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Applying systems engineering to create a population centred sleep disorders program

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Abstract

In 2005 sleep disorder diagnostic assessments for patients in the Province of Manitoba was conducted at two independent sites. Referrals had accumulated, creating a waiting list of over 3400 patients while only 1200 patients were studied annually. Wait times for diagnosis and treatment increased dramatically. No managed patient database existed, nor were there standards to measure the effectiveness of the services. A system redesign resulted in tripling the throughput with a 35% increase in operating budget, evaluation metrics, elimination of diagnostic handling and treatment start delays, and an increase in treatment rates for positively diagnosed patients from 55% to 70%.

Key Words
Sleep Disorders, Systems Engineering, Population Centred

1. Background

The Province of Manitoba provides 1.1 million people with publicly funded health care. Health services are provided through a fee-for-service agreement with physicians; all other special services are negotiated and managed by health authorities. Sleep disorder care was provided by four respiratory sleep physician specialists and polysomnographers (PSGs) at physician managed sleep labs. Respiratory Therapists (RTs) provided treatment and managed all positive pressure equipment distribution at an independent treatment clinic.

While this system served the province well for many years, a gradual rise in patient referrals for sleep disorders after 2001 led to an untenable situation. By 2006, there were 3400 patients waiting for testing for a sleep disorder, wait times exceeded three years, and the status of patients throughout the process was unknown. Once diagnosed it took an additional six months for treatment to start. Once the patient started treatment, normally with Positive Air Pressure, the equipment and the patients comfort with the treatment plan was supposed to be monitored by their general practitioner unless additional specialist intervention was requested. This limited the sleep disorder program's ability to formally monitor compliance. Even though Manitoba covered all costs related to positive airway treatment, both for initial equipment set-up and long term supply costs, no record was kept of the patient's adherence to treatment, the benefits of the treatment, or the ongoing appropriateness of the treatment. The responsibility rested with the patient to request free replacement for worn equipment, and to identify if the treatment

plan was no longer effective.

The model was inefficient and unable to accommodate the accumulated demand. Service was inconsistent due to inappropriate redundancies, delays and poor interdisciplinary communication. No standards had been established and no outcomes data was being collected to measure the effectiveness of the service.

The increase in referrals to the Manitoba sleep physicians was predictable. In the past 10 years there has been heightened familiarity with sleep disorders, particularly obstructive sleep apnea, as well as developments in diagnosis and treatment methods. The online medical academic library PubMed cited 5670 articles related to sleep apnea from 1990- 2000 and 12,439 between 2000-2010. Equipment manufacturers were also motivated to increase awareness in the public and prescribing physicians.

2. Methodology

In 2006 the regional health authority internal medicine program that oversees this service decided to address this problem using a systems analysis approach [1]. A multi-disciplinary team was convened to improve the system to meet the population's needs. They articulated a vision, conducted a demand analysis, and then described the current state of the system. Using the demand analysis and their understanding of the current state they defined the desired state and worked through the process changes requirements to bridge the gap from the current state to the desired state.

3. Vision

Initial discussions focused on outlining the high level vision that fit within the organization. Discussions focused on what it meant to provide safe, effective, patient centred, timely and efficient care. All system changes were to be evaluated by their contribution in achieving this goal. The team's vision was to improve the quality of patient care by:

- matching resources to patient needs
- eliminating all waiting lists from diagnosis to treatment
- providing seamless service to patients
- learning from our patients

The primary mission statement was defined by the program director as "To provide appropriate diagnosis, education and a treatment prescription for our sleep disorder patients within 46 days from the time of referral, and to start treatment within 21 days."

4. Demand Analysis

The second step was an in-depth analysis, beginning with data collection on the number of referrals, studies conducted, and treatment rates over the past 5 years and detailed process and value stream mapping. We needed to estimate demand based on historical referral and treatment data and evidence based best medical practice.

To determine the true waiting list, the existing lists at all three sites were amalgamated. Many patients were found to exist on more than one list or had multiple entries. The list was then reconciled with the provincial health insurance provider to update the status of these patients and to remove patients who had passed away or moved out of province. In a controversial move, all patients who had a referral between 2 and 8 years ago were contacted and offered a study date. In doing this it was discovered that many had made alternative care arrangements and no longer desired the service. In the end, the number of patients truly waiting were 2500 (approx 900 fewer than previously thought).

To determine the actual referral rate required agreement by sleep physicians to a centralized referral system and the creation of a standardized referral form [2]. Once this was established, we were able to collect data and determined that the average rate of referral in 2005 was 230 consults per month.

We needed to know how many patients were currently on therapy to determine what treatment support services were required. Since all public treatment and ongoing equipment supply was handled through one office it should have been easy to determine this number. Unfortunately because of record keeping inconsistencies, this was not the case. This question was ultimately solved through contacting patients by mail and conducting an extensive chart review. We found that less than half the patients historically referred for treatment were still complying with their therapy. While treatment was publicly funded, some patients chose to purchase equipment privately out of pocket to avoid the public service delays. We asked the sleep specialists to speculate on the number of patients who chose this route so that this demand was not completely lost in our models.

A thorough literature review was conducted with the assistance of the sleep specialists to determine what the likely epidemiological percentage of Manitobans with sleep disorders or sleep disorder-like symptoms was. Obstructive Sleep Apnea (OSA) is the most common sleep disorder and is an issue for more than 85% of the sleep referrals. Prevalence studies predict conservatively 4% of males, 2% of females have OSA [3]. Given that there are approximately 839,400 Manitobans over the age of 20, there are roughly 25,000 (3%) adults with OSA. In addition an estimated 5,000 Manitobans have other types of sleep disorders. In total we estimated that 30,000 patients need treatment for a sleep disorders.

5. Current State

The next step was to document the current state of the services. To ensure that all current steps were addressed all tasks were documented and analyzed from the perspective of a patient flowing through the system. Interviews were conducted with key stakeholders regarding what information was collected, how the process and information was managed, and what were the decision making processes for diagnosis, treatment and support. With this knowledge, we mapped out the process of sleep diagnosis and treatment throughout the province and discovered there were 5 possible paths.

The process started with a GP referring the patient to one of 6 sleep specialists or out of province. All five paths varied in their care process and assessment methodology. In three of the paths, patients were assessed by physicians to determine if they needed a sleep study while the other three used survey tools. There were three different diagnostic methodologies. There were two different treatment paths, one completely publicly funded used by 95% of the Manitobans, the other through private equipment providers. Neither of these paths had a formal ongoing patient follow-up process, nor was there any feedback as to how patients actually benefited from the provided treatment.

To explore possible sources of the problems within the current system, staff provided suggestions. This revealed many perceived possible root causes for the problems in service delivery. For example, many tasks were duplicated due to an inability to share information between staff working at different stages of patient care. In general the problems fell into four categories, process, manpower, management, and equipment issues.

In understanding the current state, we found that stakeholders and drivers could be seen as the foundation of our system; when there were changes in the drivers the processes needed to be reconsidered and potentially completely redesigned. We explored the system drivers that defined the values and objectives of the service and found that they were also fundamentally responsible for the failure of the service. For example, ambiguity in medical research created inconsistent practices within the sleep specialist group resulting in variations in diagnostic study preferences and treatment approaches.

Throughout discussions about the current service model, it became clear that the support services had a vital impact on the ability to improve performance. For example, the transcription services that were used to generate letters for study results had been considered slow and unreliable. When we investigated this further and mapped out the transcription process, it became clear that the bottleneck was not in the actual transcription of letters but in the delay in actual dictations, and in the fact that dictations were submitted infrequently and in bulk.

6. Desired State

In order to articulate a desired state, the project steering committee needed additional benchmarking information [4]. The original discussions were based on literature reviews regarding best practices in sleep diagnosis and treatment.

Research was also conducted into types and costs of various diagnostic methodologies. It was decided to retain the traditional diagnostic methodology involving overnight laboratory sleep testing by a PSG, and to introduce newer and potentially less costly home studies involving portable monitoring devices as appropriate [5].

Consideration was given to the operational realities, and to determine how the mission could be achieved within the existing resource confines. It was critical that this be done in consultation with stakeholders, staff, patients, administrators and managers.

The committee decided that the desired state would be to provide treatment to patients of the lowest priority within at most 67 days. To accomplish this it was decided that the following were needed:

1. Removal of pre-study assessment clinics for the majority of patients for whom the referral alone makes it clear that they require a sleep study.
2. A standardized referral form to feed an algorithm to prioritize patients and determine who still required pre-study assessment visits with the physicians. This would eliminate pre visits for 87% of patients and free up physician time. The ultimate intension was to remove the need to prioritize patients by booking all patients upon referral.
3. A centralized referral process to smooth wait times for different specialists.
4. A centrally managed interpretation process
5. A centralized 10 bed sleep testing facility and associated clinic space to meet capacity requirements based on projected referral rates and operational considerations.
6. Introduction of a home study process and associated equipment to diagnose patients who present with typical symptoms with no chronic conditions or comorbidities.
7. Use of RTs to run assessment and follow-up clinics for simple cases to reduce demand on the sleep physicians.
8. Contracting out the fitting and management of equipment
9. Contracting out of monitoring of new patients for three months for comfort and adoption of the therapy, with a view to increasing the number of patients who continue on therapy.
10. A centralized electronic to manage referring algorithms and patient outcomes.
11. A centralize transcription service to eliminate delays in typing sleep studies reports and to monitor transcription performance standards.

7. Bridging the Gap

To get from the current state to the desired state the items defined in the desired state needed to be implemented and integrated into existing systems.

In order to stratify referral priorities and stream patients through the diagnostic processes we identified concrete information identifiable by a general practitioner physician, and that would be sufficient to guide decisions. In conjunction, a prioritization algorithm was devised to inform booking staff which patient on the list should be booked next.

We implemented a standardized referral form to gather the required information, and a custom database and program to manage the patient data and administrative documentation gathered in the referral form. This same program is also being used to book studies and appointments, and for monitoring outcomes and referral trends.

Space of the existing facilities was limited and not used effectively. One site was completely dedicated to manage equipment. The two major testing facilities were housed in places that could not support an expansion. They were combined and moved to a new site. This centralization of service significantly improved the manager's ability to oversee the resources.

Since it was clear that even a 10 bed facility would not be able to meet referral demands, a second stream of home testing was introduced to deal with cases that, using referral data only, could be identified as medically uncomplicated patients who are likely to suffer from sleep apnea.

RT-run clinics were set up to process the patients identified as uncomplicated to reduce demand on the sleep physicians.

Fitting and management of equipment had previously been done by RTs much overqualified for the task in space that could have been used for clinics. This work was contracted out. The same contract also included a requirement to monitor patients for three months upon introduction of therapy to track compliance in order to increase the number of patients who continue on therapy

Standardization of clinician and staff procedures was a very important step to achieving the desired state. Previously process standards were informal, communication to new staff was inconsistent and there was little management oversight. As part of the new systems redesign:

- job descriptions were created with specific performance targets
- a PSG training program was developed to improve and standardize the technical work involved in performing and scoring sleep studies
- administrative standards were established around booking and charting
- rules were created to manage equipment supplies distribution
- appropriate management structures were established to redefine accountability and lines of authority.

8. Results

As of January 2009 all recommended steps had been adopted and set in place. Results as of July 2010 show the following:

- Time from referral to sleep study was reduced from over 600 days to a median of 125 days
- All treatment start within 21 days of a prescription being generated, in 2005 the norm was three months
- There has been a 87% reduction in pre-clinic patient visits
- The wait for treatment after study has been reduced from six months to three weeks.
- There is no longer a need to reprioritize treatment referrals
- Supplies management is no longer conducted by medical staff
- There is now just one chart and one waiting list
- By reducing the process time, charts do not need to be reviewed as many times
- Outcomes measures that report patients response to treatment are available
- Annual studies have increased from 1347 in 2004/5 to 4289 2009/2010 (318% increase)
- Staff increased from 21.41 to 27.99 equivalent full time staff (31% increase)
- Historically approximately 55% percent of patients referred actually followed-up on therapy. With the new service model 70% of referred patients are on the recommended treatment
- The monthly rate of referrals increased from 170 in 2004/2005 to 454 in 2009/2010
- Study transcription time went from two weeks to two day and physicians can track the status of transcribed dictations and report quality issue.

The process has become significantly simpler for patients by consolidating services under one roof, providing one point of contact, and expediting the overall diagnosis and treatment processes.

9. Discussion

One of the greatest challenges during this project was to ensure that the management understood the rationale for changes and fully bought into them. There is always an inclination to revert to traditional processes when new processes are not fully understood or need refining. At that point, the processes either need to change officially, or compliance needs to be enforced. For management to be inclined to do either effectively, they need to fully understand the rationale and significance behind individual processes and how they impact the whole system. We had difficulties in helping management understand some of these details, which has led to our continued involvement with the sleep program.

It is possible to standardize de-skill and automate the processing of referrals for a sleep lab. The biggest challenges in the realization of these improvements were to get physicians and staff to accept standardization and de-skilling of tasks such as prioritizing of referrals and running of basic diagnostic clinics.

Once the system capacity increased there was an increase in referral rates. This increase exceeded what we had calculated based on population projections. We conjecture that the increase was a result of pent-up demand as well as an increase in referrers expectations once the capacity increase became known. If we are correct in this conjecture future capacity projections should factor this in. In order to factor this in systematically the phenomenon would have to be investigated further so a function can be defined.

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