THE USE OF LEAN QUALITY IMPROVEMENT METHODS IN HEALTHCARE: IMPROVING PERFORMANCE ON A QUALITY METRIC

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Table of Contents

Figures

Tables

Appendices

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Abstract

OBJECTIVE: This paper will show how Lean quality improvement methods can be used in healthcare to improve pediatrician performance on a quality metric tracking development of plans for addressing obesity in children at well child checks.

METHODS: Using Lean methods, the entire process for measuring the documentation of obesity treatment plans, from identification of obesity to the production of the metric, was mapped out. After waste in the process was identified, root cause analysis was performed. Countermeasures were then developed and tested to eliminate waste in the process, and a new process was created. This was used to create standard work documents for training and reference.

RESULTS: After implementation of the new process, several areas of waste were identified and corrected and performance on the metric improved greatly. Key problems with the initial process identified and corrected included failure to document body mass index, failure to obtain indicated diet history, failure to address obesity, and documentation of the treatment plan in a way that was not measured by the quality metric reporting process. Once the new process was in place, the pediatrician involved in the Lean event saw his performance on the metric improve from 26% of obese children having a treatment plan prior to the event, to 100% for the two months following the event. In addition, both medical assistants and physicians showed an increased understanding of how the metric was measured and their role in the process after the project was completed.

CONCLUSION: Lean quality improvement methods can be used in healthcare to improve performance on quality metrics. Problems with both individual staff

performance and performance of information technology systems including electronic health records can be identified and corrected. Continued monitoring is required to ensure that improvements resulting from the Lean improvement event are sustained.

Introduction

Over the last decade or so, improving healthcare quality has been increasing in importance in the United States. In this era of rising healthcare costs, organizations are striving to find ways to improve both cost and quality of healthcare. A number of different quality improvement methods have been used with varying success. One of particular interest at a number of organizations is Lean. Based on methods developed at Toyota, Lean focuses on eliminating waste as a means of improving efficiency of an organization. Although most widely used in manufacturing, a number of healthcare organizations have turned to Lean methods to improve healthcare. Thedacare, a multihospital healthcare group in central Wisconsin has achieved success in a number of areas through use of Lean, continues to use Lean on a daily basis, and is continually finding new problems to which it can apply Lean. Pediatric obesity is one such area. Thedacare has recently begun to focus on this increasing problem, implementing a quality improvement metric measuring how well its pediatricians are doing at creating plans with families to address obesity. There is variation in how pediatricians are performing on this metric. As an example of the potential of Lean methodologies to improve healthcare, a Lean improvement project was completed to demonstrate how methods originally developed for improving manufacturing can be applied to the much different business of healthcare.

Background

Lean: The roots of Lean quality improvement methodology are found in the work of Taiichi Ohno in Japan in the 1950s.[1] Ohno was an engineer with Toyota Motor Corporation, whose work on process inefficiency led to the creation of the Toyota

Production System (TPS).[2] This system, focused on product flow and process in response to customer needs, helped Toyota become one of the world's leading automobile manufacturers. Because of Toyota's success, the TPS was studied and emulated throughout first the Japanese auto industry, and then to other industries and other countries. It became more popular in the US in part due to the work of Jim Womack, Ph.D., whose research team from MIT first used the word "Lean" to describe the concepts of the TPS.[3] Although primarily thought of as a tool for manufacturing, Womack and his team have been able to show that it can be applied to service sectors as well, including healthcare.

The main objective of Lean is to increase value, as defined by the customer, while eliminating waste. This is accomplished by examining and improving processes across the continuum of the organization, rather than in isolation. There is a five step process for implementing Lean techniques, identified by Womack.[4, 5] The listed steps will be covered in greater detail below.

1. Identify value from the standpoint of the customer
2. Identify the value stream and identify waste
3. Create continuous flow
4. Establish pull between steps
5. Manage toward perfection

One of the key factors of Lean is that value is identified from the customer perspective, and anything not of value to the customer is potential waste to be eliminated. In healthcare, the customer is generally considered the patient. However, for internal processes, there may be other customers, such as nurses, physicians, or others involved in the care process.[6] Value is often thought of as what the customer would be willing to pay for. For example, in healthcare, the patient would generally value accurate diagnosis and effective treatment of their problem. Drawing blood, on the other hand, which the physician may view as necessary for that diagnosis, is not of value to the patient, only the ultimate diagnosis and treatment are.[7] Another way to consider value is to ask, "What is the ultimate product of the process?"

Once value has been determined, the next step is to examine the current process for creating that value. This should involve an improvement team actually going to the place the work is done, and observing the actual work taking place.[6] This is important, as it avoids inaccurate assumptions about how the work is being accomplished. The improvement team will generally be a small group, including representatives of various roles involved in the process. A customer is also included if possible, in order to capture their perspective. The observation of work will typically include measurements of time and distances, which may help in identifying waste. Quality measures are also made, in order to determine how often the process or individual steps in the process are completed without defect.

After observation, the team will then create a representation of the process, sometimes referred to as a Value Stream Map (VSM). The VSM as it exists at the start of the improvement work may be referred to as the Current State VSM (CS VSM) or sometimes just the Current State (CS). This mapping of the process is used to identify waste and value-added steps, from which an ideal process may be created. The ideal process may be referred to as the Future State (FS) or a Future State VSM (FS VSM).

Based on the newly acquired knowledge of the current state, the team will then begin to identify which steps are value added, and which are potentially waste. The non-value added steps are examined to determine if they are necessary or wasteful. Ohno identified seven types of waste in his work with the TPS.[8] Examples of these wastes from healthcare were identified by Roger Bush.[9] The wastes are as follows, with examples:

1. Overproduction: producing what is unnecessary, when it is unnecessary or in unnecessary amount. This includes obtaining history multiple times, repeating lab tests because results were not available, or ordering preventive services too frequently.
2. Waiting: for materials, inspections, or other idle time. Examples include patients waiting for the physician, clinical laboratories batching tests, or waiting for equipment to be available.
3. Transportation: moving items unnecessarily. Moving equipment in and out of rooms, or storing items at a distance from where they will be used are examples.
4. Processing: unnecessary steps. Redundant processes such as entering data in multiple places in an electronic record, or producing and sending hard copies of information already sent electronically would be processing waste.
5. Inventory: having more of something on hand than is needed. This would include having large stocks of medications, which represent cost, especially if expiring before used. It would also include charge slips waiting to be processed.
6. Movement: any unnecessary movements, such as having to leave an exam room for supplies that should be in the room.

7. Defects: errors in output, which result in need for rework or time to deal with complaints. This also includes cost of inspection. Examples include hospital acquired infections, misdiagnosis, and incorrect billing.

In addition to the seven errors described above, Thedacare has recognized an additional waste, talent.[7] This is identified as failure to listen to employees' ideas and failure to train individuals or make use of training they have. An example is requiring a cardiologist to read an EKG before initiating a treatment plan rather than allowing a trained Emergency Department (ED) physician to read it. This example will be discussed in a later section.

Once the team identifies waste, they will develop countermeasures to eliminate waste if possible. The first step in developing countermeasures is to do a root cause analysis to determine the real reasons behind the waste. One of the more common or useful tools for this is Five Whys, or a variant, Branching Whys, used commonly at Thedacare.[7] The Five Whys technique involves asking why a waste occurs, then asking why the answer to the first question is the case. This step is repeated several times to try to arrive at an ultimate, actionable cause of the waste in question. The Branching Whys technique is similar, but recognizes that for any particular step in the Five Whys process, there may be more than one cause. This technique can help assure that all causes are identified.

After identifying causes of waste, the team will develop countermeasures. These countermeasures may be rapidly tested in the workplace, with repeat of the initial observations to determine if they improve outcomes. There may be additional cycles of countermeasures and testing to refine the countermeasures. Once this testing is complete, a FS VSM is created incorporating the newly developed changes. As much as possible, the FS VSM should include smooth “one-piece” flow, so that there is minimal waiting or batching of work, which are both wasteful and can introduce error. Likewise, the processes should establish pull, such that work is not done until required by customer needs, to avoid inventory build up or overproduction. The new FS VSM is then trained and implemented, and becomes the CS VSM for any future improvement efforts. Metrics continue to be tracked to determine if improvement is sustained.

Lean methodology does overlap significantly with other quality improvement methods such as CQI and Six Sigma, and may incorporate tools from these other systems.[6] Indeed, Lean often uses the plan-do-study-act (PDSA) cycles originating in Continuous Quality Improvement (CQI). It also shares with Six Sigma a focus on measuring and eliminating defects and standardizing processes. Indeed, the terms Lean Sigma or Lean Six Sigma are used in describing hybrid systems.[10,11,12] The crucial differences with Lean are the emphasis on customer-defined value and the focus on elimination of waste to increase value.

Lean in Healthcare: Many healthcare organizations have had success with Lean improvement methods. For example, Virginia Mason Medical Center in Seattle, Washington used Lean to decrease ventilator associated pneumonia cases from 34 in 2002 to 4 in 2004, at a cost savings of nearly half a million dollars.[6] This was accomplished through computerized order entry with patient safety alerts.[9] They were also able to more efficiently use space in their cancer center to allow them to see 57% more patients.[6] Park Nicollet Health System in Minneapolis, Minnesota was able to increase capacity for CT, MRI and chemotherapy and antibiotic infusions.[6] They also cut urgent care clinic waiting time from 122 minutes on average to 52 minutes and decreased surgical instrument processing by 40,000 instruments per month.

At Community Medical Center in Missoula, Montana, pathology result turn-around time has decreased from 5 days to 2 days. They also decreased time from medication order to administration from 4 hours to 12 minutes on average.[6]

The University of Michigan also has had success with Lean, increasing the percentage of peripherally inserted central catheters (PICC) inserted within 24 hours.[6] Prior to the improvement process, only 50-70% were placed within 24 hours. That number increased to 90-95% after the Lean project. This was achieved by evaluating the entire continuum of the PICC process, from order to gathering information to placement of the line to obtaining the chest X-ray to confirm proper placement.

Lean at Thedacare: Another organization which has great success with implementation of Lean methods in Thedacare. Thedacare is a community health system in central Wisconsin, consisting of 5 hospitals, along with 23 self-standing clinics and two ambulatory surgery centers. Thedacare employs about 190 healthcare providers, mostly in Primary Care, out of a total staff of over 5,500. In addition, the system offers Behavioral Health, Occupational Health, laboratory services, home care and extended care facilities. Thedacare uses an electronic health record (EHR) from Epic (Epic Systems Corporation, Verona, WI) throughout the organization.

Thedacare began its implementation of Lean methods in 2002, following a series of quality improvement efforts that either fell short, or were successful but unsustained.[7] John Toussaint, then CEO of Thedacare, was determined to find a structured improvement program that would work, but was not happy with those currently in use in healthcare. Thus, he turned to manufacturing, and discovered Lean in use at a Wisconsin producer of snow blowers, Ariens. The result has been a journey toward Lean healthcare, which is still a work in progress despite the successes. Along the way, Thedacare has learned a number of lessons about successful implementation and sustainment of Lean methods.

One notable area of success has been the improvement in treatment of ST-segment elevation myocardial infarctions (STEMI), a type of heart attack treated with balloon angioplasty.[7] The standard of care for this condition is to have the patient receive balloon angioplasty within 90 minutes of arrival at the emergency department (ED). In 2006, Thedacare was achieving this about 65% of the time. By evaluating the processes for diagnosing and treating STEMI, they identified a number of inefficiencies or wastes that contributed to poor outcomes. One of the major wastes was that the cardiologist needed to come to the hospital and read the EKG to determine that the patient was having this type of heart attack prior to calling in the rest of the team and getting set up to do the angioplasty. By training the ED doctors and allowing them to read the EKG and then activate the system to call in the cardiologist and the cardiac catheterization team at the same time, significant decreases in time were achieved.   Shortly after the improvements were in place, no patients exceeded the 90 minute time, and the average time for treatment is now 37 minutes. Nor has work stopped there. A pilot program was created to allow EMTs to obtain EKGs in the field and either recognize STEMI or transmit the EKG to the ED for reading prior to patient arrival.

Another significant achievement has been "collaborative care", designed to remove inefficiencies and waste from all aspects of inpatient care. After spending more than 6 months evaluating every aspect of care of inpatients, including admission and rounding through to discharge, one hospital unit was converted to a new system referred to as collaborative care. In this system, the patient care team, including the physician, nurse, and pharmacist, meets together with the patient and family within 90 minutes of admission. History, exam, and development of the care plan are done once with the whole team present, avoiding repetitive activities and decreasing miscommunication. Daily rounds occur the same way. Computers are brought with the team, so that orders can be entered immediately. Needed supplies are stocked in each exam room, using slide out cabinets that can be restocked from the hallway without disturbing the patient. Nurses no longer have to go in search of equipment that should be in the room. The system has resulted in nearly error-free medication reconciliation, increased patient satisfaction, decreased length of stay, and decreased costs per case. Compliance with quality measures for community acquired pneumonia has gone from 38% to 90-100%. Similar efforts have been undertaken for outpatient care.

These improvements did not come without difficulties. As part of the journey to Lean, Thedacare leadership had to learn how to cope with resistance from physicians, deal with the "shame and blame" culture, and overcome distrust among staff.[13] They also needed to make sure that improvements were sustained over time, without requiring excessive effort to track the improvements.

Physicians tend to be autocratic, used to making decision for themselves rather than being told how to work, or how members of their team should work. In dealing with physicians, Thedacare found a few important rules: "never lie; be willing to admit management mistakes; ask for opinions and take their advice seriously; be forthright about intentions. Perhaps the most important: be clear about the process of care delivery and how it needs to work."[7] Physician commitment to the process was achieved through a series of meetings to explain the intentions and need; through trust in Dr. Toussaint's commitment to quality improvement and commitment to the physicians; and through the example of pioneering physicians whose success with Lean fueled the competitive nature of the other physicians.

Another difficulty that had to be overcome was the "shame and blame" culture, the common practice in medical organizations to blame bad outcomes on individuals rather than processes. This leads to a lack of candor and unwillingness to report errors. Problems get covered up rather than examined. Thedacare has found that the majority of problems are due to processes rather than people. Fortunately, Lean is well suited for addressing this problem, with its focus on processes and root cause analysis to address defects.

On the other hand, distrust among staff was a problem exacerbated by Lean. When people examine processes that they are involved in, they identify waste that may be a significant portion of their job. Eliminating this waste may require eliminating positions. Thus, the very people working on process improvement may suffer personally because of those improvements. Staff sometimes felt as though they were improving themselves out of a job. To address this concern, Thedacare introduced a no-layoff policy. Although positions may be eliminated as a result of Lean activities, people are not. Instead, they may be reassigned to a different unit of the hospital or retrained to a different type of position.

Sustaining improvements over time was one of the reasons Toussaint and the rest of the leadership at Thedacare chose to use Lean methods. However, the very success of Lean has resulted in a significant number of improvements which need to be implemented and tracked over time to be sure the improvements persist. One way of doing this is by creating standard work, a document that details the step by step processes resulting from improvement projects. This document is used for training as well as for reference to correct problems when they arise. Recognizing problems requires ongoing tracking of metrics resulting from improvement projects. However, Thedacare as an organization typically has 5 to 6 improvement projects per week, resulting in large amounts of data. Thedacare has created a system for tracking these metrics. In any given clinic or unit, the most important metrics are tracked on boards in the workplace, visible to all, and updated frequently. The important metrics are typically the ones most recently implemented or for which the unit is not meeting goal. When metrics are not making progress toward goals or when they start to slide away, troubleshooting is done in the workplace to determine the cause of the decreased performance and to correct it. Metrics that are meeting goal and stable will be tracked less frequently and perhaps less visibly, but will still be monitored to ensure sustained performance. This data is rolled up form units or clinics, through supervisory levels to the senior leadership. Leadership also visits the workplaces and reviews data with the management and staff as well.

Criticism of Lean: Lean healthcare is not without its detractors. Critics have noted that Lean is just one of several quality improvement methods popularized over the years. One noted that the various forms of quality improvement used in healthcare are very similar, with differences only in emphasis.[14] This critic termed the introduction of new quality improvement methods "pseudoinnovation," noting that it was a problem because quality improvement methods generally require long term commitment. Redesign of quality improvement programs may impair their effectiveness.

Another study of the United Kingdom's National Health Service questions the effectiveness of Lean in healthcare based on questions around the definitions of both "customer" and "value" in healthcare.[15] The authors note that unlike in manufacturing where there is a clear customer for a product, in healthcare, there may be multiple customers, including patients, staff, and payers. These various customers may have very different ideas about the value of a given service. They propose that there are three critical dimensions to value in healthcare: Clinical, Operational, and Experiential. The clinical dimension emphasizes best patient outcomes. The operational dimension, which the authors argue has driven most Lean efforts in healthcare, is based on decreasing costs, including costs due to delay of care or poor quality care. Finally, the experiential dimension revolves around satisfaction that patients and staff experience in healthcare. They conclude that due to lack of a singular customer, and various values, the use of Lean in Healthcare is necessarily fragmented and complex.

Thedacare has addressed this concern via its "True North" metrics.[7] These consist of metrics in four areas that are to be addressed, to the extent possible, in every Lean improvement event. The four are: Safety/Quality, Financial Stewardship, People (Thedacare staff), and Customer Satisfaction (Figure 1). Although at times it may be difficult to improve each of these areas, Thedacare strives to achieve a balance amongst all.

Figure 1. Thedacare's True North Metrics, used to ensure that Lean projects address all important domains.

That leaves the unanswered question as to whether Lean has something unique to offer healthcare when compared to other quality improvement methods. Why choose Lean amongst the various methods or programs proposed over the years? One answer particularly relevant to medical informatics is found in Lean's emphasis on processes and flow. One of the more significant and promising changes in health care is the dissemination of EHRs. However, implementation of EHRs can result in a number of unintended consequences.[16,17] Ash, et al. noted several types of unintended consequences related to workflow, processes or waste that may be avoidable through Lean techniques.[16] First, they noted issues with more or new work due to CPOE, which would need to be incorporated into processes, including dealing with alerts or passwords. They also noted workflow issues resulting from mismatch between clinical information systems (CIS) and existing workflows. Persistence of paper was another such consequence, which could be a waste, but may also be an effective part of the process. Communication issues were also important, as CIS altered communication patterns. New kinds of error were also created, such as clicking on an adjacent item on a list, rather than the intended item. Power structures also changed, with an increase in power of nursing staff and information technologists. Lean has the potential to identify and avoid or ameliorate some of these unintended consequences.

Harrison, et al., built on this characterization of unintended consequences in Health Information Technology (HIT) to develop a framework that described important relations among HIT, workflows, clinicians and organizations.[17] The framework emphasized the importance of examining actual use of HIT, not just the perceived or planned use. It also stresses the impact of physical settings and technology on use of HIT and the recursive interaction between social and technical systems, such that introduction of HIT changes workflow and communication patterns, and existing and altered patterns affect the way HIT is used. This pattern changes over time as a result of the sociotechnological interactions. The authors of this study recommended that the ways in which HIT are used be tracked over time to recognize emerging consequences. This focus on continuing monitoring of processes in the workplace, and working toward an ideal state is another feature of Lean methods.

Pediatric Obesity: The issue of pediatric obesity is of increasing concern in the United States. The percentage of obese children in the US has increased from about 5% in 1963 to 17% in 2004.[18] An Expert Committee of the American Academy of Pediatrics released a report on the prevention, assessment and treatment of obesity in 2007.[19] In this report, they noted health concerns related to overweight in children, including sleep apnea, asthma, exercise intolerance, nonalcoholic fatty liver, gallstones, and Type 2 diabetes mellitus. Orthopedic problems were more common in obese children, including Blount disease, slipped capital femoral epiphyses and an increase in fractures. They also noted an increase in cardiovascular problems, including hypertension and hyperlipidemia. A more recent study of Israeli Army soldiers tracked over time showed that a high BMI at age 17 was predictive of coronary artery disease in adulthood, independent of adult BMI.[20] That is, teenagers with a high BMI were at risk for developing heart disease later in life, even if they achieved a normal BMI as adults. The Expert Committee report included recommendations for universal screening as well as detailed recommendations for counseling families on obesity prevention and treatment. Specific recommendations for treatment plans were included as well, based on patient age and BMI percentile, as well as the family's willingness to make changes.

The Expert Committee recommendations are not always followed, however, as documented in a 2010 study.[21] Although nearly all respondents to a survey regarding adherence to the Expert Committee guidelines were measuring height and weight, only 52% reported assessing BMI. Pediatricians in larger group practices and those who had recently attended continuing medical education on BMI were more likely to assess BMI, and were more likely to address elevated BMIs. Providers noted lack of time and poor results of counseling on overweight and obesity as reasons for not following the recommendations.

Because of growing concern for obesity in children, Thedacare has begun to measure how its pediatricians address this problem. This measurement began in 2008 with a metric assessing whether BMI was determined at well child checks, and if elevated over the 85^{th} percentile for age and gender, was added to the patient's problem list.

Pediatricians at Thedacare met the goals for this measure within the first year. The next step was to determine not only if providers were measuring BMI, but also whether elevated BMIs were prompting action. Thus, one of the metrics for pediatricians, introduced in 2010, is the pediatric BMI plan metric, measured for each pediatric primary care provider (PCP). The metric is, in simple terms, the percentage of obese children who have a documented plan to address their weight. The denominator for the metric is the number of a PCP's patients age 3 to 18 with a BMI over the 95^{th} percentile for age at a well child check. The numerator is the number of those patients for whom a plan to address the high BMI was documented. Although the majority of pediatricians at Thedacare did well on this metric, it was noted that one clinic was struggling to meet the goal for this metric. A Lean event, described in the Methods section of this paper, was held at this clinic to determine the causes and develop countermeasures.

EHR software: Before discussing the Lean event, it is important to discuss the EHR used at Thedacare, as many of the processes and workflows involved in the project involve the EHR. Thedacare uses the Summer 2009 version of the Epic EHR software, updated several times since first going live with Epic in 1997. To understand the processes involved in obtaining the pediatric BMI quality measure, it is first necessary to understand the Epic tools available for documenting patient visits. Information on these tools is available in the Epic Hyperspace Basics Guide[22], as well as the EpicCare Ambulatory Administrator's Guide.[23]

Documentation of patient encounters is done via a Visit Navigator, which is a screen within the EpicCare Ambulatory application containing a variety of sections for entering and/or displaying information related to an encounter. The sections contained within the navigator are customized locally and will vary depending on the department, visit type, and security of the person using the Navigator. Of particular interest for the quality measure are sections for Vitals, Diagnoses, Progress Notes, and Patient Instructions.

The Vitals section of the Navigator allows entry of the patient's vital signs, including height and weight, in either English or metric units. Epic stores these as discrete data elements associated with the date and time they were entered. BMI is not stored discretely, but is calculated by the system based on height and weight for the encounter and displayed within this section. In addition, percentiles for age for height, weight, and BMI are calculated and displayed in the section. The growth parameters, including BMI, are also plotted on a standardized growth chart specific for age and gender. There are no hard stops requiring vital signs to be entered, but BMI will not be available within the encounter if there is not both a height and a weight entered during that encounter.

The Diagnosis section of the Visit Navigator allows entry of diagnoses, which are mapped to the corresponding ICD-9 codes and stored discretely. From within this section, diagnoses can also be added to the patient's problem list, or diagnoses from the problem list may be added to the encounter diagnoses.

The Progress note section is where the bulk of the provider's documentation occurs. Although encounter notes can be dictated, the majority of users at Thedacare no longer dictate, instead using Epic features to document directly into the Progress note section. Well Child Checks are documented exclusively using these features. Epic has a number of what they call SmartTools available to assist with documentation. These include SmartSets, SmartTexts, SmartLinks, SmartLists, SmartPhrases, and SmartData (Figure 2). Together these allow rapid and flexible documentation, including the potential for capturing discrete data in addition to free text information.

- **SmartSet:** a collection of tools used for a common purpose, including orders, diagnoses, level of service codes, and SmartTexts for documentation.
- **SmartText:** a documentation template that may include free text, SmartLinks, and SmartLists.
- **SmartLink:** used to place discrete data such as age, gender, or vital signs, into a note from elsewhere in the patient's record.
- **SmartList**: a drop-down list used to provide options in documentation.
- **SmartPhrase:** a smaller piece of documentation than the SmartText, often used to add customized information not included in a SmartText.
- **SmartData:** an element attached to an option in a SmartList to allow tracking and reporting on the selection of that option.

Figure 2. SmartTools used for documentation in Epic.

The tools used for a well child check at Thedacare will be considered as an example. Documentation begins with selection of a Well child SmartSet specific to the age and gender of the patient. The SmartSet allows the user to accomplish several tasks pertinent to the encounter, including selecting reason for visit, placing orders, entering diagnoses and level of service codes, and inserting documentation tools such as SmartTexts into Progress Note and Patient Instruction sections of the Navigator. The SmartSet will have sections for these tasks, with the most commonly used options defaulted, but other options available for selection. These tasks can be accomplished without use of the SmartSet by directly entering information into the appropriate Visit Navigator section, but the SmartSet has the advantage of pulling together the relevant information into one tool, and defaulting common options for the user. Thus it serves as both a time-saver and a decision support tool.

For documentation of the Progress Note, the Well Child SmartSet may allow choice of one or more SmartTexts, or alternatively, a SmartText may be chosen from within the Progress Notes section of the navigator. A SmartText, sometimes referred to as a template, is a pre-built document that makes use of other SmartTools to allow rapid, customized documentation. It consists of free text, as well as SmartLinks and SmartLists.

SmartLinks are used to pull in data from other portions of the patient's chart. For instance, SmartLinks can pull in the patient's name, age, gender and other demographic information stored discretely in the chart. They may also be used to pull in the patient's medication list, problem list, lab values, diagnoses or vital signs, including BMI. When the SmartText containing SmartLinks is inserted into the patient's Progress Note, Epic replaces the SmartLink with the corresponding patient-specific information. Since some of the information, such as diagnoses, may change during the encounter, some SmartLinks are designed to be refreshable. When information changes after the SmartText is inserted, the documenter can opt to refresh the SmartLink and pull in the new data. Otherwise the old data remains in place. Once the note is electronically signed, the SmartLink is finalized and no longer refreshable.

SmartLists are used when options are required. For instance, for documenting a physical exam, the SmartText may include a SmartList for the eye exam, which allows the documenter to simply select one or more normal or abnormal findings. There is often also a "wild card" option, consisting of three asterisks, which allows the documenter to enter free text for findings not on the list or to add additional details. SmartLists can be created so that the most typical options are defaulted, allowing rapid documentation of normal findings.

SmartPhrases are typically smaller pieces of documentation that can be added on the fly, and are often created or customized by individual users. These are sometimes referred to as "dot phrases" as they are added to a note by typing a period followed by a mnemonic for the individual phrase. SmartPhrases can contain SmartLists and SmartLinks as well. These are often used when there are additional concerns that aren't included in the SmartText chosen for the encounter. They also are used to add custom information, to the plan or Patient Instruction documentation, for example.

SmartData is used in conjunction with SmartLists to create discrete data. In general, when SmartList options are chosen, the choices are converted to free text within the note. No specific searchable information is retained by Epic as to which options were chosen. However, a SmartData element may be attached to options within a SmartList, such that when the option is chosen, information is stored in the Epic database indicating that the option was chosen for the patient. The data stored may include the specific encounter at which the option was chosen. This allows reports to be run to determine whether a specific option was chosen at a specific encounter, avoiding the need to do chart reviews to find free-text documentation.

All of these SmartTools are highly customizable by the organization using them. For organizations currently installing Epic at their facilities, Epic has created Model Systems, which contain many pre-built SmartTools. These can be adopted and customized by current users as well. However, systems such as Thedacare, which have been using Epic for many years, did not have this available to them when they first installed Epic. Thus, the SmartTools in place at Thedacare have mostly been developed and refined locally over time.

BMI metric performance: Most of the pediatricians in Thedacare were doing well on the BMI quality metric by the end of 2010, with rates averaging 77% (range 52-100%).

However, the author of this paper, a pediatrician at Thedacare, was showing much lower performance, with quality reports showing only 26% of obese patients age 3-18 having a plan to address their BMI during 2010. The reason for this discrepancy was unclear. Because of this it was decided to hold a rapid improvement event to address the problem of low BMI plan quality metrics.

Methods

A rapid improvement event, or RIE, is a short, intense effort aimed at producing quick results. It typically begins with a period of defining the problem, developing metrics and gathering data. This may occur over as long as eight weeks prior to the event, although it can be compressed into a much shorter period as well, if the problems being dealt with is more urgent. The first step in preparing for the quality improvement event involved a small group meeting to determine the problem statement and background conditions. The author met with the manager of his clinic, his medical assistant (MA), and a Lean facilitator. After a brief discussion, they began with an initial vague problem statement intended to guide further work. The vague statement was simply "Not meeting BMI metric for pediatric patients." The group then discussed the background conditions for this problem, producing a short list of facts which they felt were related. The list included:

- 26 % of patients age 3-18 had a plan for weight management documented at a well child check
- The data applies to patients assigned to the author, but not necessarily seen by him (i.e. if another provider saw the child for the author, it was still counted toward the author's metrics)
- The author is the only pediatrician at this clinic, with the other providers being family practitioners, family nurse practitioners, or physician assistants. This is in contrast to other Thedacare pediatricians who all practice in pediatric clinics.
- A BMI SmartLink, which pulls the BMI into the well child SmartText, does not always appear in the well child SmartText, indicating an older or incorrect

SmartText was being used at times. The correct SmartText also includes a BMI Questionnaire to be completed by the MA when rooming the patient (Figure 3).

- The correct SmartText contains, in the Plan section of the note, a SmartList, containing a SmartData element that is used to determine if the provider selected a plan from the list. If the first choice on the list is selected, the SmartData element is added to the database and associated with that encounter (Figure 4).
- Quality measures and expectations are not clear to the entire clinic team
- The author was not currently on the Thedacare compensation plan, in which a small portion of the physician's compensation is based on performance on quality measures.

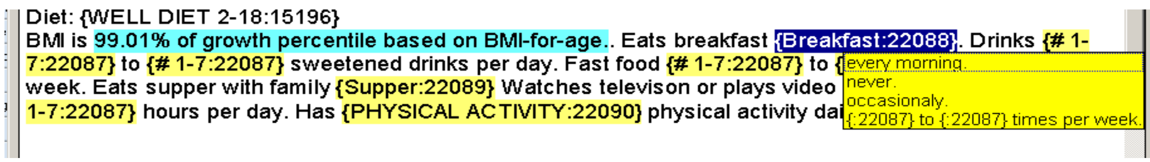

Figure 3. The BMI history questionnaire used by the MA to document more detailed diet and exercise history for obese patients.

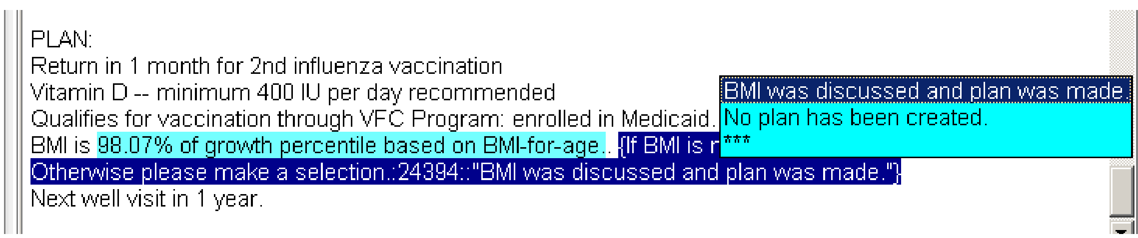

Figure 4. The BMI SmartList required for the quality measure. The first choice on the list, "BMI was discussed and plan was made" must be chosen for the SmartData element to be filed in the database for the metric to be satisfied.

Following the delineation of these background conditions, the team developed a brief description of the process for documenting a BMI plan, including the people involved. This was done using a tool known as a SIPOC, an acronym for Suppliers, Inputs, Process, Outputs and Customers (Figure 5).

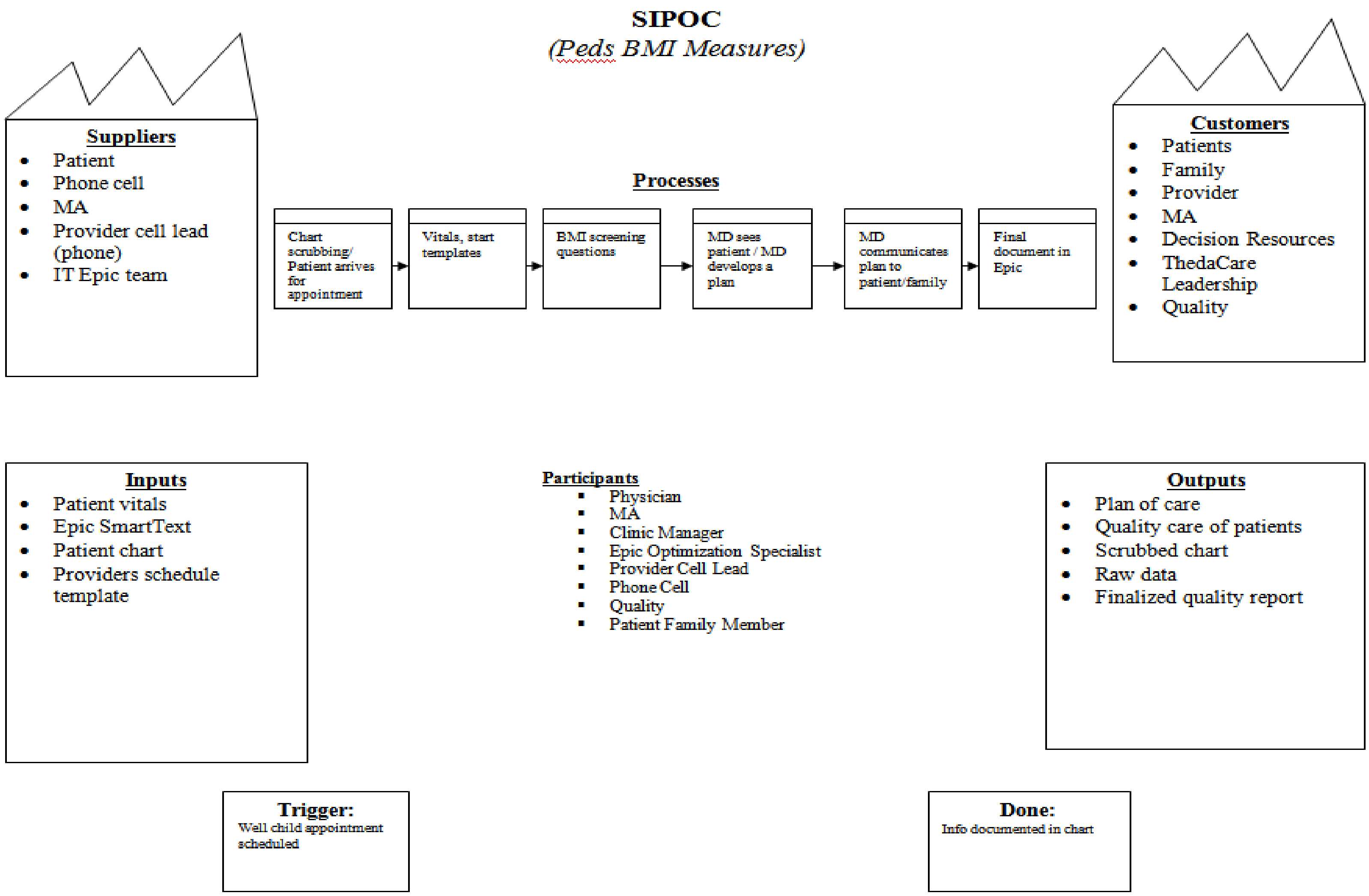

Figure 5. The SIPOC: Suppliers, Inputs, Processes, Outputs, and Customers.

A few comments on terminology in the SIPOC diagram are in order. Under suppliers, the term “phone cell” refers to the set of staff members responsible for answering phones and scheduling appointments. The Provider cell lead is a staff member who is responsible for ensuring smooth operations in the patient care areas of clinic, overseeing staff and troubleshooting problems. In the first box of the process, “chart scrubbing” refers to a process of reviewing charts prior to scheduled patient visits and adding notes to the provider schedule listing needed services. For the BMI measure, the chart scrubber will check whether the patient was obese at a previous visit, and , if so, add a note to remind the provider and MA to check the BMI.

Based on the vague problem statement, background, and SIPOC, the group created a more specific problem statement: “Dr. Collins and his Provider Care Team are not meeting system metrics for pediatric patients BMI plan (3-18 yrs) during Well Child visits. 26% of eligible patients have a plan for weight management, when the system goal is 72%. When this is not successfully addressed patients are at greater risk for major health issues with an increased number of medications, Emergency Room and Inpatient Hospital admissions.” A list of goals for the projects was then developed, including improving quality metric scores, providing better care of patient, identifying patients at risk for problems due to obesity, and creating individual plans for the patients identified. Given the baseline of 26% on the measure, a modest target of a 20% improvement, to approximately 32%, was proposed. The Thedacare system target for the metric has since been increased to 80% for 2011, up from a goal of 72% for 2010.

Over the course of the next few weeks, the team gathered data. Based on the background conditions identified, the data collection plan focused on determining provider and MA familiarity with the process for capturing BMI information and developing the plan. Separate questionnaires were administered to all the primary care providers (Figure 6) and MAs (Figure 7) working in the clinic. The author also performed a chart review of his patients who showed as failures on the BMI plan metric, i.e., those who had a BMI over the 95th percentile and did not have a BMI plan by report.

1. Are you seeing the Pediatric BMI Questionnaire on patients with BMI>95th percentile? (Yes/No/Sometimes)
2. Is the BMI Questionnaire completed? (Yes/No/Sometimes)
3. If not completed, are you completing it? (Yes/No/Sometimes)
4. Do you develop a plan with the patient, and do you pick the box identifying you have created a plan? (Yes/No/Sometimes)
5. Do you know how the Peds BMI plan metric is measured? (Yes/No)
6. What is your overall comfort level that you are addressing childhood obesity with your patients? (6 point Likert Scale, 0=not at all, 6=completely comfortable)

Figure 6. Provider Questionnaire, used to determine provider familiarity with the BMI metric process

Of seven primary care providers responding to the questionnaire, only four reported they consistently saw the BMI questionnaire in their well child progress notes, while two saw it some of the time. Of those reporting they saw the questionnaire, one-third reported that it was always completed, while one-third reported it was never done. Further, only 60% of the providers completed the questions when the MA did not do so. Thus, the BMI questionnaire is inconsistently used, both by MAs and providers.

Regarding the BMI plan, four of the seven providers noted that they picked the SmartList option stating they had created a plan, one reported “sometimes” picking it, and two did not recall seeing the options. Interestingly, although none of the providers replied that they knew how the BMI measure was calculated, the average comfort level that they were addressing high BMIs was 4.3 on a 6 point scale, with 6 being “Extremely

Comfortable". The providers are reasonably confident that they are addressing BMI, even though they have poor understanding of the BMI plan metric process.

1. Do you get height and weight on all well childs and sports physicals? (Yes/No)
2. Do you address the BMI questions if the BMI>95th percentile? (Yes/No)
3. In no to question 2, why not? (Free text response)

Figure 7. MA questionnaire, used to determine MA familiarity and adherence to the BMI metric process.

All of the MAs reported that they obtain height and weight for patients presenting for well child or sports physicals. However, only one-third stated that they used the BMI questionnaire when a patient had a BMI>95th percentile. Reasons given for not using the BMI questionnaire include:

- I do not know how they relate to BMI
- I do not understand, the provider usually does it
- I do not recall seeing the questions, I go right past it
- I do not know what that is

In addition, one MA stated she did complete the BMI questionnaire, but was unsure if she was supposed to. Like the providers, the MAs did not seem to have a good understanding of the process or their role in it.

- BMI questions were asked using correct SmartText: 26%
- A plan was created, but SmartText not used to document it: 52%
- Correct SmartText was used: 32%

Figure 8. Results of the chart review of metric failures.

The chart review (Figure 8) included all of the author's patients who failed the BMI plan metric during the fourth quarter of 2010, and included 31 patients. The list of patients was pulled via a report of the author's patients, age 3-18 seen for a well child check or sports physical, with a BMI>95th percentile who did not have the BMI plan SmartData element associated with the encounter. Of these metric failures, nearly three quarters did not have the BMI questionnaire documented in the progress note. Just over half had a documented plan to address the high BMI using free text rather than the SmartList choice required for metric success.

In only one-third of the failures was the correct well child SmartText, containing the SmartData element, used in the progress note. Because the SmartList containing the SmartData element must be used to document that a plan was created in order to satisfy the metric, in two-thirds of the failures, success was not possible. Even if a plan was created and documented as free-text, as happened in half the failures, the quality report would not count this as a success.

Event Team: The next step in the Lean improvement process was to select team members for the rapid improvement event (RIE) (Table 1).

Team Member	Role on Team
Author	Co-leader/Stakeholder
Clinic Supervisor	Co-leader
Author’s MA	Stakeholder
Parent of a patient	Stakeholder
Quality Office representative	Subject Matter Expert
Epic Optimization Specialist	Subject Matter Expert
Radiology Technician	Fresh Eyes
Lean Expert	Facilitator

Table 1. Team members for the RIE.

The team was composed of a mix of stakeholders in the process and subject matter experts. In addition, Thedacare generally includes a member on the team with no direct connection to or knowledge of the process under investigation, a concept referred to as “Fresh Eyes.” This person comes into the event without preconceived ideas about the process, and is often invaluable for challenging assumptions. The quality office representative brought knowledge of the metric definition, measurement, and reporting process. The Epic optimization specialist was the expert on the various tools and workflows within Epic. The stakeholders are of course directly involved and affected by the process.

Workplace observation: The team was brought together for the RIE, with a plan to take two days, with potential to continue for a third day if needed. After the Lean facilitator briefed the team on Lean methods and the agenda for the event, work began. The first step was to go to the workplace to observe how the process actually occurred. Team members were encouraged to ask questions and seek as much information as they needed to understand the process. Using the process developed with the SIPOC tool as a starting point, the team went first to the scheduling area to observe how patients were scheduled. Next, they observed the provider cell lead scrubbing charts. Then, since it wasn't practical to actually observe a well child exam, the author and his MA demonstrated the process of rooming a patient, evaluating the BMI, and creating and documenting a BMI plan. This demonstration was done in Epic, using a test patient, created for testing and training purposes, rather than a real patient's chart.

Identifying Waste: As part of the observation process, the team was instructed to note waste in the process, using the list of eight waste types to help identify wastes and ensure specific types of waste were not overlooked. There were some disagreements over which category particular examples of waste fell into, but general agreement on what wastes were observed (Figure 9). Not all types of waste were identified.

Unused Human Talent
    Lack of training on process and knowledge of Epic tools
    BMI history not being completed by MA
    Not recording BMI discussion with parents when parents in denial
    Personalized plan not recorded in plan section of progress note
Defects
    Template problems – wrong template placed in progress note
    Metrics not understood by all
    Chart Scrubbers not always looking for high BMI
    No plan documented when parents disagree with plan or need for plan
    High BMI not addressed during visit
    No way to meet metric when wrong template used
    High BMI is not always on problem list as reminder for chart scrubbing or MA
    Template BMI plan SmartList sometimes deleted and replaced with free text by provider
Motion
    MA needs to refresh the BMI SmartLinks after entering vitals to pull BMI into progress note
Overproduction
    Chart scrub step listed in SIPOC not needed, since all patients need to be assessed regardless of previous BMI

Figure 9. Wastes identified during the observations in the workplace.

Current State: Armed with this knowledge, the team created a CS VSM, showing the individual steps of the process as it existed at the start of the improvement event (Figure 10). This flowchart shows as many as 27 steps, with six decision points in the process. The team determined that ten of these steps were value-added, a finding the Lean facilitator felt was generous. The value-added steps included patient arrival, the MA rooming the patient, measuring height and weight, and entering vitals into the patient's chart. The team also felt that the provider reviewing the chart, entering the room, reviewing the growth chart and diet and exercise information with the patient and developing and implementing a BMI plan were value-added. All other steps were non-value added and potentially waste.

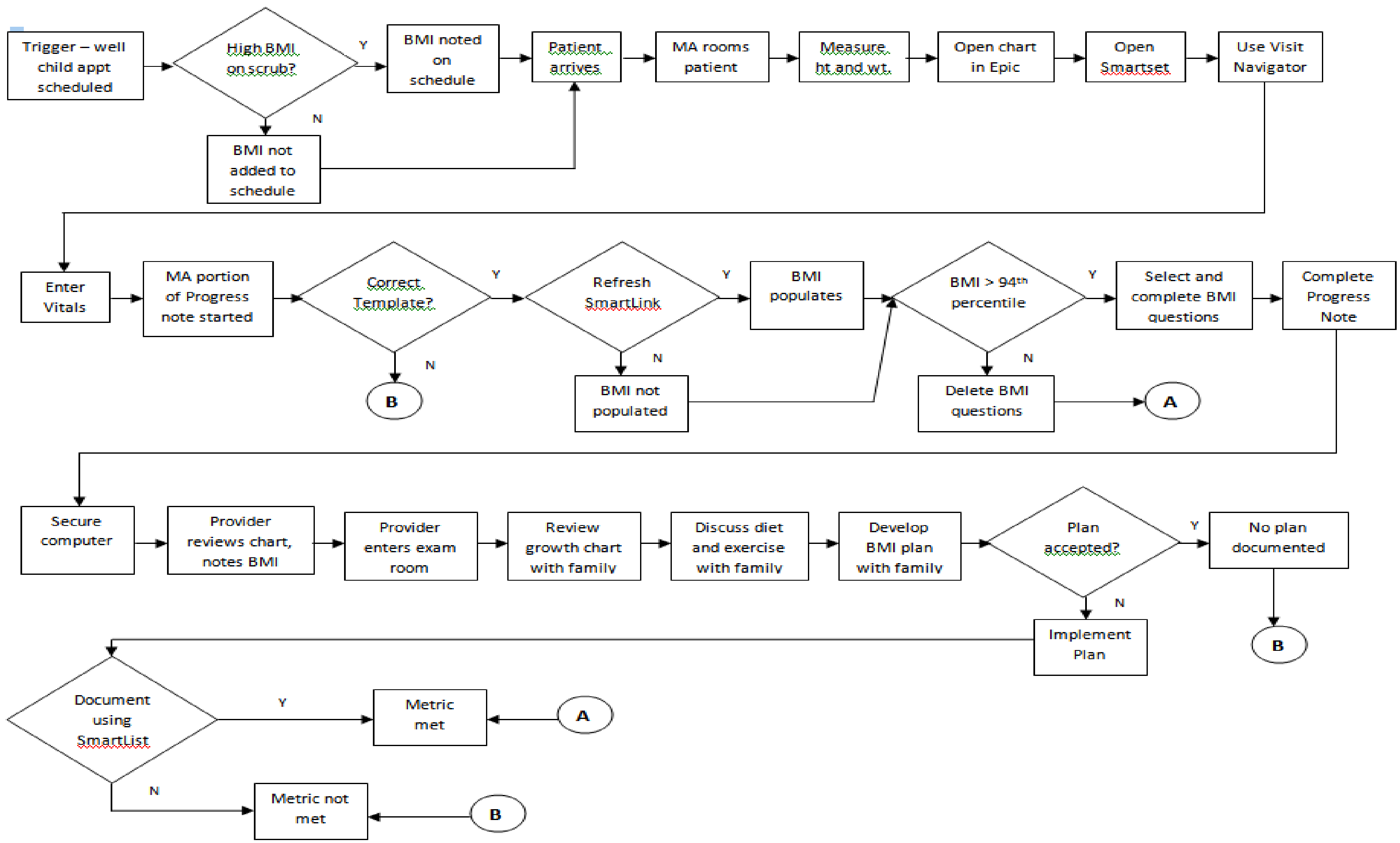

Figure 10. The Current State Value Stream Map.

Root Cause Analysis: After identifying waste and creating the CS VSM, the team started to create a FS VSM by means of a root cause analysis. First, the team identified the key problems or wastes felt most likely to be causing the metric failure. They performed root cause analysis to determine the ultimate causes of the wastes in the process. Countermeasures were then developed to address each of the root causes. A tentative FS VSM could then be created, followed by testing of countermeasures when practical and refinement of the FS VSM as needed.

The list of wastes were evaluated and grouped when possible. From this the following list of key problems was developed.

- The MA not refreshing the BMI SmartLinks to pull BMI data into the progress notes
- The provider using free text to document the plan, rather than using the SmartList
- BMI not being addressed by the provider for any reason
- Not having a way to add the SmartData element if the wrong SmartText was used or SmartList is deleted
- The provider not documenting a plan after creation of a plan.

The first of these was a problem because if BMI data was not pulled into the note, there would be no prompt for the MA to complete the BMI questionnaire which assists the provider in developing a plan. In turn, the provider would not have an indicator of increased BMI in the note to remind him to address the issue. If the provider deletes the SmartList, free-text documentation of the plan will not satisfy the metric, and there is no way to add the SmartList back in. Finally if the provider doesn't develop a plan, or develops a plan, but fails to document it, the metric will not be satisfied.

Root cause analysis was conducted using the Branching Why technique. Figure 11 shows the results of the root cause analysis for the first key problem.

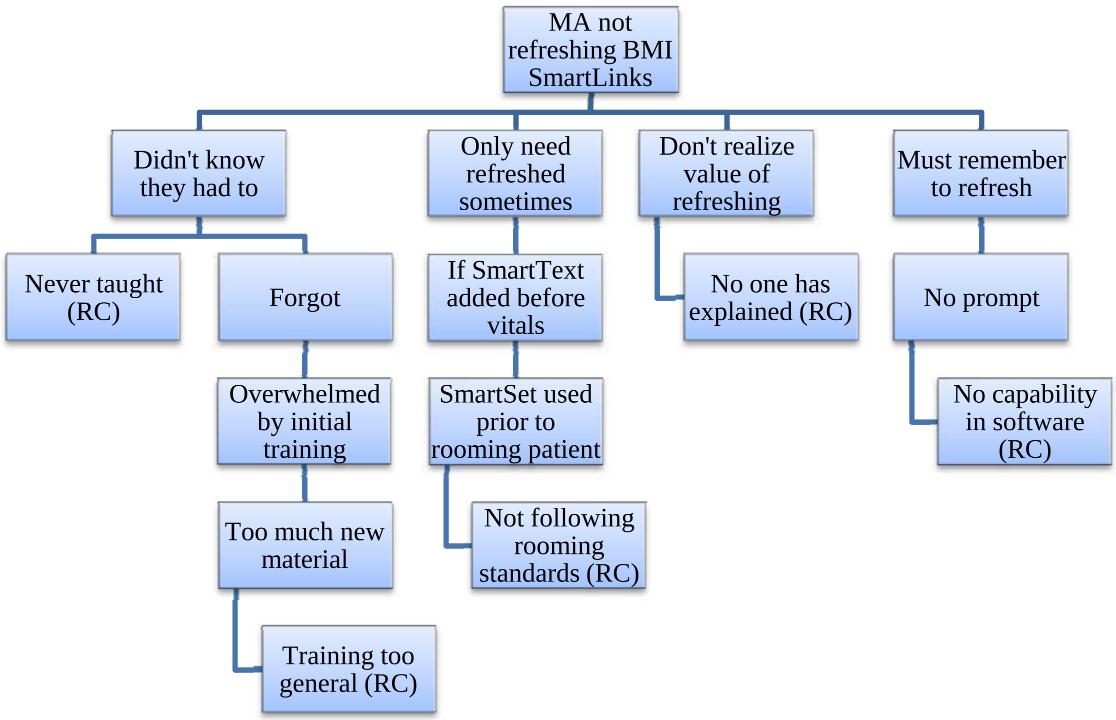

Figure 11. Root Cause Analysis, showing reasons why the MA does not refresh BMI SmartLinks. "(RC)" denotes a root cause.

Reasons identified that the MA does not refresh the SmartLink included that they didn't know they had to refresh, that SmartLinks don't always need to be refreshed, that the MAs didn't realize the value of refreshing, and that they must remember to refresh. The reasons the MA didn't know to refresh included that they were never taught and that they forgot. Not being taught was considered a *root cause*. Forgetting what they were taught was felt to be caused by being overwhelmed with initial training, which was felt to be due to having too much new material to learn. This in turn was felt to be due to training being too general, designed for all types of roles, not just MAs. This was also considered a *root cause*. The second branch of reasons for not refreshing was that SmartLinks only need to be refreshed some of the time. If the vital signs are entered before the SmartText is chosen, the SmartLink contained in the SmartText will automatically insert the BMI. If, however, the SmartText is chosen first, before vital signs are entered, there will be no BMI information for the SmartLink to insert. In that case, the SmartLink will need to be refreshed for the BMI to show in the SmartText. The SmartTexts are added before the vital signs because the MAs select the well child SmartSet prior to rooming the patient, which does not follow the Thedacare rooming standards. These standards state that the SmartSet should be selected only when the user reaches the progress note section of the visit navigator, which is *after* the vital signs are entered. This is another *root cause*. The third branch, that the MA does not realize the value of the BMI, was felt to be due to inadequate explanation to the MAs, which was considered a *root cause*. Finally, the MA having to remember to refresh was felt to be due to the lack of a prompt to refresh, which leads to the *root cause* that the software lacks the prompting the capability.

A similar process was followed for each of the key problems. For the issue of using free text to document plans and deleting the SmartList, there were three root causes found (Figure 12). First, free text allows addition of needed details of the plan for continuity of care and follow-up. Second was the assumption that it was acceptable to substitute free text for the SmartList choices. This is a common practice, as it allows providers the flexibility to alter standard documentation to meet the needs of the individual patient. Finally, the provider did not realize this affected the metric outcome.

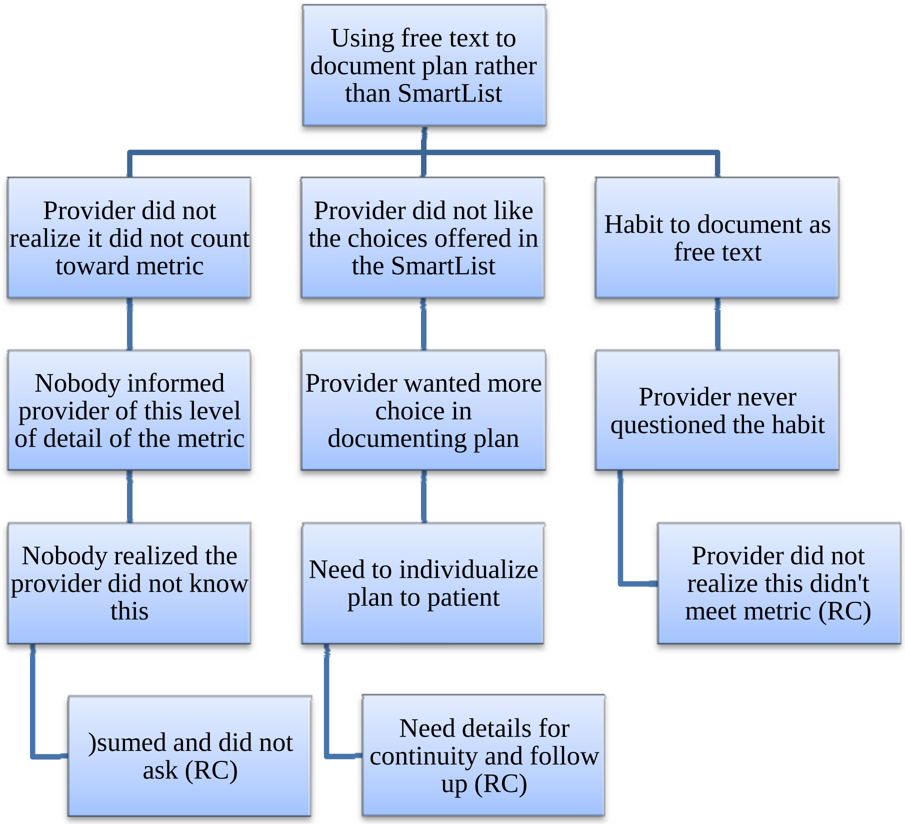

Figure 12. Root Cause Analysis, showing reasons why free text is used to document the plan. "(RC)" denotes a root cause.

The problem of BMI not being addressed during the well child check had two root causes (Figure 13). The first is that BMI is a chronic problem, while the patient may actually have more acute or urgent problems that the provider feels need to be addressed in the limited timeframe of the well child check. In addition, the family may not understand the importance of a high BMI, and wish to discuss other issues during the well child check.

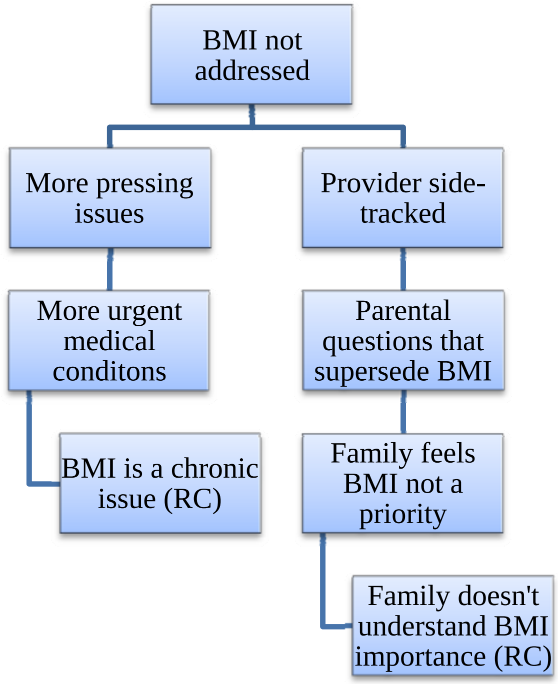

Figure 13. Root Cause Analysis, showing reasons why BMI is not addressed. “(RC)” denotes a root cause.

The fourth problem was that there was no way to add the BMI plan SmartList to the progress note if it was deleted or if the wrong template was placed. The root cause for this was simply that this was not recognized as a problem, so no way to achieve this was created (Figure 14).

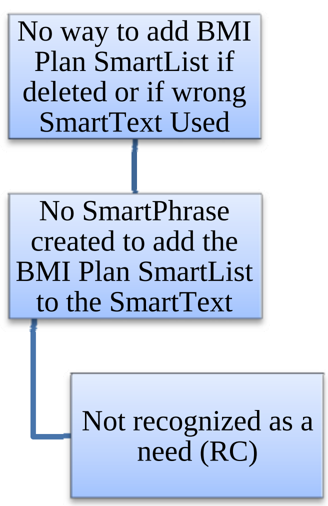

Figure 14. Root Cause Analysis, showing reasons why no way to add BMI SmartLists exists. “(RC)” denotes a root cause.

Finally, for the issue of the provider not documenting a plan after creating it, there were two root causes (Figure 15). The first was that the provider did not perceive a reason to document a plan in cases where the parents did not agree with the need for a plan to address BMI. In these cases, the plan would be to follow up at the next visit, but this was not being documented. The second cause really deals with the issue of incorrect SmartTexts being placed in the progress note. The root cause for this is a communication gap in the design of SmartSets and the SmartTexts they contain. The information technology (IT) staff responsible for building these did not understand the clinical needs, and the clinical personnel responsible for developing these did not understand their complexity.

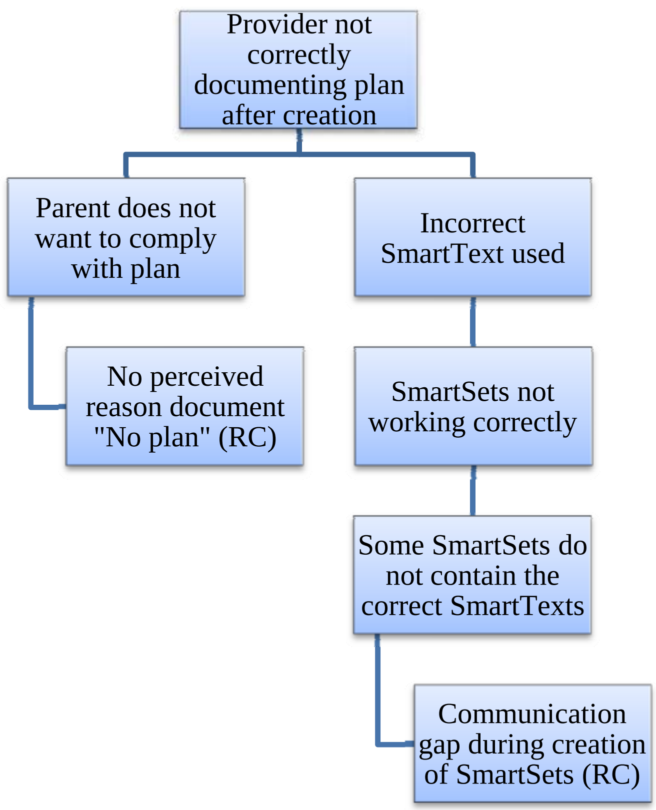

Figure 15. Root Cause Analysis, showing reasons why the Provider did not correctly document the plan. "(RC)" denotes a root cause.

The second issue of incorrect SmartTexts was one of the more significant findings, and deserves further explanation. As the chart review demonstrated, in more than two-thirds of the metric failures, an incorrect SmartText was used. One cause for this, found on further review of a limited number of these charts, was that a SmartSet was not used to select the proper SmartText. Instead, the MA picked the SmartText from within the Progress Note from a much more extensive list of SmartTexts. Sometimes the wrong SmartText was picked, since older versions of the SmartText without the BMI questionnaire were available. One question that this raised was why the old versions of the SmartTexts were still in the system. The answer, as supplied by the Epic optimization specialist on the team, was that the older versions were being used by family practitioners. Since family practitioners are not being included in this metric, some of them did not want to see or have to complete the additional BMI tools. As a result, there is a duplication of SmartTexts for each age group. One set of SmartTexts, with “Peds Only” added to their names, contained the BMI tools. The others, lacking this label, were the older SmartTexts, without BMI tools. There was no clear indication on the older SmartTexts that they were not to be used for pediatric patients, nor was there understanding of the difference by the MAs. The result was that at times the older version was picked, either from within or outside of a SmartSet.

Picking from a SmartSet should ideally give the proper SmartText, but that was not always the case. Some patients from the chart review had a SmartSet used for the encounter, but still ended up with the wrong template. This was initially felt to be due to picking the wrong SmartText from the SmartSet, if a choice was offered between the old and new versions. Since the author, a pediatrician, works in a primarily family practice clinic, some of the MAs may have understood the “Peds Only” term in the name of the SmartText to imply it was only to be used in the Pediatric clinics, rather than by all pediatric PCPs. Further investigation revealed that the SmartSets were not offering a choice between the two SmartTexts, but only one or the other. Some of the SmartSets would only list the “Peds Only” SmartText for one patient, but then show only the old SmartText for another patient. This puzzling behavior was explained by the Epic optimization specialist on the team, who was instrumental in sorting out the difficulties involved in selecting the proper SmartText. SmartSets have the ability to show different SmartText options depending on context. In this case, some (but not all) of the SmartSets were built to show the “Peds Only” SmartText when the patient was scheduled as a “Well Child” or “Sports Physical” appointment type. If the patient was instead scheduled as a “Physical” appointment type, the SmartSet displayed the older version of the SmartText. In the Pediatric clinics, where only children were being seen, appointments were always, or almost always, scheduled as “Well Child” or “Sports Physical” types. In family practice clinics, the “Physical” appointment type was often used.

To determine how the children were scheduled in the author’s clinic, the team went back to the workplace to discuss this with the schedulers. They did not find a standard for which appointment type was used, although there did seem to be a trend toward using the “Physical” appointment type for teenagers who weren’t getting sports physicals. None were aware that how the appointment was scheduled made an impact on the appointment documentation.

Discussions with the optimization specialist revealed the underlying complexity for well child SmartSets. There are seven age ranges for the SmartSets, based on different history and anticipatory guidance needs, as well as different vaccine recommendations. Within each age range there are three different SmartSets, one each for patients with private insurance, Medicaid, or self-pay. This difference allows for different billing codes for vaccines to be used. This means there are 21 different well child SmartSets. Each SmartSet may have anywhere from two to eight different SmartTexts attached to it, depending on age and gender of the patient, whether it is "Peds Only" and whether it is a sports physical. In addition, some of the SmartSets have a new SmartTexts for asthma patients, built in anticipation of addition of an asthma control quality measure to the pediatric measures. This brings the total to twelve SmartTexts for some of the SmartSets. In total, there are 28 different well child SmartTexts, 17 of them marked "Peds Only." See Appendix 1 for details.

The communication problems between clinical and IT staff identified in the root cause analysis (Figure 15) arose because the clinical staff who developed the documentation process for the BMI measure did not understand this complexity. They instructed the IT staff to make certain Well Child SmartSets limit the SmartTexts shown based on appointment type, but did not include all the possible combinations. The IT staff made the changes requested, but did not consider the reason for the changes or ensure that all the Well Child SmartSets were updated to show the proper SmartTexts based on context. Further, there was lack of communication of these changes to the schedulers who were the ones deciding what appointment type would be used. The result was inconsistency in which SmartText was available in any given SmartSet.

Countermeasures: Once root causes for waste were identified, the next step was to develop countermeasures to correct the identified problems (Figure 16).

Problem	**Root Cause**	**Countermeasure**
MA not "refreshing" at beginning of Progress Note	Never taught	Teach the MAs
	Training too general & overwhelming	
	No one explained value of the metric process	Make Metric more visible
	Must remember to refresh – no trigger	"Sticky note" reminder to "refresh"
	Rooming Standard contradicts entering Height & Weight earlier	1)Train staff not to enter SmartSet until Progress Note 2)Teach staff to "refresh"
Using "free text" to document plan vs. other options	Need detail for continuity	Re-word 3 options for more detail
	Assumption that this option is acceptable	Teach detail of how Metric is measured
	Did not realize this affected the metric outcome	
BMI not addressed for any reason	BMI is chronic vs. acute/urgent	Schedule Follow-up Visit to address BMI
	Did not understand importance of BMI	Educate patients and family on importance
There is no way to add questions in if they don't populate	Not recognized as a need	Create SmartPhrase that is "Reportable"
Provider not documenting plan after creation	No perceived reason to document when plan not acceptable to parents	Train providers to document that plan is to readdress next visit
	Communication gap during template build	Fix templates and create Standard for communication to all involved

Figure 16. Countermeasures developed for each of the root causes.

The countermeasures are tentative solutions, subject to further testing and refinement. When possible, they were tested immediately, refined, and retested as needed. Given that the BMI plan process does not apply to most office visits, it was not possible to test most of the countermeasures during the event. One notable exception was the creation of a SmartPhrase containing the reportable SmartData element. This was created and tested to ensure that it did satisfy the metric, allowing the provider to insert the SmartPhrase when the old SmartText was used. This was a temporary measure until the issues resulting from the complexity with the SmartSets could be resolved.

Following the development of these countermeasures, a FS VSM was created, incorporating the changes resulting from the countermeasures (Figure 17). The FS VSM represents the ideal state, which would happen if all goes according to plan. For instance, it assumes the correct SmartText will be used every time. The final FS VSM is simplified and omits some of the trivial steps in the CS VSM, such as “Provider Enters Room”. It also leaves out the initial chart scrubbing steps, wherein the charts were reviewed for high BMI the day before the visit, not because they caused errors, but because they were unnecessary. All well child check patients need BMI measured, not just those with a high BMI in the past. The number of steps in the process was reduced to 13, with only one decision point.

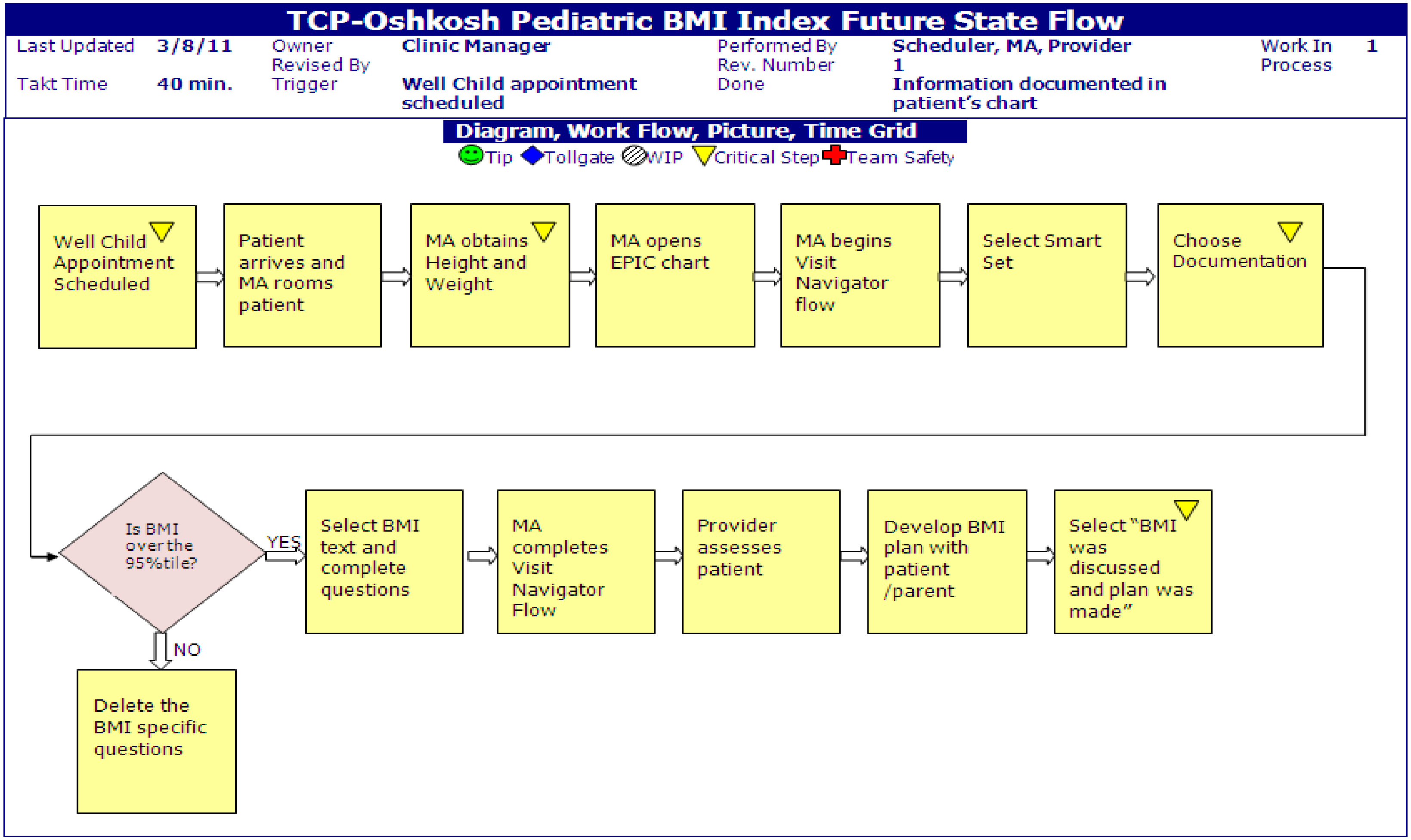

Figure 17. Future State Value Stream Map, showing the redesigned process resulting from the event.

Implementation plan: Once countermeasures and the FS VSM were determined, a plan was created to implement the measures within the clinic. The first step was to create a standard work document, detailing the steps to be followed to ensure a BMI plan is created and documented (Appendices 2 and 3). This standard work document details the steps and the rationale, as well as any helpful hints to assist the users in following it.

After creation of the standard work document, a list was made of work to be done to implement the countermeasures, along with assignment of responsibility for each task and anticipated completion dates. These tasks included:

- Educating providers about the BMI metric and the standard work
- Creation of the BMI SmartPhrase to be used when incorrect SmartText used
- Testing of the SmartPhrase to be certain it is captured by the BMI metric report
- Updating well child SmartSets and SmartTexts so that the proper SmartTexts are displayed
- Addressing the communication gap between clinical and IT staff
- Developing a communication charter to train MAs
- Training MAs on the BMI metric and standard work
- Adding the BMI quality metric to the tracking board in the clinic to increase visibility

The majority of this work was completed during the project or within a few days afterward. The primary exception was addressing the communication gap between clinical and IT staff. This was beyond the scope of the project team. It had, in fact, been recognized as a problem, and separate work is being done to address this larger issue.

Results

The BMI metric report is run on a monthly basis. The first two months after the project completion, the author achieved 100% on the BMI metric. Interestingly, the other pediatric clinics, which were not directly involved in the improvement event, also showed improvement in their BMI metrics, with an average rate of 85%, up from 77%. Although the standard work and training was not implemented at the other clinics, it is possible the improvements seen were a result of improvements in the SmartSets. However, the improvement at the other clinics may also be unrelated to the current improvement event.

In addition to the BMI metric itself, improvement was also found in the provider and MA surveys, which were repeated one month after the event. On the provider survey, four responses were returned. Of these, three stated they had seen the BMI questionnaires, already completed by the MAs. The fourth had not seen any children with BMI>95th percentile since the project occurred. However, only two of the providers stated they had developed and appropriately documented the BMI plan. The providers' average overall comfort level that they were addressing childhood obesity with their patients was 5.3 on a 6-point Likert scale, up from 4.2.

On the MA survey post-project, all of the MAs again stated that they document height and weight on all well child encounters. Five of six MAs returning the survey stated they address the BMI questions when BMI>95th percentile. The sixth stated she would when she saw such a patient, but hadn't seen one since the event. The reasons stated for addressing the BMI questions included: "It's standard work" from three MAs, and "I do, now that I know it is required" from one MA.

The initial results of the improvement event are very reassuring. However, the time frame is very short, and it will be important to continue to track the BMI metric to ensure sustained performance. The BMI metric has been added to the clinic tracking board, with monthly updating of data. If the BMI metric begins to decline significantly again, some or all of the team which worked on the project will reconvene to determine the cause and develop new countermeasures as needed.

Discussion

While the example presented here is simple compared to many quality improvement projects, it demonstrates the potential for the use of Lean in healthcare. The focus on customer-defined value, processes, and eliminating waste facilitated the rapid improvement in the BMI quality metric, in a way that may not have occurred without such a systematic approach. The improvement process uncovered problems with training, workflows and communication. Although the improvement event focused on a small problem in one clinic, the findings had far-reaching implications for other clinics, for other processes, and for future improvement projects throughout the organization.

Without the use of Lean, it would have been easy to attribute the author's poor performance on the metric to lack of clinical skills or effort. Perhaps a more charitable observer would have noted that the author was isolated from the rest of Thedacare's pediatricians and was "out of the loop." The response to either of these explanations would likely have been encouragement of the author to "try harder," with perhaps some additional training or explanation of the metrics. While additional communication and training of the staff at the clinic was necessary, the improvement team was able to dig deeper and discover fundamental flaws in the BMI plan reporting methods. These flaws included the presence of incorrect SmartTexts, incorrect linkage between appointment types and SmartTexts within SmartSets, and lack of standard work for determining the appointment for scheduling well child checks. By developing countermeasures and implementing standard work based on these countermeasures, the team was able not only to improve the BMI metric, but also to improve both provider and MA understanding of the metric and the process for obtaining it. The benefits of the improvement work done

on the SmartTools may have also spread to the other Pediatric clinics, based on improvement of their performance on the BMI metric during this same time. Further investigation is needed to determine if their improvement in performance was due to a decrease in incorrect SmartTexts being used, or due to other coincidental causes.
Even at the author's clinic, the rapid improvement seen may be at least in part a result of increased attention to the metric. Not all of the improvement could be attributed to the changes made to the SmartSets. Addition of the BMI plan metric to the tracking board in the clinic serves to emphasize the importance of sustaining the improvement.

This event is only the first step in Lean. The more important, and ongoing, task is to sustain the improvements achieved and, if possible, further refine the process. Standard work is a large part of the sustainment effort, because it is used to train and reinforce the improved process developed in the FS VSM. Once the standard work is in place, the FS VSM really becomes the CS VSM upon which further improvements are based. There is ongoing effort required by the schedulers to choose the correct appointment type, by the MAs to select the proper SmartSet and SmartText when offered a choice, and by the provider to develop a plan and document it using the SmartList. If continued tracking shows a decline in performance on the metric, troubleshooting will look first at whether standard work is being followed. If not, retraining will be required. If this does not resolve the problem, then further evaluation of the standard work may be required to look for further improvement opportunities. When sustained improvement on the metric is seen for a significant period, the metric may be removed from the tracking board to make room for newer metrics needing scrutiny. The metric will continue to be tracked, however, particularly as it is one of the quality improvement metrics on which providers are rated.

The findings of this project have implications for other quality improvement efforts as well. For instance, Thedacare is currently developing an additional Pediatric quality measure of the assessment of asthma control at well child checks. It is anticipated that this measure will follow a pattern similar to the pediatric BMI metric. When an asthma patient presents for a well child check the SmartText will contain a section for assessing asthma control using a standard instrument, with a SmartData element used for reporting purposes.

A few important lessons for implementation of the new metric are found in the current project. First, development of standard work for the new measure should be created before it goes into effect. Providers and MAs should be trained on this standard work as well. It is critical that all involved in the process are aware of what is being measured, why, and what their role in the process is. Finally, and perhaps most importantly, thought needs to be given to the complexity of the SmartSets and SmartText combinations required for this process. As additional similar measures are added, this issue will only become more complex. There have already been problems with communication between the clinical staff who develop the measures and the IT staff who design the SmartText and SmartSets, due to lack of familiarity with each others' realms of expertise. The optimization specialist who took part in this event is now working on a simplified scheme, involving fewer, but more customizable, SmartTexts and SmartSets. This would allow for simpler maintenance of these tools, and less chance for error when a new measure as added. Updates would occur in fewer SmartTexts, decreasing the chance that some would be missed.

Of note, some of these findings relate to the unintended consequences of implementing HIT systems, as noted in the background section. In particular, there was increased work as well as change in workflows required by the BMI metric process as initially planned, which went unrecognized or uncommunicated.   The introduction of SmartData elements for reporting also introduced a new type of error, resulting from deletion of the SmartData element. In such cases, even though a plan was documented it was not counted in the metric. Prior to the use of the SmartData element for reporting, a chart review would have been used and the plan would have counted toward the metric. These unintended consequences were discovered through the Lean event. Some such unintended consequences could be avoided altogether if Lean tools are used to examine the process prior to implementation. For the future, it is recommended that Lean tools be used in the initial design of these metrics, including mapping the process for generating the data required for the metric.

Conclusion

Lean quality improvement methods, developed from the Toyota Production System, have been increasingly used in service industries, including health care. While there are a number of successes associated with use of these methods, there is still concern about whether these methods offer significant advantage and are sustainable. Thedacare is an example of an organization that has had a great deal of experience in Lean healthcare, and has sustained improvements over time. The use of these Lean methods to improve performance on the BMI quality metric shows how Lean can contribute to improvements that may not have been possible without such a structured approach. Lean in particular was useful for capturing the changes in, and complexity of, workflow brought about by use of HIT.

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Appendices

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Age Range	Well Child SmartSet	WC SmartText	WC SmartText Peds only	Asthma WC SmartText Peds Only	WIAA WC SmartText	WIAA WC SmartText peds Only	WIAA w/Asthma WC SmartText Peds only
3 year	267	12113	19398	n/a	n/a	n/a	n/a
3 year Healthcheck	726	12113	19398	n/a	n/a	n/a	n/a
3 year Free Vaccine	734	12113	19398	n/a	n/a	n/a	n/a
4 year	268	12112	19399	21347	n/a	n/a	n/a
4 year Healthcheck	727	12112	19399	21347	n/a	n/a	n/a
4 year Free Vaccine	735	12112	19399	21347	n/a	n/a	n/a
5 years	269	11926	19400	21348	n/a	n/a	n/a
5 year Healthcheck	736	11926	19400	21348	n/a	n/a	n/a
5 year Free Vaccine	737	11926	19400	21348	n/a	n/a	n/a
6 years	339	11926	19400	21348	n/a	n/a	n/a
6 year Healthcheck	738	11926	19400	21348	n/a	n/a	n/a
6 year Free Vaccine	739	11926	19400	21348	n/a	n/a	n/a
7-10 years	292	12111 female	19387 female	21340 female	11962 female	19393 female	21342 female
		12110 male	19391 male	21341 male	11964 male	19395 male	21343 male
7-10 year Healthcheck	740	12111 female	19387 female	21340 female	11962 female	19393 female	21342 female
		12110 male	19391 male	21341 male	11964 male	19395 male	21343 male
7-10 year Free Vaccine	741	12111 female	19387 female	21340 female	11962 female	19393 female	21342 female
		12110 male	19391 male	21341 male	11964 male	19395 male	21343 male
11 years	1361	12111 female	19387 female	21340 female	11962 female	19393 female	21342 female
		12110 male	19391 male	21341 male	11964 male	19395 male	21343 male
11 year Healthcheck	1362	12111 female	19387 female	21340 female	11962 female	19393 female	21342 female
		12110 male	19391 male	21341 male	11964 male	19395 male	21343 male
11 year Free Vaccine	1363	12111 female	19387 female	21340 female	11962 female	19393 female	21342 female
		12110 male	19391 male	21341 male	11964 male	19395 male	21343 male
12-20 year	742	11965 female	19397 female	21345 female	11962 female	19393 female	21342 female
		11963 male	19396 male	21346 male	11964 male	19395 male	21343 male
12-20 year Healthcheck	744	11965 female	19397 female	21345 female	11962 female	19393 female	21342 female
		11963 male	19396 male	21346 male	11964 male	19395 male	21343 male
12-20 year Free Vaccine	743	11965 female	19397 female	21345 female	11962 female	19393 female	21342 female
		11963 male	19396 male	21346 male	11964 male	19395 male	21343 male

Appendix 1. Combinations of SmartTexts available in different SmartSets, showing the complexity of updating SmartSets when SmartTexts are changed. The numbers in the SmartText columns refer to ID numbers used in Epic to identify different SmartTexts. WIAA refers to sports physicals, i.e. Wisconsin Interscholastic Athletic Association physical.

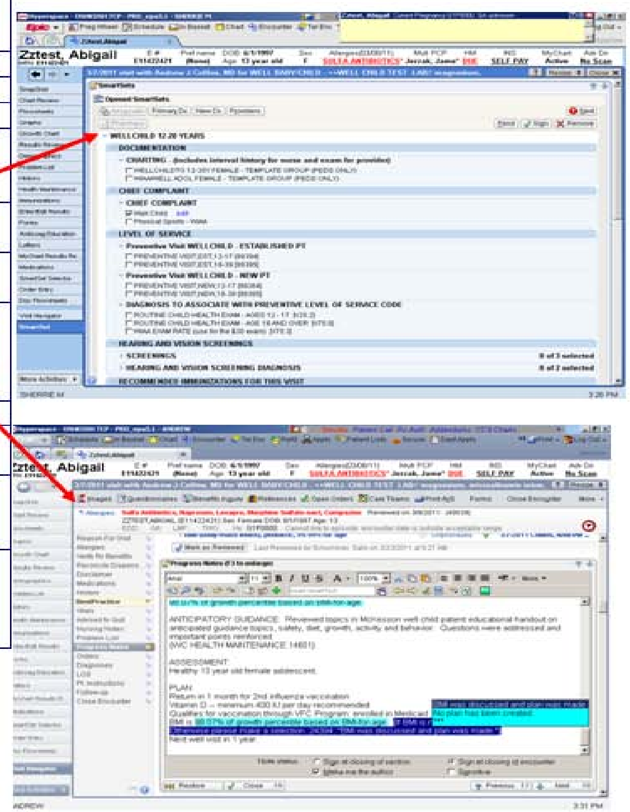
TCP-Oshkosh Pediatric BMI Index Standard Work

Last Updated	**3/8/11**	Owner	**Clinic Manager**	Performed By	**Scheduler, MA, Provider**	Work In Process	**1**
		Revised By		Rev. Number	**1**		
Takt Time	**40 min.**	Trigger	**Well Child appointment scheduled**	Done	**Information documented in patient's chart**		

	Major Steps	Details (if applicable)	Time
1	Well Child Appointment Scheduled	▽ Schedule all patients 18 and under as a Well Child or Sports WIAA for yearly exam. ***DO NOT schedule as Physical***	
2	Patient arrives and MA rooms patient		
3	MA obtains Height and Weight	▽ Must do to calculate BMI	
4	MA opens EPIC chart	Verifies correct patient	
5	MA begins Visit Navigator flow	See rooming standards ***Vitals must be entered prior to smart set***	
6	Select Smart Set	Must be within Progress Notes to ensure BMI is calculated	
7	Choose Documentation	▽ Select the Documentation that specifies "PEDS ONLY"	
8	Complete BMI text as indicated	-If BMI is not over the 94th percentile, then delete the BMI specific questions. If BMI is over the 94th percentile then select BMI text and complete questions	
9	MA completes Visit Navigator Flow	See rooming standards	
10	Provider assesses patient	Include diet and exercise history, physical exam, and relevant labs	
11	Develop BMI plan with patient/parent	Plan may include handouts, web information, referrals, labs, and follow up appointments	
12	Select plan	▽ Select "BMI was discussed and plan was made" ☺ Additional details of plan may be added after selection	

Diagram, Work Flow, Picture, Time Grid

☺ Tip ◆ Tollgate ⊘ WIP ▽ Critical Step ✚ Team Safety



Appendix 2. Standard Work for the new BMI metric process. The first page lists the steps with details, including screen shots to clarify steps.

TCP-Oshkosh Pediatric BMI Index Standard Work

Last Updated	**3/8/11**	Owner	**Clinic Manager**	Performed By	**Scheduler, MA, Provider**	Work In Process	**1**
		Revised By		Rev. Number	**1**		
Takt Time	**40 min.**	Trigger	**Well Child appointment scheduled**	Done	**Information documented in patient's chart**		

Job Instruction Sheet

	Major Steps	Details (if applicable)	Reasons (Why)
1	Well Child Appointment Scheduled	Schedule all patients 18 and under as a Well Child or Sports WIAA for yearly exam. ***DO NOT schedule as Physical***	If scheduled as physical, proper documentation template will not be available in smart set.
2	Patient arrives and MA rooms patient		
3	MA obtains Height and Weight	Must do to calculate BMI	
4	MA opens EPIC chart	Verifies correct patient	
5	MA begins Visit Navigator flow	See rooming standards ***Vitals must be entered prior to smart set***	Must be completed in this order to pull BMI into Progress Note
6	Select Smart Set	Must be within Progress Notes to ensure BMI is calculated	If vitals are not entered prior to smart set then you must refresh the Progress Note to pull BMI
7	Choose Documentation	Select the Documentation that specifies "PEDS ONLY"	Peds only template contains the reportable element for the BMI metric
8	Complete BMI text as indicated	-If BMI is not over the 94th percentile, then delete the BMI specific questions. If BMI is over the 94th percentile then select BMI text and complete questions	To ensure additional history is obtained for patients with an elevated BMI. The history is used to develop a plan.
9	MA completes Visit Navigator Flow	See rooming standards	
10	Provider assesses patient	Include diet and exercise history, physical exam, and relevant labs	Also important in development of plan
11	Develop BMI plan with patient/parent	Plan may include handouts, web information, referrals, labs, and follow up appointments	To coordinate a mutual plan between provider and patient/parents and provide education and other tools. If patient/parent resistant to BMI plan, plan may just be to monitor at future visits.
12	Select plan	Select "BMI was discussed and plan was made" Additional details of plan may be added after selection	**This must be selected to satisfy BMI Metrics**

Appendix 3. Standard Work for the new BMI metric process. On the second page, the steps and details are the same, but justification for each step is added if needed.