With an increase in the number of patients with cancer receiving treatment in the ambulatory setting, a need exists to evaluate lean approaches to provide safe, effective, and timely care delivery. Acuity-based scheduling (ABS) was implemented across the regional ambulatory care centers of a National Cancer Institute–designated comprehensive cancer center. ABS involved templates and a reconfiguration of clinical space and staff according to acuity levels. Results suggest improvement in wait times, capacity, infusion hours, chair use rate, patient visits, chair turns, average infusion length, and patient satisfaction.

**AT A GLANCE**
- Evaluating opportunities for the implementation of lean methodologies in the ambulatory oncology treatment setting is essential to consistently respond to increasing patient volumes.
- The use of ABS allows for natural delineation of patients based on the type and acuity of care they are receiving.
- ABS may result in a lean, efficient clinic environment that enhances nursing practice, patient care delivery, fiscal responsibility, and a more favorable patient and provider relationship.

**KEYWORDS**
- acuity-based scheduling;
- regional cancer center;
- wait times;
- chemotherapy

**DIGITAL OBJECT IDENTIFIER**
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**Outcomes in ambulatory oncology centers**

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Oncology care, specifically medication administration and chemotherapy infusions, have increasingly moved to the ambulatory setting. Increases in patient and procedural volumes have led to operational challenges and patient satisfaction, particularly around wait times, which are consistently reported as a contributor to patient dissatisfaction (Hendershot et al., 2005; Leddy, Kaldenberg, & Becker, 2003). The need for operational efficiency is critical to enhance financial outcomes for institutions and quality outcomes for patients. The use of lean-based approaches, including defined space for infusion services, and an acuity-based approach to ambulatory chair management, have been reported as means to enhance the efficiency and efficacy of ambulatory oncology care (Duska, Mueller, Lothamer, Pelkofski, & Novicoff, 2015; Lamm, Eckel, Daniels, & Amerine, 2015). An opportunity was identified to enhance the efficiency of infusion chair use at the regional cancer centers (RCCs) of the University of Texas MD Anderson Cancer Center, a National Cancer Institute (NCI)–designated comprehensive cancer center.

**Background**

Timeliness is one of the six aims identified by the Institute of Medicine ([IOM], 2001) for improving healthcare quality; however, it also is one of the most consistently reported concerns among patients. Long waits create emotional distress and, in some cases, lead to harm (Leddy et al., 2003). Improving wait times for shorter chemotherapy infusions and injections has been reported to promote increased efficiency for longer treatments (Kallen, Terrell, Lewis-Patterson, & Hwang, 2012). The idea of creating a dedicated space and/or template for fast-track services is growing in popularity as patient volume increases (Ahmed, Elmekkawy, & Bates, 2011; Looker et al., 2016).

The University of Texas MD Anderson Cancer Center conducted about 1.5 million ambulatory visits, treatments, and procedures in 2015, including both the main campus operations and at four RCCs. In 2015–2016, the RCCs generated 215,000 billable encounters, a growth of 9% from the previous fiscal year, and 31,000 appointments, a growth of 27% during a three-year fiscal period. With significant increases in patient volume came patient concerns about wait times.

An interdisciplinary team of nurses, administrators, and pharmacists from one of the RCCs engaged in a quality improvement project to maximize efficiency of patient scheduling and the use of chair space for different types of infusions. They identified the challenges of mixing treatment types of varying durations in one chair space and with one nursing assignment as a primary source of inefficiency, resulting in extended waiting periods for procedures lasting only minutes. The aim of this project was to increase chair use and to maximize scheduled (patient) hours per day.
**Intervention**

Acuity-based scheduling (ABS) was implemented to enhance operational efficiencies and patient satisfaction. ABS consists of a scheduling modality based on the duration and acuity of a patient’s treatment and translates into how patients are assigned to a particular chair space and nursing assignment. ABS is modeled on evidence related to nurse staffing approaches (Vortherms, Spoden, & Wilcken, 2015; West & Sherer, 2009), although, in this case, it applies to defining the acuity of patients to structure the patients’ rather than the nurses’ scheduling. Procedures were classified according to six levels (see Table 1). Nurses were assigned a target acuity level of no greater than 20 per day, which could consist of a combination of multiple lower-acuity patients or several higher-acuity patients.

**Project Implementation**

ABS was implemented with a rapid cycle test of change approach. The level 1 template was implemented at one of the RCCs to evaluate the efficiency of this template related to the care of patients with lower-acuity treatments. The patients were scheduled on a separate template based on the availability of allocated resources (nursing staff and chair). The template times were scheduled 30 minutes apart with a quota of two per hour. Once efficacy was established, clinic and chair space was designated by acuity level, additional acuity level templates were operationalized, and ABS was implemented across RCCs. The infusion center added a new room with three additional infusion chairs organized according to level 1 and 2 templates and designed to accommodate 15–20 infusion hours per day. With 17 chairs in this designated infusion space, a total capacity of 136 infusion hours per day was available. The target goal was 110 hours per day with an 80% use rate. Shorter infusion treatments were shifted from the main infusion floor to this room. Staffing included one level 1 nurse with 10–15 patients and one level 2 nurse with 6–8 patients per day who assisted with level 1 add-ons, walk-ins, and overflow. The main infusion suite has 14 chairs staffed by six nurses, with an aim of 98 infusion hours per day.

**Outcome Measures**

Capacity, infusion hours, chair use rate, patient visits, chair turns, and average infusion length were measured to evaluate efficiency wait times. Patient satisfaction was measured using the Press Ganey patient satisfaction survey and through patient feedback. These metrics were collected prior to the implementation of the acuity templates and six months following ABS implementation.

**Outcomes**

To date, the six acuity level templates have been operationalized across the RCCs. The results are reported from the center that piloted the level 1 and 2 acuity template implementation in a separate infusion area to improve scheduling and chair use.

**TABLE 1.**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>TREATMENT DURATION</th>
<th>TREATMENT TYPES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Less than 30 minutes</td>
<td>Non-chemotherapy infusion, dressing changes, routine vascular access maintenance</td>
</tr>
<tr>
<td>2</td>
<td>30 minutes to 1 hour</td>
<td>Short treatments such as zoledronic acid (Zometa®), bortezomib (Velcade®), trastuzumab (Herceptin®), bevacizumab (Avastin®), fluid, electrolyte, and antibiotic infusions</td>
</tr>
<tr>
<td>3</td>
<td>1–2 hours</td>
<td>Gemcitabine (Gemzar®), paclitaxel protein-bound (Abraxane®), carfilzomib (Kyprolis®), paclitaxel (Taxol®), trabectedin (Yondelis®), daratumumab (Darzalex®), vinorelbine (Navelbine®)</td>
</tr>
<tr>
<td>4</td>
<td>2–4 hours</td>
<td>Paclitaxel, FOLFOX, etoposide (Toposar®), IV immunoglobulin, FOLFIRINOX, platini (Cisplatin®)</td>
</tr>
<tr>
<td>5</td>
<td>4–6 hours</td>
<td>Rituximab (Rituxan®), carboplatin (Paraplatin®)-paclitaxel, docetaxel (Taxotere®)-carboplatin, blood products</td>
</tr>
<tr>
<td>6</td>
<td>Greater than 6 hours</td>
<td>Multi-drug regimens, blood products</td>
</tr>
</tbody>
</table>

FOLFIRINOX—folic acid, fluorouracil, irinotecan, and oxaliplatin; FOLFOX—folic acid, fluorouracil, and oxaliplatin

**TABLE 2.**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>PRE (X)</th>
<th>POST (X)</th>
<th>CHANGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (n)</td>
<td>112</td>
<td>136</td>
<td>21.4</td>
</tr>
<tr>
<td>Infusion hours</td>
<td>81.8</td>
<td>99.7</td>
<td>21.9</td>
</tr>
<tr>
<td>Utilization rate (%)</td>
<td>73.04</td>
<td>73.31</td>
<td>0.37</td>
</tr>
<tr>
<td>Patient visits (n)</td>
<td>38.9</td>
<td>51</td>
<td>31.1</td>
</tr>
<tr>
<td>Chair turns</td>
<td>2.78</td>
<td>2.99</td>
<td>7.6</td>
</tr>
<tr>
<td>Average infusion length (hours)</td>
<td>2.11</td>
<td>1.99</td>
<td>-5.7</td>
</tr>
</tbody>
</table>

Note. The pre-implementation period was January 2015 to March 2015; postimplementation was September 2015 to August 2016.
An overall improvement in infusion efficiency was noted after the intervention by separating scheduling templates. The breakdown of the three templates to make up the entire ambulatory treatment center are designated as main infusion (67%), level 1 (17%), and level 2 (16%).

Metrics related to capacity, infusion hours, patient visits, chair turns, and average infusion length improved across all outcome measures and are presented in Table 2. Number and volume of visits prior to and following level 1 implementation are presented in Table 3. Because level 2-type procedures could not be extrapolated from baseline data, only the postimplementation data are presented. In addition, overall center visits and hours are presented pre- and post-ABS implementation.

Patient satisfaction also improved, as reflected by Press Ganey survey data on two questions related to ambulatory wait times and comfort (see Figure 1). The data represent a 2.1-point improvement in mean scores on both questions, which translated to a 16 and 24 percentile improvement in Comprehensive Cancer Center Consortium for Quality Improvement (C4QI) ranking, respectively. Subjectively, both patients and staff reported overall improved satisfaction, including ease of scheduling and transitioning through treatments more efficiently.

**Discussion**

This quality improvement initiative resulted in measurable improvements to operational efficiency and patient satisfaction. In addition to improving the overall scheduling capacity within the infusion suite, added benefits included patient, staff, and provider satisfaction, reduction in expenses related to decreased overtime hours, and increased revenue. The use of acuity-based templates allows for greater structure and efficiency in scheduling and delivering care to patients with cancer receiving treatment in the ambulatory setting consistent with results from other published work using template-based scheduling (Ahmed et al., 2011).

Staffing to ensure adequate nursing support for each defined template area is a primary logistical concern. A limitation of this implementation is that there were times when, because of lean staffing, level 1 acuity patients were merged into the ambulatory treatment center template. In addition, developing competencies for the skills of the various acuity templates

### TABLE 3.
**ACUITY-BASED SCHEDULING TEMPLATE DATA**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>PRE (X)</th>
<th>POST (X)</th>
<th>CHANGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 hours</td>
<td>5.775</td>
<td>7.46</td>
<td>29.2</td>
</tr>
<tr>
<td>Level 1 visits</td>
<td>11.55</td>
<td>14.9</td>
<td>29</td>
</tr>
<tr>
<td>Level 2 hours</td>
<td>–</td>
<td>7.32</td>
<td>–</td>
</tr>
<tr>
<td>Level 2 visits</td>
<td>–</td>
<td>6.4</td>
<td>–</td>
</tr>
<tr>
<td>Main infusion hours</td>
<td>76.05</td>
<td>84.91</td>
<td>11.7</td>
</tr>
<tr>
<td>Main infusion visits</td>
<td>27.25</td>
<td>29.53</td>
<td>8.4</td>
</tr>
</tbody>
</table>

*Note.* The pre-implementation period was January 2015 to March 2015; postimplementation was September 2015 to August 2016.

### FIGURE 1.
**PRESS GANEY PATIENT SATISFACTION SCORES**

Q4QI—Comprehensive Cancer Center Consortium for Quality Improvement

*Note.* N values differ based on survey response and whether patients answered each question.
was fundamental to ensuring that care was delivered not only expeditiously but, most importantly, safely. The administrators on the interprofessional team worked with clinical nurses to develop competencies for each acuity template to ensure staff could be cross-trained to safely deliver care.

As future templates are implemented, an opportunity exists to employ approaches in the literature to further enhance efficiency. These include the use of modelling to determine the best configurations for the template based on space, staffing, and resources (Ahmed et al., 2011), and time and motion studies to map the most logistically efficient configuration of available space (Shinder et al., 2012).

**Implications for Practice**

Evaluating opportunities for lean methodologies to be implemented and evaluated in the ambulatory oncology setting is essential to continually respond to the increasing volumes of patients with cancer receiving care in this setting. The use of ABS allowed for a natural delineation of patients based on the type and acuity of care they are receiving and made efficient use of space and personnel resources. Because expanding space may not always be a possibility, delineating infusion chairs and rooms by acuity level templates can provide an efficient approach to patient care. Nursing engagement in the implementation of such templates is critical to their success.

**Conclusion**

Ultimately, ABS may result in a lean and efficient clinic environment that enhances nursing practice, patient care delivery, fiscal responsibility, and patient and provider satisfaction. ABS provides the nurse leader with opportunities to ensure that the fixed resources of an infusion center are used to the highest capacity. Employing lean principles through projects such as ABS afford the opportunity to directly influence cost containment, work flow efficiency, and patient experience, often with the resources and personnel already in place. As ambulatory oncology services continue to expand in service to larger populations of patients with cancer seeking care in the community setting, ABS offers a model template for developing and implementing efficient, treatment-driven work flow.

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