenagers, and young adults with hematologic and oncologic conditions who received care at the pediatric hematology, oncology, and BMT outpatient clinic. Patients treated at the clinic range from less than one year old to late 20s. Conditions treated at the clinic consist of hematologic malignancies, solid tumors, and neurological cancers. Non-malignant hematologic conditions treated include sickle cell anemia, hemophilia, and thrombosis. The clinic also provides care for patients who have undergone BMT for treatment of an oncologic or non-malignant disease. Additional oncologic and hematologic diagnoses aside from those listed are also treated.

The most common types of appointments that occur in clinic include: (a) provider visit, laboratory studies, and infusion; (b) provider visit, laboratory studies, and blood product transfusion; and (c) provider visit and laboratory studies.

Clinic staff that were invited to participate in the survey questions included those that provide direct care to patients as they move through the various intersections of a clinic visit. The people in these roles are best able to understand and analyze clinic throughput.

Inclusion and Exclusion Criteria

We included all patients, including male, female, and all races, seen at the clinic who met inclusion criteria. Patients were included if they met the following criteria: (a) were of any age and being seen at the clinic, (b) had a hematologic or oncologic diagnosis, (c) were receiving chemotherapy or biotherapy, (d) were receiving non-chemotherapy infusions or treatments, (e) were receiving blood product transfusions, (f) were receiving any combination of treatments, (g) were scheduled or walk-in patients, and (h) were being admitted to the hospital from clinic.

Patients excluded from the study were those who had the following: (a) a procedure scheduled during the clinic visit (i.e. bone marrow biopsy or lumbar puncture), (b) a diagnostic test scheduled during clinic visit (i.e. CT scan or echocardiogram), (c) an appointment to see the provider and/or have a treatment without laboratory studies, (d) treatment scheduled that was not contingent upon laboratory results from that day, and (e) repeat visits for a single patient. Patients with tests and procedures were excluded because the tests may have occurred during the visit before the initiation of treatment and created inaccurate representation of throughput. Patients without laboratory studies were excluded because these types of appointments rarely occur and the lack of time measurement for laboratory studies may have skewed the overall assessment of throughput. The three most common types of appointments were included in the analysis of throughput: (a) provider visit, laboratory studies, and infusion; (b) provider visit, laboratory studies, and blood product transfusion; and (c) provider visit and laboratory studies.

Clinic staff included the following: (a) physicians, fellows, advanced practice nurses, nurses, nursing attendants, or certified medical assistants; (b) individuals providing direct medical, nursing, or supportive care to patients throughout all phases of the clinic visit; and (c) individuals able to read and write in English.

Clinic staff were excluded if they met the following criteria: (a) worked in the clinic for less than six months, (b) did not provide direct care to patients, or (c) did not interact with patients throughout all clinic intersections.

Sample Size

On average, 40-50 patients are seen per day at the pediatric clinic and 20 of those patients receive a treatment. The clinic is open Monday through Friday and closed on weekends and holidays. Approximately 200-250 patients are seen per week and 100 patients receive treatments.

A random sample of patients with appointments between November 1, 2017 and April 30, 2018 was analyzed. An analysis of variance (ANOVA) was used to compare the means of the time intervals throughout the clinic visit for each appointment type and appointment time. For three groups, assuming a small effect size (eta-squared of 0.03), power of 80%, alpha of 0.05, a minimum sample size of 105 was needed. To gain a complete understanding of clinic throughput with an adequate number of each appointment type, the goal sample size was increased to 312, aiming to collect a balanced number of subjects in each of the three appointment categories.

There are approximately 125 staff members that work in the pediatric hematology, oncology, and BMT clinic. Of those, 48 staff members are in a medical, nursing, or supportive staff role and interact with patients throughout the phases of the clinic visit. The convenience sample of 48 staff members was invited to participate in the survey regarding clinic throughput. The survey was distributed between September 10, 2018 and November 1, 2018.

Recruitment of Subjects

Participants for the retrospective chart reviews were identified through historical schedule information from November 1, 2017 to April 30, 2018. During the twenty-six-week study period, patients were randomly selected from the schedule, starting with the first scheduled day each week, to reach the total sample size. Starting from November 2017, a patient was chosen at random and every tenth patient was assessed for eligibility for inclusion in data analysis. This process continued until the goal sample size was reached.

An email was sent to all 48 staff members that met inclusion criteria explaining the purpose of the study and inviting them to participate in the survey. The institution required that an information sheet, including the consent statement, be provided to survey participants. This information sheet was incorporated in the e-mail invitation to participate in the survey as well as a link to complete the survey. Follow up emails were sent weekly through the end of the data collection period. The goal response rate for survey completion was 50%.

Setting

The clinic is a combination physician office and infusion center. Depending on the patients' needs and type of appointment, patients may have laboratory studies drawn, see the provider, and receive treatment in one location during their visit. Providers at the clinic include physicians, fellows, and advanced practice nurses. Registered nurses access central lines, draw laboratory studies from CVCs, place peripheral intravenous lines, administer medications including chemotherapy and blood products, and provide supportive care. Support staff include nursing attendants who assess vital signs and provide supportive care; and certified medical assistants who perform phlebotomy, assess vital signs, and provide supportive care.

Patients check-in at the front desk upon arrival at the pediatric cancer center, which then generates their identification band and signals the start of their visit. Patients wait in the waiting room until called into the triage area where vital signs are assessed. The phlebotomy room for peripheral laboratory studies is located within the clinic treatment area. The cancer center pharmacy prepares our clinic patients' chemotherapy and other medications. The laboratory in the cancer center processes most studies drawn in the clinic, although some specialized studies are sent nearby to the main hospital laboratory. The blood bank is located across the street in the main hospital and blood products for clinic patients are obtained by a courier.

Instruments and Measurement

All study data were entered in a Microsoft Excel spreadsheet. Data were extracted manually through retrospective chart reviews. Demographic information (i.e. age and sex), clinical information (i.e. diagnosis and route of laboratory studies), and appointment information (i.e. appointment type and appointment time) were obtained from the electronic medical record (EMR). Time intervals were calculated in minutes based on defined time points for the four clinic intersections (Table 1) and were extracted from the EMR. Patients were immediately coded upon data extraction by linking medical record number to a participant identification number in the Excel spreadsheet. The code sheet linking the two numbers as well as the Excel spreadsheet were stored on an encrypted thumb drive. Once data collection was complete, the code sheet was deleted.

The prospective staff survey included four multiple choice demographic questions about age range, gender, job title, and number of years working in the clinic. Participants were also asked two open-ended questions regarding patient throughput. The first question asked, "What is your overall opinion of patient flow in the clinic? Patient flow is defined as: The movement of patients through the various phases of their clinic visit starting with check-in, triage, attainment and resulting of laboratory studies, and ending with either treatment initiation or provider visit (if no treatment is required)". The second question asked, "Please share your opinion about what could be done to improve patient flow in our clinic" (see Appendix A for survey). Responses were exported from Qualtrics to Excel for data analysis.

Data Collection Procedure

Patient-specific, appointment-specific, and clinical data were collected through retrospective review of the EMR. Data were obtained from header of the EMR, provider and nursing progress notes, medication administration record, and flowsheets. The time of scheduled appointment and time of check-in were found in a separate electronic system which manages the schedule. The student investigator of the study collected all data.

Time intervals between clinic activities were measured in minutes based on time points at the various intersections. Our cancer center has a two-part check-in process which involves two computer systems; one of which generates the identification band, and one that generates the bill. Our study measured check-in time from the system that generated the bill. Time at triage was specified by the time when triage vital signs were entered in the EMR. Time that laboratory studies were received was based on the time stamp on the result in the EMR. Time of treatment initiation was recorded based on the time that the medication was signed in the EMR or the time that the blood product was started as documented in the transfusion note. Time intervals between each clinic activity were calculated separately and added together for total throughput time.

Demographics and qualitative information from clinic staff regarding their opinion about patient throughput were obtained through survey questions on Qualtrics between September 10, 2018 and November 1, 2018. Responses were read and analyzed by the student investigator and validated by a second reader.

Data collection by one person was reasonable in this study because the sample size was not too large. Using one person for data collection helped to ensure consistency in the data that was retrieved.

Data Analysis Plan

Data were entered in the Microsoft Excel spreadsheet by the student investigator. Data from the Qualtrics survey were exported into Excel at the completion of the data collection period. To ensure accuracy of data entry, 10% of the data was randomly selected to be double checked by a second student investigator who was familiar with the institution's EMRs and had completed the Collaborative Institutional Training Initiative (CITI) program. The accuracy check was performed in October 2018. Inaccurate data were flagged by the reviewer and subsequently reviewed by both parties together. One incorrect entry was identified and corrected. Following collection of all data and the accuracy check, the data were exported from Microsoft Excel to IBM SPSS 25, which was used for data analysis.

Descriptive statistics were performed for each variable. Descriptive statistics were used to address research questions one through four which assessed the average time intervals between each clinic intersection. Mean, standard deviation, minimum and maximum times were examined.

In addition, the distributions were examined using skewness and histogram with normal curve imposed, and outliers were identified.

ANOVA was used to assess research questions five and six, which analyzed whether there was a difference in the total mean throughput time based on appointment type or appointment time. Post-hoc analyses were calculated using the Scheffe test to identify mean group differences by appointment type and appointment time. The level of significance was set at 0.05.

A qualitative assessment of survey responses was performed for research questions seven and eight to identify recurring phrases and themes about staff's opinion of patient throughput and what might be done to improve throughput. First, the student investigator read all the survey responses to get a general sense of the information. Next, the data were hand-coded into categories by similar phrases and organized in an Excel spreadsheet. Based on the recurring phrases, themes were identified. A second student investigator also read the survey responses and validated the themes. The findings of the analysis were described in narrative form.

Research Ethics

Our study received Institutional Review Board (IRB) expedited approval from the medical center where research took place as well as The George Washington University. Participation in the staff survey was voluntary and participants opened the survey through an anonymous link. Responses were accessible only by the student investigator. Once data were exported from Qualtrics to Excel, the data were stored on an encrypted thumb drive.

Patient medical record numbers were assigned a participant identification number, which was used in the Excel data spreadsheet immediately upon data extraction. The code sheet linking the two numbers was stored on an encrypted thumb drive and once data collection was completed, the code sheet was deleted. Patient data were stored in an Excel spreadsheet on an encrypted thumb drive. The SPSS data files were also stored on an encrypted thumb drive.

Results

Retrospective Chart Reviews

Demographic and clinical patient characteristics. For the total sample of 312 patients (Table 2), most were between the ages of three and 17 (n = 222; 71.2%). The majority of patients were male (n = 165; 52.9%). Most patients had a hematologic malignancy (n = 79; 25.3%) or non-oncologic hematology diagnosis (n = 130; 41.7%). Peripheral venipuncture was the most common route of laboratory studies (n = 217; 69.6%).

Average time between clinic intersections. To address research questions one through four, the mean time in minutes and standard deviation between specified clinic intersections were calculated (Table 3). The shortest interval was check-in to triage with a mean time of 18.49 ± 18.21 minutes. The intention was to measure check-in to triage time for every patient, however it was discovered upon data collection that 89 patients were triaged before check-in. Of those 89 patients, 46.1% were receiving infusions or blood product transfusions and 54% were having a provider visit and laboratory studies only. Of note, 59.6% of the patients who were triaged before check-in had appointments between 8:00 and 10:00 a.m. Therefore, the mean check-in to triage interval was calculated for the 223 patients who followed the intended sequence. The mean time from triage to receiving laboratory results was 94.19 ± 61.92 minutes. The longest time interval was between receiving laboratory results to treatment initiation with a mean time of 136.73 ± 77.98 minutes. The total mean clinic throughput time was 146.03 ± 89.60 minutes.

Difference in total throughput time by appointment type. For the total sample of 312 patients (Table 2), most had appointments consisting of provider visit and laboratory studies only (n = 222; 71.2%) followed by provider visit, laboratory studies, and infusions (n = 58; 18.6%), with the fewest consisting of provider visit, laboratory studies, and blood product transfusions (n = 32; 10.3%). To address research question five, a one-way ANOVA was conducted to evaluate differences in total throughput time based on the type of appointment (Table 4). The shortest total mean throughput time was found in the provider visit and laboratory studies only group (115.53 ± 71.36 minutes) while the longest was the provider visit, laboratory studies, and blood product transfusion group (230.84 ± 105.08 minutes). The difference in total mean throughput time for the three appointment types was statistically significant ($F = 62.67$; $p < .001$). Scheffe post hoc analyses indicated that throughput time was significantly shorter for appointments consisting of provider visit and laboratory studies only compared to visits involving infusions ($p < .001$) and blood product transfusions ($p < .001$). There was no significant difference in throughput time between infusion appointments and blood product transfusion appointments.

Difference in total throughput time by appointment time. The majority of appointments were between 8:00 and 10:00 a.m. (n = 124; 39.7%) and 10:01 a.m. to 12:00 p.m. (n = 100; 32.1%). The lowest volume was between 12:01 and 2:00 p.m. (n = 40; 12.8%). Between 2:01 and 6:00 p.m. there were 48 appointments (15.4%; Table 2). To assess research question six, we evaluated differences in total throughput time based on appointment time using a one-way ANOVA. The shortest total mean throughput time was in the 2:01 to 6:00 p.m. group while the longest was in the 8:00 to 10:00 a.m. group (Table 4). The differences in total mean throughput time for the four appointment times was statistically significant ($F = 4.01$; $p = .008$). Scheffe post hoc analyses indicated that throughput time for appointments between 8:00 and 10:00 a.m. (162.26 ± 103.68 minutes) was significantly longer than appointments between 2:01 and 6pm (112.48 ± 58.28 minutes; $p = .013$). The other appointment times were not statistically different.

Prospective Staff Survey

Staff survey participant demographic and role characteristics. There were 22 of 48 eligible staff members who responded to the survey (46% response rate; Table 5). The majority of respondents were registered nurses, medical assistants, and nursing attendants (n = 9; 40.9%), and advanced practice nurses (n = 7; 31.8%). Most respondents had worked in the clinic for over 10 years (n = 14; 63.6%) or between 1 and 5 years (n = 7, 31.8%). Almost all respondents were females (n = 21; 95.5%) and most were between the ages of 21 and 51 (n = 12, 54.6%) years old.

Clinic staff overall assessment of patient throughput. The first open-ended question on the staff survey assessed research question seven. Overall, staff believed that patient throughput was suboptimal. Four people referred to throughput as inefficient. Three responses indicated that the clinic flow was poor. Other responses described throughput as complicated, illogical, inconsistent, and fair at best. Respondents noted that the flow is contingent upon several variables and that bottlenecks form at both check-in and triage. Several staff commented that the current process could be improved.

Clinic staff opinion about what might improve throughput. Research question eight was assessed by the second open-ended survey question. Problems that contributed to throughput inefficiencies and delays as well as solutions for improvement were identified and could be organized into seven themes (Table 6). The most commonly cited problem was non-compliance with appointment time (n = 14; 63.6%). Respondents explained that patients frequently arrived at clinic several hours before or after their specified appointment time and were still accommodated, which significantly impacted the clinic flow and wait times. A solution recommended by several staff was that appointment times should be strictly enforced, and if medically safe, patients should be rescheduled when they are late. Phone calls reminding patients of their appointment date and time was another proposed solution.

The second most commonly occurring problem was laboratory processes (n = 12; 54.5%). Specifically, issues surrounding ordering laboratory tests were cited several times. staff proposed requiring orders to be placed in advance and to revise the procedure for same-day ordering when necessary as a solution. Another problem was the workflow for drawing blood. Recommended solutions were to assign a designated CVC nurse and a dedicated phlebotomist without additional clinic responsibilities. Issues locating the laboratory requisitions were also discussed as cause for laboratory delays and creating a standard method to organize the requisitions was a recommendation for improvement.

It seemed to be the consensus that the front desk staff played an important role in clinic functionality, but problems with the front desk workflow and check-in process were cited 10 times (45.4%) in survey responses. Specifically, respondents noted that there was a lack of accountability, collaboration, and leadership with front desk staff which contributed to dysfunction at this clinic intersection. Another problem was that there was a two-part check in process; one to generate an identification band, and one to generate a bill. Recommended solutions were to simplify this process to one step and to actively involve the front desk leadership in daily operations and clinic meetings.

Triage workflow was another problem identified in the surveys (n = 8; 36.3%). Limited space in triage causing a bottleneck was mentioned several times, as well as the recommended solution to expand the area, creating the ability to simultaneously triage multiple patients. Another suggestion to improve efficiency was to modify the documentation process to eliminate paper and allow for vital-sign entry into the EMR only.

Physician timeliness was a problem that was mentioned seven times (31.8%). Physicians arrived late to clinic and did not see patients based on their appointment times. Respondents suggested that when physicians are scheduled in clinic, they should not also be scheduled to perform procedures in the operating room. Another issue was fellow and advanced practice nurse scheduling and duties (n = 5; 22.7%). Staff reported that the fellows transitioning from covering the oncology service in the morning to the hematology service in the afternoon contributed to significant inefficiency. A suggestion for resolution was that fellows do not cover both services on the same clinic day. Additionally, advanced practice nurses' schedules did not align with clinic needs. A recommendation for improvement was to schedule more advanced practice nurses on days when clinic volume is typically higher. Saving seats in clinic was an issue which was mentioned four times (18.1%). Patients often saved infusion chairs before they were ready to receive their treatment which created congestion and chaos in the treatment area. A proposed solution was to restrict this practice to improve clinic flow.

Discussion

We assessed four time intervals between clinic intersections to determine where delays were occurring during clinic visits. The findings indicated that the mean time from check-in to triage was reasonable. Conversely, check-in and triage were cited in the staff survey as major areas of bottlenecking and delays in the clinic. Notably, when collecting the data, we realized that many patients were triaged before being checked-in. Upon further evaluation, we discovered that the two-step check-in process was the most likely cause for this discrepancy in the expected sequence of clinic events.

The clinic uses two separate computer systems for check-in purposes. A patient is checked-into one system to generate their identification band and the second system generates their bill after the visit. In our study, we measured check-in time from the system that generates the bill. The staff member that manages the billing system did not start work until 9:00 a.m., which caused a delay in the check-in time for patients who had appointments between 8:00 and 9:00 a.m. Of note, the billing check-in did not delay the start of the clinic visit and was only required to generate the bill afterward. Another reason that triage occurred before check-in was if a patient arrived who required immediate medical attention. These patients bypassed the billing check-in station and were escorted to the treatment area to be assessed. Patients that did not follow the intended sequence of check-in followed by triage were excluded from the check-in to triage time assessment. Based on these discovered complexities and disorganization, check-in and triage are likely two areas of clinic that contribute to substantial inefficiency.

Our findings also indicated that the process of drawing laboratory studies and obtaining results contributed to delays in clinic. There were laboratory delays, although not perversely long. Therefore, the time interval for this clinic intersection may represent the typical time required to perform the necessary tasks and process the laboratory studies to some degree. However, it is expected that the throughput results for this clinic intersection reflect instances when tests were not ordered the day before the visit, there were delays in drawing blood, there were interruptions in processing samples in the laboratory, and requisitions were not organized. There were likely instances when the providers may have had the ability to identify potential for delays in the laboratory process in real-time and intervene to correct the issue. In these cases, the disruption in provider workflow could have potentially contributed to delays later in the visit due to unexpected redistribution of staff resources.

The literature revealed that laboratory processes were a commonly identified issue which contributed to delays in outpatient cancer centers (De Pourcq et al., 2018; Gjolaj et al., 2014;

Gjolaj et al., 2016; Hendershot et al., 2015). Eliminating laboratory studies on the day of treatment could reduce the number of process steps in a clinic visit, which was the approach used by Gjolaj et al. (2016) to improve their clinic flow. Gjolaj et al.'s (2016) team identified patients that were eligible to have orders signed and laboratory studies completed the day prior to treatment. Using the expedited workflow process, there was a decrease of 17 minutes in mean wait time and a 17% increase of value-added time for 527 eligible patient visits over a five-month period. Similarly, De Pourcq et al. (2018) compared throughput times for patients having laboratory studies drawn the day before versus the day of treatment for 243 visits at two outpatient chemotherapy centers. There was a statistically significant decrease in mean throughput time of 53 minutes for patients whose laboratory studies were drawn the day before treatment. Drawing blood in advance of the treatment day requires additional travel and time commitment from the patient, however, this process could be coordinated with a laboratory or physician office closer to home. Additionally, the improvement in patient experience the day of treatment may outweigh the inconvenience of the added visit.

The longest interval in our study was the time from receiving laboratory results to treatment initiation, which encompassed the time required for providers to clear the patient for treatment, the time for pharmacy or blood bank to prepare and dispense medication or blood product, and the time for the registered nurse to initiate therapy. As expected, we found that appointments with provider visit and laboratory studies only were significantly shorter than those with infusions or blood product transfusions, as the infusions and transfusions required additional preparation. Notably, there was no significant difference in throughput time between infusion and blood product transfusion appointments, which indicated that the blood bank and pharmacy had comparable preparation times. Neither pharmacy nor blood bank processes were recognized as areas which contributed to clinic inefficiencies on our staff survey. However, the identified staff survey themes of physician timeliness, and fellow and advanced practice nurse scheduling and duties likely contributed to delays in evaluating and clearing patients for treatment.

Soh et al. (2015) tested the impact of preparing chemotherapy the day before scheduled treatment on throughput times. They found that preparing chemotherapy in advance depended upon drug stability, cost, and the patient’s ability to complete laboratory studies in advance of the visit. Soh et al. (2015) found that mean wait times were reduced by 66% from 65.74 minutes to 22.44 minutes over the six-month study period by preparing chemotherapy in advance of the visit. Notably, there were no drug wastages. Eliminating time spent waiting for laboratory results and drug preparation would likely significantly reduce throughput time and streamline flow.

Our findings indicated that appointments scheduled between 8:00 and 10:00 a.m. were significantly longer than those between 2:01 and 6:00 p.m. The most frequent appointment time was 8:00 to 10:00 a.m. and the majority of all appointments were scheduled between 8:00 a.m. and 12:00 p.m. The sheer volume of patient appointments scheduled during the morning hours likely contributed to clinic congestion and delays. Suss et al. (2017) used a discrete event simulation model to develop a scheduling algorithm for their outpatient cancer center to optimize resource utilization and decrease patient throughput times. Specifically, they adjusted the order and rate that patients arrived for appointments based upon projected length of appointment and required resources. The algorithm alone decreased wait time by 25%. When they incorporated interventions to reduce pharmacy delays for order clarification from 33% to 10%, the average overall wait time decreased by 44%. These reductions in wait time highlight the benefit of strategic scheduling and the impact that it can have on overall clinic functionality.

Despite careful scheduling, noncompliance with appointment time is a factor that can perpetuate disorganization and inefficiencies. Although noncompliance was the most commonly cited theme in our staff survey, we did not measure data on compliance with scheduled appointment time in our study. Skeldon et al. (2014) identified appointment lateness as a factor that contributed to wastefulness in their uro-oncology clinic and therefore implemented telephone and e-mail appointment confirmations. The reminders in combination with other modifications to clinic workflow significantly reduced mean clinic throughput time from 46 minutes at baseline to 35 minutes at 60 days ($p < .001$) and 41 minutes at 90 days ($p = .051$).

Our study revealed that clinic throughput was perceived as generally suboptimal by the staff. The identified themes supported the data that we collected which identified congested clinic intersections including check-in at the front desk, triage, and the laboratory. The dual-check-in process and lack of accountability of the front desk staff were identified as problems that could be addressed to improve efficiency. Bottlenecks at triage due to lack of space were also recognized as problems which contributed to delays. Laboratory orders not being placed in advance, prolonged wait time for blood to be drawn, and disorganization of laboratory requisitions were issues identified by staff that should also be corrected. Physicians being late to clinic and being scheduled for procedures during clinic hours were problems that staff identified as contributing to delays. Advanced practice nurses' schedules being misaligned with clinic volume needs and fellows switching services between oncology and hematology midday were also issues that staff felt contributed to clinic inefficiencies. Staff also described patients "saving seats" in the treatment area before they were ready to receive their therapy as an issue that caused congestion and chaos. Each of these identified problems had associated solutions which could potentially improve clinic efficiency and reduce throughput times.

Study Limitations

A limitation of this study was the inability to obtain a balanced sample size in the three appointment type categories because we excluded repeat clinic patients. Most patients receiving infusions and blood product transfusions returned to clinic during the study period but could be included in analysis only once, which resulted in smaller sample sizes in the infusion and blood product transfusion groups. Another limitation is that we did not measure data on compliance with appointment time. Understanding the volume of noncompliant patients would lend insight to the impact of this issue on clinic functionality.

Additionally, we did not collect information about time from patient clearance for therapy to treatment initiation. This time interval would directly reflect pharmacy and blood bank preparation time and highlight potential delays due to their workflows. The time interval that we studied, from laboratory results being received to treatment initiation, encompasses the time required for patients to be assessed by the provider. Therefore, it is not clear whether the time span reflects provider, pharmacy, or blood bank delays.

Another limitation is that we did not measure the time interval between laboratory studies being collected and receiving study results. This time interval would directly correlate with internal laboratory processes which may or may not contribute to delays. Rather, we measured the time from triage to laboratory studies being available, which could potentially encompass a delay in laboratory studies being drawn after triage occurred. Additionally, we did not collect information about whether laboratory studies were ordered the day before the treatment. Understanding the volume of same-day laboratory orders would have been useful in identifying the impact of advanced laboratory ordering on throughput.

Implications/Recommendations for Practice, Policy, and Research

Delays occurred at each clinic intersection and staff identified specific issues as well as overarching problems which contributed to clinic inefficiencies. We intend to implement targeted interventions via a structured action plan to address the most significant issues to reduce delays at each clinic intersection. The first step of translating the study findings into practice and developing recommendations to address throughput issues is to present our results to the clinic staff and leadership team. The primary focus of this presentation is to generate discussion about the findings and reach consensus about the clinic's top priority throughput issues and how to correct them. To manage delays and disorganization at the front desk, we recommend that the check-in process be simplified to one-step which will generate both the identification band and the patient bill. We also suggest that front desk leadership be included in routine meetings and communication regarding clinic operations in order to improve accountability and collaboration with clinic staff. To address the problem of noncompliance with scheduled appointment time, we favor the implementation of appointment reminder text messages sent electronically through the EMR. We suggest that clinic leadership develop a protocol to manage patients who arrive late or early for their scheduled appointment time. Additionally, we recommend that clinic leaders collaborate with schedulers to strategically arrange patients more evenly throughout the day to alleviate the volume between 8:00 a.m. and 12:00 p.m.

To reduce bottlenecks at triage, we support creating a second triage space to simultaneously triage patients and expedite throughput at this intersection. Laboratory results could be expedited by facilitating more timely blood draws. Therefore, we recommend that the phlebotomist not be assigned additional clinic duties, especially between the busiest hours of 8:00 a.m. and 12:00 p.m. Additionally, we favor printing laboratory requisitions each evening for the next clinic day to help maintain organization and simplify laboratory throughput. To improve efficiency in assessing and clearing patients for treatment, we suggest eliminating the fellows' mid-day change in service coverage. In doing so, the fellows would see strictly oncology or hematology patients during the clinic day, switching on a weekly basis. This schedule would help to avoid role confusion and facilitate continuity of care and undisrupted progression of patient flow during the clinic visit. In order to avoid congestion in the treatment area, we support restricting the practice of "saving seats" whereby patients would be seated in infusion chairs only when ready for treatment. Implementation of these interventions have the potential to increase the efficiency of clinic flow, reduce throughput times, and improve patient and staff satisfaction.

The findings of our study have added to the literature by supporting the need for a thorough evaluation of current clinic throughput to gain an understanding of areas that contribute to significant delays. Our study highlighted the value of this initial assessment and demonstrated the ability to utilize the information gained to develop an action plan to address the identified issues. Other outpatient cancer centers could use our study design to conduct a similar appraisal of their clinic throughput processes with the goal of using the knowledge to make valuable changes to improve efficiency.

Sustainability

The interventions proposed in the action plan would not cost money to implement except for a new computer system to eliminate the two-part check-in process. However, the new EMR has already been purchased by the medical center and is in the process of execution. This EMR system would also enable the text message appointment reminders.

To obtain buy-in and engage the entire clinic team in the proposed changes, nursing, medical, and administrative leadership must unite and communicate a clear and consistent plan to their staff. A crucial aspect is to ensure that new processes are being adhered to, which will also be the responsibility of the clinic leaders. Additionally, after implementation, a reevaluation of patient flow must be done to determine the effectiveness of the interventions. Obtaining feedback from the team is vital in order to identify details that may require modification to meet the needs of the clinic, team members, and patients. The cycle of reevaluation, modification, and implementation is necessary on an ongoing basis for the changes to be successful and lasting.

Conclusions

Our study took the critical first step of performing a thorough evaluation of patient flow to identify areas of clinic that contribute to significant delays in order to develop an action plan to improve throughput. We found that delays occurred at each clinic intersection. The longest interval was from receiving laboratory results to treatment initiation and the shortest was from check-in to triage. Differences in throughput time by appointment type and appointment time were significant. Throughput time was significantly shorter for appointments consisting of provider visit and laboratory study only compared to visits involving infusions and blood product transfusions. Throughput for appointments between 8:00 and 10:00 a.m. was significantly longer than appointments between 2:01 and 6:00 p.m. Staff reported that throughput was suboptimal and identified issues at each clinic juncture as well as overarching problems that prolong wait time and cause inefficiencies. The most common problems they identified were appointment noncompliance, laboratory workflow, and bottlenecks at the front desk and triage. The identified issues will be addressed by implementing targeted interventions via a structured action plan to reduce delays at each clinic intersection. These interventions have the potential to increase the efficiency of clinic flow, reduce throughput times, and improve patient and staff satisfaction.

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Figure 1. Principles of Lean Transformation (Lean Enterprise Institute, 2018)

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Table 1. Study Variables including Theoretical and Operational Definitions

Variable	Type of Variable / Level of Measurement	Theoretical Definition	Operational Definition
Patient age	Demographic / Nominal	Chronological age in years.	1 = 0 to <3 years 2 = 3 to <12 years 3 = 12 to <18 years 4 = ≥18 years
Patient sex	Demographic / Nominal	Biological determinant.	1 = Male 2 = Female
Patient diagnosis	Clinical / Nominal	Medical diagnosis patient is being treated for at the clinic.	Hematologic or oncologic condition that patient is being treated for at the clinic. BMT status if applicable. Diagnosis also corresponds to which division and practitioners are seeing the patient. 1 = Hematologic malignancy 2 = Solid tumor 3 = Neurological malignancy 4 = BMT 5 = Hematology (non-oncologic)
Route of laboratory studies	Clinical / Nominal	Route by which laboratory studies are obtained (peripheral venipuncture or via CVC)	1 = Peripheral venipuncture 2 = CVC 3 = N/A
Appointment type	Independent / Nominal	Type of appointment that the patient is scheduled for at the clinic.	Classification of appointment type based on services provided during that visit to the clinic. 1 = Provider visit, laboratory studies, infusion treatment. 2 = Provider visit, laboratory studies, blood product transfusion. 3 = Provider visit, laboratory studies only.

Variable	Type of Variable / Level of Measurement	Theoretical Definition	Operational Definition
Time of scheduled appointment	Independent / Nominal	What is the scheduled time of the patient's appointment?	1 = 8:00 a.m. - 10:00 a.m. 2 = 10:01 a.m. - 12:00 p.m. 3 = 12:01 p.m. - 2:00 p.m. 4 = 2:01 p.m. - 6:00 p.m.
Time from check-in to triage	Dependent / Interval	Measure of time from when the patient checks in at the front desk of the clinic to when they arrive in triage. This information is found in the scheduling EMR.	Actual time measurement in minutes from when patient checks in at front desk of the clinic to when they arrive in triage.
Time from triage to receiving laboratory results	Dependent / Interval	Measure of time from when the patient arrives in triage to when laboratory study results are posted in the electronic medical record. Triage arrival is determined by the time that triage vital signs are documented. This is found in the EMR.	Actual time measurement in minutes from when the patient arrives in triage to when laboratory study results are posted in the electronic medical record or N/A.
Time from receiving laboratory results to treatment initiation	Dependent / Interval	Measure of time from when the patient's laboratory study results are posted in the medical record to the initiation of their treatment. Treatment initiation is documented in the medication administration record and in the blood product transfusion note depending on the type of treatment. This is done in EMR.	Actual time measurement in minutes from when the patient's laboratory study results are posted in the medical record to the initiation of their treatment or N/A.

Variable	Type of Variable / Level of Measurement	Theoretical Definition	Operational Definition
Total throughput time	Dependent / Interval	Measure of time from when the patient checks in at the clinic front desk to the final phase of clinical visit.	Actual time measurement in minutes from the first contact in clinic (check-in or triage) to the final phase of their clinic visit. Final phase of clinic visit will vary depending on appointment type. a. For patients receiving treatments, measurement will end with initiation of first treatment. b. For patients having a provider visit and laboratory studies, measurement will end with receipt of laboratory results.
Staff role	Demographic / Nominal	Job title of the staff member in the clinic.	A = Attending physician B = Fellow C = Advanced practice nurse D = Registered nurse, medical assistant, or nursing attendant
Staff's length of employment in clinic	Demographic / Nominal	Number of years that staff member has been employed in the clinic.	A = <1 year B = 1 to 5 years C = 6 to 10 years D = >10 years
Staff gender	Demographic / Nominal	Biological determinant.	A = Male B = Female
Staff age	Demographic / Nominal	Chronological age in years.	A = 21 to <36 years B = 36 to <51 years C = 51 to <65 years D = >65 years
Staff assessment of patient throughput	Qualitative	Clinic staff's overall assessment of patient throughput in the clinic.	Staff were invited to describe their assessment of patient throughput in the clinic in their own words. Recurring ideas and themes were identified.

Variable	Type of Variable / Level of Measurement	Theoretical Definition	Operational Definition
Staff opinion about methods to improve throughput	Qualitative	Clinic staff's opinions about what could be done to improve patient throughput in the clinic.	Staff were invited to describe their opinion about what might be done to improve throughput in the clinic in their own words. Recurring ideas and themes were identified.

Table 2. Demographic and Clinical Patient Characteristics

Variables	**Freq (%)**
Age (years)	
• <3	58 (18.6)
• 3 to <12	135 (43.3)
• 12 to <18	87 (27.9)
• ≥18	32 (10.3)
Gender	
• Male	165 (52.9)
• Female	147 (47.1)
Diagnosis	
• Hematologic malignancy	79 (25.3)
• Solid tumor	53 (17)
• Neurological malignancy	16 (5.1)
• BMT	34 (10.9)
• Hematology (non-oncologic)	130 (41.7)
Route of laboratory studies	
• Peripheral venipuncture	217 (69.6)
• CVC	95 (30.4)
Appointment type	
• Provider visit, laboratory studies, infusion treatment	58 (18.6)
• Provider visit, laboratory studies, blood product transfusion	32 (10.3)
• Provider visit, laboratory studies only	222 (71.2)
Scheduled appointment time	
• 8:00 a.m. - 10:00 a.m.	124 (39.7)
• 10:01 a.m. - 12:00 p.m.	100 (32.1)
• 12:01 p.m. - 2:00 p.m.	40 (12.8)
• 2:01 p.m. - 6:00 p.m.	48 (15.4)

Table 3. Clinic Interval and Throughput Time in Minutes

Time Variable	**N**	**Mean (SD)**	**Range**
Time from check-in to triage	223	18.49 (18.21)	1 - 159
Time from triage to receiving laboratory results	312	94.19 (61.92)	6 - 568
Time from receiving laboratory results to treatment initiation	90	136.73 (77.98)	16 - 374
Total throughput time	312	146.03 (89.60)	18 - 583

Table 4. Clinic Total Throughput Time by Appointment Type and Scheduled Appointment Time

Variables	Mean (SD)	Statistics	p value
Appointment type		F = 62.67	< .001
• Provider visit, laboratory studies, infusion treatment	215.98 (73.61)		
• Provider visit, laboratory studies, blood product transfusion	230.84 (105.08)		
• Provider visit, laboratory studies only	115.53 (71.36)		
Scheduled appointment time		F = 4.01	.008
• 8:00 a.m. - 10:00 a.m.	162.26 (103.68)		
• 10:01 a.m. - 12:00 p.m.	147.29 (90.41)		
• 12:01 p.m. - 2:00 p.m.	132.85 (53.59)		
• 2:01 p.m. - 6:00 p.m.	112.48 (58.28)		

Table 5. Demographic and Role Characteristics of Staff Survey Respondents

Variables	Freq (%)
Role	
• Attending Physician	4 (18.2)
• Fellow	2 (9.1)
• Advanced Practice Nurse	7 (31.8)
• Registered Nurse, Medical Assistant, or Nursing Attendant	9 (40.9)
Length of employment in clinic (years)	
• <1	0 (0)
• 1 to 5	7 (31.8)
• 6 to 10	1 (4.5)
• >10	14 (63.6)
Gender	
• Male	1 (4.5)
• Female	21 (95.5)
Age (years)	
• 21 to <36	6 (27.3)
• 36 to <51	6 (27.3)
• 51 to <65	9 (40.9)
• >65	1 (4.5)

Table 6. Staff Survey Themes about Problems that Contributed to Throughput Inefficiencies and Delays

Theme	Occurrences in Survey N (%)
Appointment time non-compliance	14 (63.6)
Laboratory processes	12 (54.5)
Front desk workflow	10 (45.4)
Triage workflow	8 (36.3)
Physician timeliness	7 (31.8)
Fellow and advanced practice nurse scheduling/duties	5 (22.7)
Saving seats	4 (18.1)

Appendix A

Staff Survey

Outpatient Oncology Throughput

Demographic Information

Q1 Please select your job title.

- ○ Attending Physician
- ○ Fellow
- ○ Advanced Practice Nurse
- ○ Registered Nurse, Medical Assistant, or Nursing Attendant

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Q2 Please indicate the number of years you have worked in the outpatient pediatric hematology, oncology, and BMT clinic.

- ○ < 1 year
- ○ 1 to 5 years
- ○ 6 to 10 years
- ○ > 10 years

Q3 Please select your gender.

- ○ Male
- ○ Female

Q4 Please select your age range.

- ○ 21 to < 36 years
- ○ 36 to < 51 years
- ○ 51 to < 65 years
- ○ > 65 years

Patient Flow Assessment

Q5 What is your overall opinion of patient flow in the clinic?
Patient flow is defined as: The movement of patients through the various phases of their clinic visit starting with check-in, triage, attainment and resulting of laboratory studies, and ending with either treatment initiation or provider visit (if no treatment if required).

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Q6 Please share your opinion about what could be done to improve patient flow in our clinic.

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