Program Evaluation of a Quality Improvement Intervention to Increase Provider Adherence to National Guidelines for Metabolic Monitoring in Psychiatric Patients

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On my honor, I have not given nor received help on this document.

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Abstract

Aim: This was a formal evaluation of a quality improvement project that was implemented at a University Health System inpatient psychiatry unit between 2017 and 2019. The project goal was to increase provider adherence to the ADA/APA 2004 Guidelines for metabolic monitoring.

Method: The Centers for Disease Control framework for program evaluation was used. Based on stakeholder feedback, five questions were answered. Reports from the University Health System data analytics, a Qualtrics survey and quantitative analysis were employed.

Results: 1. Personal reminders by an inpatient pharmacist increased rates of metabolic monitoring from 40% to 76%. Implementation of a computer "smart" rule further increased rates to 89%. 2. After 11 months, there was no statistical difference in lipid testing between the pharmacist reminders and the computer smart rule ($p = .098$, 95% CI -28.50 to 1.98). Rates were maintained with less monthly variability and with less intervention from the pharmacist after the rule was implemented. 3. The smart rule was found to fire repeatedly until a provider ordered the metabolic labs 4. Lipid testing was the least ordered component of the metabolic panel. Qualtrics survey ($n=22$) showed providers were aware of the guidelines (95%) and agreed with them (75%). They believed the smart rule was a facilitator to adherence (85%).
5. Nurses were able to obtain 94% of labs ordered before patient discharge.

Implication: An automated computer smart rule was able to sustain and improve upon rates of provider compliance with guidelines for metabolic monitoring. This allowed reduced interventions by the inpatient pharmacist.

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Patients with serious mental illness such as schizophrenia and bipolar disorder die on average 25 years earlier than the general population (National Association of State Mental Health Program Directors, Medical Directors Council, 2006). Reasons for this are multifactorial, including high rates of smoking and poor access to medical care. However, since the early 1990s, it has been recognized that the drugs commonly used to treat mania and psychosis can contribute to early mortality (Ferrara et al. 2015). The class of drugs, called atypical antipsychotics, can increase blood sugar, cholesterol, and cause weight gain. This triad of metabolic derangement is called metabolic syndrome. These side effects can start within months of taking the medications, adding serious health consequences to an already vulnerable population (Ferrara et al. 2015).

In 2003, the United States (US) Food and Drug Administration (FDA) required that class warnings be printed on labels for atypical antipsychotics, describing increased risk of hyperglycemia and diabetes (Mitchell, Delaffon, Vancampfort, Correll & De Hert, 2011). The hope was that patients at risk for metabolic disturbance would be detected and treated earlier, the FDA reported (Rosack, 2003).

In 2004, a conference was held with the American Diabetes Association, American Psychiatric Association, American Association of Clinical Endocrinologists, and the North American Association for the Study of Obesity. These organizations published a consensus statement, the first American guidelines (ADA/APA 2004 Guidelines) for regular monitoring and treatment of metabolic syndrome for patients taking atypical antipsychotics. Drugs in this class include olanzapine, ziprasidone, quetiapine, risperidone, and aripiprazole.

The ADA/APA 2004 Guidelines recommend baseline monitoring of body mass index, blood pressure, glucose, and lipid panel. Patients should be screened at three months after the initiation of the antipsychotic and then annually. If the medication is causing adverse effects, the Guidelines recommend switching to another drug in the class. If problems persist (such as serum elevations of glucose, lipids, or weight gain), but the patient is benefitting from the drug, the Guidelines recommend appropriate treatment be initiated, or referral to a specialist.

In 2005, the Centers for Medicaid and Medicare (CMS) required that inpatient psychiatric hospitals follow the ADA/APA 2004 Guidelines for metabolic monitoring. CMS required inpatient psychiatric hospitals report their levels of monitoring as part of a bundle of quality control measures, called the Inpatient Psychiatric Facility Prospective Payment System (IPFPPS) (CMS, 2019a). Hospitals that do not comply with CMS quality reporting could receive a 2% reduction in CMS payments. For example, in 2018, facilities that provided all required quality data, including metabolic screening, would receive a federal per diem base rate of $771.35 to $782.78 for FY 2019. Providers who failed to report quality data would receive a federal per diem rate of $767.00 (CMS, 2018, p. 38,577).

Rates of monitoring are available to the public on the CMS Hospital Compare website. In 2017, hospitals in Virginia were completing the metabolic panel less than 70% of the time, as shown in Figure A1 (Medicare.gov Hospital Compare, 2019). The University Health System had the lowest rates when compared to two other regional hospitals at that time, at 55%.

Despite the dissemination of the ADA/APA 2004 Guidelines, studies show that provider adherence rates are low. Mitchell et al. (2011**)** published a systematic review and meta-analysis to determine if publication of the guidelines resulted in increased monitoring. The authors reviewed 39 pre-guideline studies and nine post-guideline studies and pooled data of

71,594 patients in five countries. Pre-guideline glucose monitoring was 44.3% (CI 36.3-52.4) and post guideline was 56.1% (CI 43.4-68.3). Pre-guideline lipid testing was 22.2% (CI 16.4-28.7) and post-guideline 37.2% (CI 23.7-51.9). Investigators concluded that in routine clinical practice, metabolic screening rates were low in patients taking antipsychotic medication. They stated the majority of patients in these studies were not being adequately tested for potentially treatable and reversible illnesses.

Similarly, in a study of 9,317 Missouri Medicaid recipients between 2010 and 2012, Morrato, et al. (2016) studied claims for metabolic testing in patients that also had new claims for antipsychotic medication. Settings included prescriber specialty-settings (24.3%), community mental health centers (CMHC) (27.6%), non-CMHC behavioral health (24.3%), primary care practitioners (23.8%), other/unknown. Annual testing rates were 79.6% for glucose and 41.2% for lipids, thus leaving more than half of patients without the recommended full screen.

Low rates of adherence to the ADA/APA 2004 Guidelines were recently addressed in an editorial in the Journal of the American Medicine Association, Psychiatry (Druss, 2018). The author directs the Center for Behavioral Health at Emory University and is widely published in the field of mental health and general medicine. Druss called attention to deficits in primary, secondary and tertiary prevention in people with schizophrenia. He reported that despite extensive literature documenting early mortality in these patients, the mortality gap seems to be widening.

Saha, Chant and McGrath (2007) used systematic review and meta-analysis to calculate standardized mortality ratios (SMR) for patients with schizophrenia over three decades in 25 nations. If the SMR statistic was 2.0, that indicated people with schizophrenia were twice as

likely to die as those without. Investigators reported SMR for patients with schizophrenia was 1.51 in the period of 1960 - 1996, 1.57 between 1973 - 1995, but 2.58 between 1980 - 2008. Thus the authors concluded that SMR for all-cause mortality had increased during recent decades in patients with mental illness (p=.03), while the general population was enjoying increased life span.

Background and Significance

Prior to the 1950s, there were no effective treatments for mania or psychosis. Mental asylums were overcrowded. The first antipsychotic medication to be approved by the Food and Drug Administration was chlorpromazine (Thorazine) in 1954 (Haddad, Kirk, & Green, 2016). This medication reduced auditory hallucinations and paranoia in patients with schizophrenia and helped them to organize thoughts. The advent of this medication contributed to the decentralization movement of the 1960s and the closing of large mental institutions with a trend toward supporting patients in their communities. Patients that had been in psychiatric wards all their lives were able to be released to outpatient care (Haddad et al. 2016). During the 1960s, other antipsychotic agents became available, such as haloperidol and fluphenazine. These are now called first generation antipsychotics and were an improvement over chlorpromazine, causing less sedation, for example. However, serious movement disorders were connected to the drugs, such as odd facial movements and tics. Sometimes these movement disorders would progress into the permanent syndrome called tardive dyskinesia.

In 1989, clozapine was approved as the first in a new class of antipsychotic medications, called atypical, or second generation antipsychotics. Risperidone, olanzapine, and quetiapine were approved in the 1990's and were more effective in the treatment of certain elements of schizophrenia and bipolar illness, with reduced threat of permanent movement disorders. The

drugs began to be widely prescribed in the 1990s (National Association of State Mental Health Program Directors, 2006).

The atypical antipsychotics were perceived as well tolerated and safe, and were adopted in many off label uses, such as for insomnia, behavioral disorders, and aggression (Alexander, Gallagher, Mascola, Moloney & Stafford, 2011). Aripiprazole was found to be a good "booster," or adjunct to antidepressant medication. It was the highest earning drug in the US in 2015 (Reidbord, 2015).

The National Institute of Mental Health (NIMH) reported that in 2017, 4.5% of all US adults had serious mental illness, or 11.2 million adults (NIMH, 2019). That year there were 12,000 inpatient and outpatient facilities, of which 668 were identified as psychiatric hospitals (Statista, 2019). Due to the prevalence of mental illness and the adverse effect of metabolic syndrome connected to the utilization of atypical anti-psychotic medications, adherence to the ADA/APA 2004 Guidelines are now considered essential for high quality care and positive outcomes in this population (Druss, 2018).

A quality improvement program was conducted at the author's practice site to improve adherence to the ADA/APA 2004 Guidelines. The purpose of this scholarly project was to complete a formal program evaluation of the program that was implemented at the University Health System between 2017 and 2019 to improve adherence to the ADA/APA 2004 Guidelines. The US Department of Health and Human Services (USDHHS) Centers for Disease Control (CDC) Six Step Program Evaluation Framework was used in this program evaluation (USDHHS, 2011).

Plan for Program Evaluation:

The Center for Disease Control Six Step Framework

The CDC offers a six step framework to guide health program employees in conducting formal program evaluations. The Center notes that managers are always assessing their programs, consulting, and making changes. However, the CDC acknowledged that more and more often, public health programs address large problems. In addition, programs to control disease have become more complex over time. To meet this challenge, the CDC recommended a formal program evaluation methodology, with the systematic collection of information according to the set of guidelines. They published "Introduction to Program Evaluation for Public Health Programs, A Self-Study Guide," first written in 1999 and updated in 2011 (USDHHS, 2011) which informed this project. The guide provides a six-step method of monitoring a program's progress toward goals, finding areas for improvement, and justifying the need for further support. The framework is depicted in Figure A2.

Step 1. Engage Stakeholders

The CDC framework puts emphasis on early and continued involvement of stakeholders when designing a program evaluation. At the University Health System, these were the people invested in high rates of metabolic monitoring, and those who would use the results of the evaluation. If stakeholders are involved in determining the questions the evaluation will answer, they are more likely to support it and act on the results (USDHHS, 2011).

As illustrated in Figure A2, four concepts were the foundation of the entire evaluation and guided development of questions for stakeholders: 1. Utility - would the evaluation provide useful information? 2. Feasibility - was there time and resources for an evaluation? 3. Propriety

- would the evaluation engage those most directly affected by the program? 4. Accuracy- would the evaluation produce findings that are valid and reliable (USDHHS, 2011)?

As part of this project proposal, stakeholder interests in a formal evaluation of the metabolic monitoring improvement program (MMIP) were assessed in two ways:

- Eleven stakeholders were interviewed including the Medical Director, Nursing Director for Psychiatry, Nursing Manager for Psychiatry, three physicians, two pharmacists, two nurse practitioners, and one RN. Details of responses are shown in Appendix G.
- Attendance at monthly Quality Assessment and Performance Improvement (QAPI) meetings, where quality measures, including rates of metabolic screening, were reviewed and Plan, Do, Study, Act cycles were used for improvement.

Stakeholder interviews. Interviews lasted five to ten minutes. Written notes were taken and stakeholders redirected as needed. Each stakeholder was first given a brief review of the MMIP. Then three questions were asked:

1. If they felt a program evaluation would be useful.
2. What they thought the main activities of a program evaluation of MMIP should be.
3. What they would consider to be useful outcomes of an evaluation.

Synthesis of interviews.

- Of the 11 stakeholders interviewed, all were supportive of a formal program evaluation of the metabolic monitoring quality improvement project.
- The most commonly voiced concern was that high rates of metabolic monitoring continue to be maintained going forward (seven respondents).

- Stakeholders wanted to see if automation of reminders (a computer smart rule) maintained rates of monitoring as well as the personal attention of a pharmacist (seven respondents).
- Stakeholders wanted to see if the computer smart rule was "firing" as often as it should be (four respondents).
- There was interest in which of the metabolic labs are ordered the least often (four respondents).
- There was interest in attitudes of providers toward metabolic monitoring (four respondents).
- There was concern that labs may be ordered but not drawn for a variety of reasons (two respondents).

QAPI meeting attendance. Inpatient psychiatry QAPI meetings were held monthly. Three of these meetings were attended by the author. The QAPI dashboard of quality metrics (number of falls, restraints, elopements, rates of tobacco cessation interventions, etc.) were reviewed by the team and Plan, Do, Study, Act cycles were used to drive improvements. During these three meetings the success of the MMIP was acknowledged. There was interest in making sure these rates were maintained going forward. Nursing Manager and Lead Quality Assurance personnel commented that the Study portion of PDSA cycles were underused and should be more formalized, possibly through use of templates.

Step 2. Describe the Program

Program description. The University Health System is an urban academic center. It includes a forty-bed inpatient psychiatric unit. In 2018, there were approximately 1,899

discharges from the inpatient unit. The average length of stay in 2018 was six days, according to internal sources.

In accordance with the CDC framework, description of the MMIP was divided into six components: Need for the Program, Target Groups, Outcomes, Activities, Outputs, Resources, Inputs, Stages of Development, and Context. Each was addressed below.

Need for the program. In accordance with CMS Inpatient Psychiatric Facility Prospective Payment System (IPFPPS) requirements, the University Health System began reporting rates of metabolic monitoring in January 2017. Rates were found to be suboptimal and actions were taken to increase the rates of monitoring. The MMIP began with the efforts of the inpatient pharmacist who championed the effort. The MMIP was implemented to improve the health of patients and increase compliance with regulatory standards.

Target groups. Multiple disciplines must cooperate to maintain high levels of metabolic monitoring on the ward. Everyone from the Medical Director to the housecleaning staff needed to work together to keep the hospital service running smoothly. For example, of the four components of the metabolic panel, two were carried out by nurses (blood pressure and weight). Providers must order the lipid and glucose elements of the screening. These labs were often obtained by patient care technicians. However, the MMIP being evaluated specifically targeted prescribers. This included four to six attending psychiatrists, four to six rotating residents, and five nurse practitioners (NPs).

Outcomes. The CDC Framework examines long, medium, and short term outcomes. The long term effect of MMIP was increased diagnosis and treatment of metabolic syndrome in patients taking antipsychotic medication. The medium term outcome was increased rates of metabolic testing as reported to the University Health System Quality Assurance Department

monthly and to CMS annually. The short term outcome was increased compliance with the Guidelines for metabolic monitoring on the inpatient psychiatry unit on a day to day basis. These outcomes were confirmed with the inpatient pharmacist spearheading the program.

The CDC Framework offers a graphic to help evaluators understand desired outcomes of the program they are evaluating. The graphic is called a Potential Hierarchy of Effects. This has been used to examine desired outcomes of the MMIP and is shown in Figure A3. In order to understand the activities of the MMIP, it was important to describe the daily routine and setting of the inpatient psychiatry unit.

Description of daily rounds. There were four teams on inpatient psychiatry. These were the Affective Disorders team, Schizophrenia team, Medical-Psychiatry team, and Geriatrics. The medical-psychiatry and geriatric patients were housed on the third floor of the unit. These patients could be frail. The fourth floor housed the schizophrenia and mood disordered patients. The layout of each unit was a central nurses' station, a day room where meals were served, and private rooms in two halls.

Each unit had three to five nurses, depending on staffing levels. Each unit also had a full time behavioral specialist. Behavioral specialists were often retired police officers and trained in the behavioral de-escalation of patients. Mental health technicians were also available to help patients gets snacks, make phone calls, and help the nurses by getting vital signs and drawing blood.

Each team had an attending physician and cared for a maximum of ten patients daily, depending on the census. Rounds typically started at 9 am and lasted for approximately three hours.

Morning rounds started in large conference rooms and were usually attended by ten to fifteen people, including:

- Attending psychiatrist
- Resident and one or two medical students. Residents and medical students changed monthly.
- Nurse practitioner and sometimes a nurse practitioner student.
- Inpatient pharmacist or pharmacy resident and pharmacy student.
- Social worker and social work student.
- Occupational therapist and occupational therapy student.
- Nurse and nursing student.

Rounds began with a presentation by one of the team members to the attending physician about each patient, events overnight, and issues that must be addressed during the day. It was a time for physicians to teach students. This was also the time the pharmacist usually mentioned that one or more aspects of metabolic screening were missing and ask providers to order them. Thus, discussion and ordering of metabolic screening had to compete for attention with other psychiatric and medical concerns and emergencies. There were also many other regulatory requirements to be considered for each patient, such as alcohol screening and tobacco cessation.

Residents and medical students rotated off the unit monthly. Nurse practitioners were permanent employees. They had the role of educating medical students and new residents on the expectations of the unit. During rounds they continued to educate on the importance of metabolic monitoring and primary prevention of cardiovascular disease.

Activities of the pharmacist. The program to improve adherence to metabolic monitoring guidelines began in October 2017 with the hiring of a dedicated inpatient psychiatric

pharmacist. The pharmacist believed increasing adherence to metabolic screening guidelines was appropriate for her role, as metabolic syndrome is a medication side effect. She also reported success on improving rates on this indicator in a previous hospital where she had worked (University Health System inpatient psychiatry pharmacist, personal communication, July 5, 2019).

The pharmacist began the quality improvement program by personally reviewing patient charts to see if metabolic screening had been done. If not, the pharmacist would speak individually to each provider during morning rounds, dividing time between the four teams over the course of the week. In addition to prompting the ordering of the labs, the pharmacist provided education about hyperlipidemia, diabetes, weight gain, and how antipsychotics can cause these. She made recommendations about how to interpret lab results, when to switch medications, or perhaps treat hyperlipidemia with a statin or elevated blood sugar with metformin. The dedicated pharmacist also trained the pharmacy residents to assist with metabolic screening on the four psychiatric teams.

Developing the smart rule. The next phase of the quality improvement project was to add a "smart rule," which was a computer prompt. The pharmacist worked with the University Health System information technology department to develop the prompt. The rule was an algorithm that assesses a patient for eligibility for metabolic screening per CMS guidelines. It was triggered when an antipsychotic of any type was ordered, regardless of patient diagnosis. The smart rule searched the chart to see if the four elements of metabolic screening had been completed within the last year (body mass index, blood pressure, glucose, lipid panel). If not, the rule determined the missing element and prompted the provider to order that test. Providers could bypass the rule, due to the frequent need for emergency antipsychotic medication on the

unit. The smart rule went live in October 2018 after approval by the information technology (IT) leadership team (University Health System inpatient psychiatry pharmacist, personal communication, July 5, 2019).

The activities of the MMIP continued with the combination of the pharmacist's individual attention and the smart rule. Results were monitored by the University Health System quality improvement department and reported monthly at unit level QAPI meetings.

Outputs. Outputs are the tangible results of the activities. For the MMIP, outputs included:

- Increased rates of metabolic monitoring as reported on the QAPI dashboard.
- Increased knowledge about metabolic monitoring by medical students and residents, as assessed by the attending physician and tested on national boards.
- Increased time for pharmacist to devote to other projects (if smart rule was effective). This was measured by QAPI dashboard indicators showing improvement on other projects spearheaded by pharmacy. For example, documentation of tobacco cessation treatment and reduction of polypharmacy.
- Increased detection and treatment of metabolic syndrome in patients.
- Compliance with this aspect of the CMS requirements.
- Improvements on Attending Provider Scorecard which included adherence to ADA/APA 2004 Guidelines and CMS requirements.

Resources/inputs. These are the people and resources needed to support the activities of the program. The list should be comprehensive because if program outcomes were not being achieved, this list of resources could be examined to find reasons activities were not being carried out as planned (USDHHS, 2011).

Medical director. The medical director met frequently with the attending physicians and set patient care priorities, and the standard of care.

Attending physicians. The attending physicians decided on the plan of care for each patient. They determined priorities for each patient on each day. They were typically on the unit for about four hours each day.

Residents and nurse practitioners. Residents and nurse practitioners discussed the plan of care with the team and spent the rest of the day carrying it out, for example, putting in orders, monitoring results, educating patients and families.

Medical students and nurse practitioner students. Medical students were on a rotation through psychiatry as they tried to determine what their specialty will be. Nurse practitioner students had already determined a psychiatric specialty. Medical students are there to learn but also assist in reporting patient information to the team daily.

Pharmacy and pharmacy students. The inpatient pharmacist and students had taken a leadership role in improving compliance with CMS Guidelines in sequential order. If the MMIP was sustained, they could address poor compliance with other regulatory standards, such as tobacco cessation initiatives.

Nursing staff. Nurses were vital to the ability to collect all the data needed for metabolic monitoring of each patient. They provided the first two components of the panel, blood pressure and weight. They also drew the labs for the remaining parts of the panel.

Nursing staff must make several clinical decisions when deciding to draw blood for the lipid and glucose components of metabolic screening. For example, if the patient was combative it may not be appropriate to obtain a lab for lipids. Or, if the patient was a "hard stick," (veins that are difficult to obtain blood from), non-emergent labs may be deferred,

possibly indefinitely. If providers did not cluster their labs but thought of various labs and ordered them throughout the day, this could cause undue work for the nurse and undue stress for the patient. Other examples of situations that prevent nurses from obtaining labs are if the patient was sleeping, or if the patient was refusing the lab. Refusal means the nurse has to verify if there was a court order to obtain the lab against the patient's will. This requires checking the chart and sometimes communicating with the provider.

Mental health technicians. Technicians were hired to assist the nurse and were required to have a high school degree. Nurses could delegate drawing labs and vital signs to mental health technicians. Program evaluation considerations could include, are there an adequate number of technicians? Where they trained to draw blood, and did they feel comfortable doing so? Were technicians too often diverted to other tasks, such as monitoring a suicidal or high fall risk patient, limiting their ability to help the nurses?

Quality improvement department at the University Health System. The hospital quality improvement department monitored and reported aspects of patient care. Many quality metrics were publicly available on the Medicare.gov Hospital Compare database, including rates of metabolic monitoring. Vendors such as were also employed for some aspects of quality assurance.

Unit level QAPI meetings. Throughout the hospital, each specialty held monthly QAPI meetings, including psychiatry, cardiology, and oncology. Each QAPI unit reported to a steering committee quarterly, and steering committees reported to the hospital administration annually.

The inpatient psychiatry QAPI meetings monitored unit compliance with three regulatory agencies. These were the Virginia Department of Behavioral Health, The Joint Commission and

CMS. The Hospital Based Inpatient Psychiatric Services (HBIPS) measures were a cluster of quality indicators that had been agreed upon by both the Joint Commission and CMS. This resulted in 16 metrics that were monitored on the adult inpatient psychiatry QAPI dashboard. These included rates of falls, patient time in restraints, and assaults on the unit. Each metric had a project leader.

The inpatient psychiatry QAPI had an attending physician as its chairman. There were 13 members, including quality improvement professionals, nurses, inpatient pharmacists, and others. A review of minutes showed a typical meeting would start with a safety moment, in which any important safety problems from the month before were analyzed. Then a review of quality metrics started.

Often the agenda would request that only metrics of concern be reviewed. Thus, if the MMIP was successful at maintaining high rates of monitoring, the committee's attention could be turned to the multiple other quality improvement efforts at hand. If the previous month's efforts to address a problem were not successful based on the metrics presented, there followed a discussion, evaluation and plan of action for the next steps. Minutes from the June 2019 QAPI meeting included a presentation by a pharmacy resident on ways to address low tobacco cessation intervention rates.

Data Analysis Vendor. Data reviewed at QAPI meetings was provided by a contracted outside vendor. This vendor was hired to collect data according to CMS requirements. Metabolic monitoring data was chart-based, meaning it was manually extracted from the charts (as opposed to claims-based data, or discrete field abstracted data). The University Health System employed personnel to work from home to extract data from charts. Most of the 11 CMS Inpatient Psychiatric Facility Quality Reporting data was chart based at that time (Data Analyst,

University Health System Performance Improvement Department, personal communication, June 28, 2019). An excerpt of data extraction instructions is shown in Appendix B.

Data from the vendor was reported on their dashboard that allowed quality improvement personnel to run various reports. To verify reliability of the vendor's data, fifteen cases were abstracted by a University Health System reviewer each quarter to monitor the inter-rater reliability of the abstractor. Match rate was 100% in the October 2019 report (Data Analyst, University Health System Performance Improvement Department, personal communication January 9, 2020).

Vendor sampling procedure. CMS mandates the sampling procedure, which was carried out by the outside vendor for the University Health System. Per CMS guidelines, the number of charts to be sampled was dependent on the number of discharges a psychiatric department had per year. The University Health System inpatient psychiatry unit discharged approximately 1,899 patients in 2018. Therefore, they must sample 609 cases because the total number of annual discharges was between 609 – 3,059 (CMS, 2019b). The vendor chooses to oversample by 5% to ensure an adequate sample for reporting, resulting in 642 charts sampled annually which included both pediatric and adult inpatient psychiatric facilities (Data Analyst, University Health System Performance Improvement Department, personal communication, June 28, 2019).

Stages of Development

The CDC described three phases of program development: planning, implementation, and maintenance. The maintenance phase was defined as the program being in effect for one year or longer (USDHHS, 2011). MMIP was in the early maintenance stage.

Phase 1: Monitoring only: January 2017 through August 2017 = 8 months of data.

Phase 2: Inpatient pharmacist began verbal reminders to providers to order metabolic monitoring on eligible patients: September 2017 through October 2018 = 14 months of data.

Phase 3: Smart rule initiated, pharmacist reported reduced verbal reminders. November 2018 through September 2019 = 11 months of data. (University Health System inpatient psychiatry pharmacist, personal communication, June 3, 2019).

Illustration of the Program

The CDC recommends use of a logic model to illustrate program components. Logic model components include inputs, activities, outputs and outcomes. A logic model is included in Figure A4.

Definition of Terms. The following definitions were excerpts from the Centers for Medicare and Medicaid Services Inpatient Psychiatric Facility Quality Reporting Program Manual (CMS, 2019b).

Metabolic monitoring. Percentage of patients discharged with at least one antipsychotic from an inpatient facility for which structured metabolic monitoring of four elements was completed in the past year. Metabolic monitoring must contain four tests:

1. Body mass index
2. Blood pressure
3. Blood glucose or HbA1c
4. Lipid panel

Hospital based inpatient psychiatric services (HBIPS) core measure set. A specific set of measures developed and maintained by The Joint Commission for the inpatient psychiatric population, some of which were used by CMS in the IPFQR Program.

Inpatient psychiatric facility prospective payment system (IPFPPS) – A payment system for psychiatric hospitals and certified psychiatric units in acute care hospitals established by Section 124 of the Medicare, Medicaid, and State Children's Health Insurance Program Balanced Budget Refinement Act of 1999 (BBRA). Facilities paid under this system are required to report under the CMS Inpatient Facilities Quality Reporting (IPFQR) Program.

Screening for metabolic disorders performance measure description. Percentage of patients discharged from an Inpatient Psychiatric Facility (IPF) with a prescription for one or more routinely scheduled antipsychotic medications for which a structured metabolic screening for four elements was completed in the 12 months prior to discharge – either prior to or during the index IPF stay.

Review of Literature

A literature review on provider adherence to guidelines for metabolic syndrome screening in the mentally ill was performed. Articles that discussed the rates of metabolic syndrome, provider adherence to guidelines, or strategies to increase adherence were reviewed. Search terms and inclusion criteria were broad, to include a thorough review of the evidence. Because cardiovascular disease is the leading cause of death in people with mental illness (Krithides, Chow, & Lambert, 2017), the search was limited to terms for metabolic syndrome or cardiovascular disease. Specific terms for diabetes or obesity were not used in this search.

Literature Review Methodology

Searches were done in Cinahl, Pubmed, and Web of Science. Search terms included "metabolic monitoring," "lipid," mental illness," "schizophrenia," "bipolar disorder," "computer based interventions," "pharmacist," "clinical decision tool," "provider adherence," "guideline," and "intervention." Three meetings were held with a research librarian who optimized use of

Boolean operators “AND” and “OR” for each database. For the entire literature review, filters were set to human subjects only, adults, articles within the last ten years, and English language.

The initial review resulted in 246 articles. Using reference management software, 70 duplicates were identified and removed. This resulted in 176 articles for inclusion in the next phase of the literature review.

Titles of each of the 176 articles were reviewed. Articles were excluded if they did not address a psychiatric population, if they focused on increasing patient (rather than provider) adherence to guidelines, or if they addressed health issues other than those related to metabolic syndrome. This resulted in 85 articles being retained for abstract review. Abstracts were read on each of the 85 articles. Articles were then excluded if they focused on primary care clinics or providers. Articles were also excluded if the focus was general medical management of metabolic syndrome such as cardiovascular disease, statin prescribing, or myocardial infarction. Articles focusing on methods to improve shared decision making with patients were also excluded. Ultimately 20 articles were included in this literature review. A Prisma table is found in Appendix C.

Studies Showing Increased Rates of Metabolic Syndrome and Treatments

Two recent narrative reviews documenting high rates of early death in patients with mental illness were included. Kritharides, Chow, and Lambert (2017) provided a narrative review of articles from 2000 to 2016 on prevalence of cardiovascular disease, and the contribution of antipsychotic medication, in patients with schizophrenia. National and international publications and guidelines were included. Authors reported that cardiovascular disease is the leading cause of death, with antipsychotic medication as a major contributor, especially due to hyperlipidemia. Authors called for increased international attention to the

physical health needs of people with psychosis. They recommend monitoring the of physical health of people with psychosis at least annually, and offering treatment as needed.

Piotrowski et al. (2016) offered a detailed analysis of factors influencing mortality rates in patients with schizophrenia. Authors performed a systematic review of 26 European studies published between 2009 – 2014. They reported evidence that these patients may have lower access to screening tests and medical care. Authors reported a disproportion in mortality from CVD in patients without prior diagnosis of this. Authors concluded that rates of cardiovascular disease had increased in this population, which may indicate that patients with schizophrenia were not receiving the benefits of modern medicine.

Zhai et al. (2017) investigated how soon metabolic changes start after initiating an antipsychotic (including olanzapine, quetiapine, haloperidol). They performed a retrospective cohort study of 417 drug-naïve psychiatric inpatients diagnosed with first episode schizophrenia. Patients were at Xinxiang Medical University between October 2008 to May 2014. Authors reported that after mean 22.7 days of antipsychotic exposure, significant changes in lipid metabolic profile were induced (total cholesterol $p = 0.001$, non-HDL $p<0.0001$, triglycerides $p<0.0001$). They concluded that lipid metabolism risk may develop early and quickly after antipsychotic exposure, and early monitoring was required.

Olfson, Gerhard, Huang, Crystal, and Stroup (2015) employed a retrospective longitudinal cohort study to compare mortality rates and causes of death in patients with schizophrenia with the general US population. They collected records from patients with at least three Medicaid claims of schizophrenia from 45 states between 2001 – 2007. This resulted in 1,138,853 patients. Authors reported that nonelderly patients with schizophrenia die at

approximately 3.5 times the rate of the general population (all-cause standardized mortality ratio (SMR) 3.7, 95% CI 3.7-3.7) Cardiovascular disease had the highest mortality rate, SMR 3.6% (95% CI 3.5-3.6).

Cardiovascular disease is often the manifestation of atherosclerotic disease, caused by hyperlipidemia. Hanssens et al. (2007) studied forty-six patients who were taking antipsychotic medication to show that statin therapy was effective in this population. Ninety-eight percent of the patients had elevated cholesterol levels (>190) at the start of the study and were started on statin medication. Baseline cholesterol on average was 263.3, but 165.3 after three months of statin medication (p = .0001) Authors concluded that three months of statin therapy significantly reduced lipids, and statins were effective for high cholesterol in patients with schizophrenia and treated with antipsychotic medication (Hanssens et al. 2007).

Lack of Prescriber Adherence to Guidelines

Haupt et al. (2009) reported on rates of lipid and glucose monitoring before and after the ADA/APA 2004 Guidelines. They performed a retrospective cohort analysis using data from a large managed care database. A total of 5,787 pre-guideline patients and 17,832 post guideline patients were identified. Baseline lipid testing rates were 8.4% for the pre-guideline cohort and 10.5% for the post guideline cohort. Baseline glucose testing rates were 17.9% pre-guideline and 21.8% post guideline. Authors concluded that despite statistically significant improvements after the ADA/APA 2004 Guidelines were issued, monitoring for plasma lipids and glucose remained low.

Mitchell et al. (2011) provided a systematic review and meta-analysis to determine if publication of guidelines for metabolic monitoring in the mentally ill resulted in increased screening. Studies from the United Kingdom (UK), Spain and the US were included. In the US

the primary guidelines are the ADA/APA Guidelines published in 2004. Authors reviewed 39 pre-guideline studies and nine post-guideline studies, and pooled data of 71,594 patients in five countries. Pre-guideline glucose monitoring was 44.3% (CI 36.3-52.4), post guideline was 56.1% (CI 43.4-68.3). Pre-guideline lipid testing was 22.2% (CI 16.4-28.7) post-guideline 37.2% (CI 23.7-51.9). Most elements were measured in less than half of patients (cholesterol, 41.5%, glucose 44.3%, weight 47.9%). They reported these rates were similar in the US and UK studies, and in inpatients and outpatients.

Barriers to guideline implementation were listed as lack of knowledge about existing guidelines, difficulty in obtaining measurements, and confusion about whether following the guidelines were the responsibility of the psychiatric or primary care team. Authors suggested that psychiatric admission be considered a "key period" for monitoring. They suggested the main mental health providers should take responsibility for metabolic monitoring at that time. Authors further acknowledged that many mental health providers do not adhere to the guidelines due to lack of time or resources (Mitchell et al. 2011).

Morrato et al. (2016) published a retrospective cohort study to determine glucose and lipid testing rates in adults who receive a new prescription for antipsychotic medication. The sample was Missouri Medicaid claims for 9,316 adults between 2010 and 2012. The method involved a medical claim for glucose or lipid testing occurring within 180 days before and after the antipsychotic prescription claim. Testing rates were 79.6% for glucose (a 30% improvement over 2005-2006 Missouri Medicaid claims) and 41.2% for lipids (a 10% improvement). The authors concluded that progress had been made to improve diabetes screening but lipid screening remained particularly underutilized. They reported that despite now widespread knowledge of

metabolic risk in patients taking antipsychotics, knowledge had not translated into behavior change.

Mitchel and Lord (2010) have previously written on inequalities in health care among the mentally ill. In this 2010 systematic review and meta-analysis, the authors investigated rates of prescriptions for antihypertensive and lipid lowering medications in patients taking antipsychotic medications. They reviewed 17 studies and used meta-analytic pooling of nine medication studies. Authors found below average prescribing rates for several classes of anti-hypertensives. Rates of statin prescriptions were also low (five studies included, OR = 0.604, 95% CI 0.408-0.89, p = 0.0117). The authors concluded that there was little evidence that guidelines were being heeded.

Strategies to Increase Guideline Adherence

Systematic reviews and meta-analyses.

Melamed, Wong, LaChance, Kanji, and Taylor, (2019) published a systematic review of 30 interventions targeted at improving provider compliance with guidelines for metabolic monitoring in patients taking antipsychotic medications. Interventions were associated with an increase in median screening rates for glucose (28% to 65%), lipids (22% to 61%), weight (19% to 67%), and blood pressure (22% to 80%). The authors concluded that additional interventions were needed to address the current guideline-to-practice gap, in which approximately one-third of patients were unscreened for metabolic risk.

Girlanda, Fielder, Becker, Barbui, and Koesters (2017) performed a systematic review of methods used to increase adherence to clinical practice guidelines in the severely mentally ill population. They included 19 studies in their review. An important aspect of their literature review was that most studies were conducted in inpatient settings. Methods used to increase

adherence to guidelines included clinical practice manuals, algorithms, distribution of educational material, educational meetings, reminders with audits, and multifaceted interventions including two or more components. Nineteen studies were included. Among strategies tried were educational outreach visits, reminders, audits and feedback. Meta-analysis of randomized controlled trials showed no statistically significant effect between guideline intervention strategies and treatment as usual (OR 1.01, 95% CI 0.37-2.79). The authors reported low level of evidence and inability to determine which strategy performed best. However, these investigators also reported that this may not be due to disregard for patient care, but rather thoughtful and well-founded clinical decisions made by clinicians with regard to particular patients.

Lamontagne-Godwin et al. (2018) completed a systematic review of interventions aimed at increasing provider adherence to metabolic screening guidelines in the severely mentally ill. Twenty-one studies from Australia, Canada, Hong Kong, the USA and the UK met the inclusion criteria. Study designs included pre–post (n=9), consecutive prospective case series design (n=1), repeat audit (n=1), cross-sectional study (n=1), quality improvement (n=4), retrospective audit (n=4), randomized controlled trial (n=1) and cluster randomized feasibility trial (n=1). Interventions included using a screening tool, staff education and training, computer or paper based prompts to support clinicians to monitor and screen health indicators, and interventions to improve collection of data. Barriers to each intervention were reported. With regard to screening templates, lack of expertise in mental health professionals to interpret results, workload issues, reluctance of staff to see metabolic monitoring as their responsibility, and lack of investment of staff in health monitoring were reported as barriers.

With regard to staff training, workload issues were described as the major barrier, but "booster" education, team meetings and investment of staff in health monitoring were facilitators. The impact of computer or paper prompts to increase screening were hindered by lack of expertise from mental health professionals to interpret physical health results. Limited access to equipment and resources (such as blood pressure cuffs for obese patients) was also a barrier. However, having a clinical psychiatric pharmacist on the ward to remind clinicians to request screening, and provide guidelines was a facilitator to the successful implementation of guidelines in two studies. Principle findings of the report were that challenges to implementation of screening were not unique to a particular country, setting or health service. They reported quality of data was generally low, so it was difficult to determine the size of effect of any specific intervention. However, facilitators to successful implementation included team champions to encourage screening, having staff feel invested and having a sense of ownership of physical health screening, stakeholder involvement, and having a clinical psychiatric pharmacist.

The systematic review by Ferrara et al. (2015) examined strategies that have been used to increase physical health monitoring in people with mental illness. The review included 14 articles conducted in Australia, the US and the UK. Authors provided an overview of strategies implemented in a variety of practice sites to increase monitoring. Mandatory letters to practitioners emphasizing the importance of physical tests, audits and reporting, and computerized pop-up alerts were a few. Authors reported a variety of obstacles to guideline compliance such as lack of basic equipment, poor information technology support for recording labs, being overwhelmed with emergencies, and lack of sufficient training or skills. They concluded that while some interventions increased rates, screening generally remained below 50% of patients.

Computerized systems. DelMonte, Bostwick, Bess and Dalack (2012) wrote an evaluation of a computerized physician order entry system (CPOE) that was implemented on a 22 bed inpatient psychiatric unit at the University of Michigan health system. A clinical psychiatric pharmacist gave verbal reminders to prescribers for metabolic monitoring. She then partnered with information technology to create a new pop-up alert. When a prescriber ordered an atypical antipsychotic, the pop-up window reminded them to order glucose and lipids and allowed ordering of appropriate labs directly through the pop-up window. Values for previous glucose and lipids were displayed if they were available. Therefore, if no values were displayed, prescribers were to assume the monitoring had not been done. The pop-up window also included citations for more information with regard to metabolic monitoring. Total time gathering data was six months. Alert implementation led to a statistically significant improvement in the rate of patients with lipid and glucose tests (pre-alert n = 171, post-alert n = 157). Fasting glucose levels improved from 46.8% pre-alert to 70% post-alert. Fasting lipid levels improved from 18.7% pre-alert to 59.9% post-alert. Patients that had both results increased from 12.9% to 47.8% (all $p<.001$). Authors concluded that the pop-up alert significantly improved collection of metabolic monitoring data, but overall rates remained suboptimal.

Lee, Dalack, Casher, Eappen, and Bostwick, (2016) published a retrospective chart review to determine if gains made in the Delmonte et al. (2012) study were sustained after four years of use of the computer alert. They determined that after four years, the percent of patients with fasting glucose was 67.4 (non-significant change from prior study, $p = 0.634$) and fasting lipid panel 62.8 ($p=0.614$). Patients with both was 51.2% (non-significant change from

previous 47.8% rate $p = 0.568$). Thus rates were maintained but as in the previous study, less than half of patients received treatment according to guidelines (n = 129).

In a recent issue of Lancet Psychiatry, Bauer, Monteith, Geddes and Gitlin (2019) provided an overview of the increased use of technology in psychiatry, including electronic medical records, electronic prescribing, and automated clinical decision support (CDS). Used correctly, digital technology was seen as a way to improve care, reduce costs, and improve safety. They specifically stated that electronic medical records (EMR) use might increase monitoring for metabolic syndromes in patients taking antipsychotics.

Authors reported that controlled trials from diverse specialties show that CDS can change provider behavior. This was specifically seen in the area of preventive care and reminders for better use of laboratory testing. The authors did note, however, that there was scant evidence on whether this had positive effect on patient outcomes. Concerns about clinical decision tools and reminders where that the system might malfunction, could disrupt clinical workflow, and add a technical burden with an ongoing responsibility to maintain and update the system. Provider complaints of information overload were also discussed, with providers stating CDS could make it difficult to determine what was most important and actually reduce patient safety.

Nash et al. (2013) published a pre-post study to test a quality improvement effort designed by five psychiatrists at University of Pittsburg between 2010 – 2012 (n = 3,010). The goal was to increase metabolic monitoring in inpatient and outpatient mental health clinics. The intervention involved developing a computer prompt to increase metabolic monitoring, and an education program. The authors reported that lipid testing remained at less than 8% throughout the first year of the intervention. In the second year a patient care associate was hired, and lipid testing increased to 25%. The authors reported that after studying the data they found that one

physician, who cared for one third of the clinic patients, was not engaged or interested in the effort despite one-on-one meetings. Authors state this illustrated challenges in changing physician habits. The authors also reported that the most change occurred after hiring a patient care associate. Still, laboratory measures stayed in the low 25% range.

Audits. Barnes, Bhatti, Adroer, and Paton (2015) reported on a six-year quality improvement effort to increase rates of metabolic syndrome screening in London outpatient clinics. The intervention involved annual audits and surveys of provider attitudes toward screening. Based on the audits and surveys, clinics were given customized feedback and targeted interventions such as posters and reminder cards. The goal was to increase rates of screening of four metabolic syndrome elements.

The standard of care was that all patients prescribed continuing antipsychotic medication had blood pressure, body mass index, blood glucose and lipids measured once a year. Six audits were conducted between 2006 and 2012. Authors reported that 1,966 patients were screened in 2006 and 1,591 in 2012. In 2006, 11% (215) were screened for all four elements. In 2012, 34% (540) were screened for all four elements. Lipids were the least screened item but increased from 22% to 50% over the course of the study. The effect of the intervention over the six-year study period was statistically significant (OR 1.27 (CI 1.23-1.31) $p<0.001$), yet the majority of patients remained unscreened for all four elements.

Screening and monitoring tools. Kioko, Williams and Newhouse (2016) performed a pre-post study to see if adding a paper metabolic syndrome screening and monitoring tool to patient charts would increase provider compliance with guidelines for metabolic monitoring. The setting was a US mid-western outpatient mental health clinic. From one thousand charts of patients taking atypical anti-psychotic medication, 50 were randomly selected pre-intervention

and 50 post-interventions. Findings were that prior to the intervention, 22% of required labs were ordered, but 62% were ordered post intervention ($x^2(2) = 32.67$, $p<.001$). This represented a 56% increase. However, a large number of patients still did not get a full screening.

Staff education and protocols. Castillo, Rosati, Williams, Pessin, and Lindy (2015) designed a quality improvement project to determine if rates of completed metabolic panels could be increased by requiring already established home visit mental health teams to collect the measures with the help of a phlebotomist. The authors pointed out that in the Clinical Antipsychotic Trials for Intervention Effectiveness (CATIE) for individuals with serious mental illness on antipsychotics, men were 138% more likely and women 251% more likely to have metabolic syndrome compared with a demographically matched general population. The CATIE schizophrenia trial was landmark study funded by the National Institutes of Mental Health, assessing psychiatric and metabolic outcomes of antipsychotic medications (Lieberman, et al. 2005).

The setting for the Castillo et al. study was 78 assertive community treatment teams (home visit teams) in New York City between 2010 and 2011 (n = 199). The project provided educational sessions for staff and consumers and a systematic screening protocol. Additional phlebotomy support was a challenge that they met by contracting outside agencies. Ultimately, they were able to obtain five metabolic screening measurements on 71% of patients, revealing that 53% had metabolic syndrome. This team was able to show that testing could be done but did not provide for sustainability.

Nurse led intervention. Osborn, Nazareth, Wright, and King (2010) tested the impact of a nurse led, six-month intervention to improve metabolic screening in outpatient mental health clinics in the UK using a cluster randomized feasibility trial design. The intervention was a

system to monitor the tests, prompts to staff, and a dedicated nurse to complete the screening, if needed. Six community mental health teams were randomized to receive either the nurse led intervention plus education pack, or the education pack alone (intervention arm n = 59, control arm n = 62). The education arm was given guidelines and information about cardiovascular disease. After the trial, screening had increased in both arms but participants in the intervention arm were significantly more likely to have received cholesterol screening (66.7% vs. 26.9%, OR 6.1, 3.2 – 11.5).

Summary of Literature Review

The major findings from the review of these 20 studies indicated that adherence to the ADA/APA 2004 Guidelines remains low despite 15 years of targeted interventions. Attempts to increase adherence included paper reminders in charts, computer pop-ups, audits, staff education, and hiring of pharmacists. Of these interventions, those with the strongest evidence of success have had nurses or phlebotomists directly obtaining labs in the home or clinic setting (Castillo et al. 2015; Osborn et al. 2010). Obstacles frequently cited are lack of personnel able to interpret labs, lack of equipment, lack of time, lack of interest in monitoring, and confusion about who was responsible for monitoring (primary care vs. psychiatry). No intervention reported resulted in monitoring 100% of patients, and most interventions resulted in monitoring less than 50% of patients. This is a gap between the Guidelines and practice that has direct consequences for the mentally ill population.

Methods

CDC Program Evaluation Step 3: Focus the Evaluation Design

Using the CDC program evaluation framework, the most important questions were determined. A goal-based evaluation model was used. This used predetermined program goals

as the standard for evaluation (USDHHS, 2011). The initial University Health System benchmark for the metabolic monitoring program was that 50% of eligible patients would be monitored. However, stakeholders now report a goal of 100% of eligible patients receive the full set of monitoring (University Health System inpatient psychiatry pharmacist, personal communication, July 7, 2019). Other sources have also cited a monitoring goal of 100% (Lee et al. 2016).

Purpose Statement

The purpose of this scholarly project was to complete a formal program evaluation of a quality improvement project that was implemented at the University Health System between January 2017 and September 2019. The program goal was to increase provider adherence to the ADA/APA 2004 Guidelines for metabolic monitoring in inpatient psychiatric patients receiving antipsychotic medications. The program was being implemented at the author's practice site.

Based on stakeholder feedback, this program evaluation answered five questions:

1. What was the difference in adherence to guidelines for metabolic monitoring between phases 1, 2, 3?
2. Was the difference in adherence rates between phases 1, 2 and 3 statistically significant?
3. How often was the smart rule firing per month in relation to all patients who met eligibility criteria for metabolic monitoring?
4. Was there one or more element of the metabolic panel routinely not being ordered, thus preventing the full panel from being completed? If so, what were provider attitudes toward barriers and facilitators to panel completion?

5. What was the completion rate by nurses/patient technicians of metabolic screening panel orders?

Three Phases of the Intervention Being Evaluated

Phase 1: Monitoring only: January 2017 through August 2017 = 8 months of data.

Phase 2: Inpatient pharmacist began verbal reminders to providers to order metabolic monitoring on eligible patients: September 2017 through October 18 = 14 months of data.

Phase 3: Smart rule initiated, pharmacist reported reduced verbal reminders. November 2018 through September 2019 = 11 months of data. (University Health System inpatient psychiatry pharmacist, personal communication, June 3, 2019).

Study Design

Step 4 of CDC framework, gather credible evidence. The framework supported the use of multiple methods to evaluate health promotion initiatives (USDHHS 2011). This program evaluation answered stakeholder questions through quantitative analysis, reports from the University Health System information technology, and a Qualtrics survey.

Question 1. What was the difference in adherence to guidelines for metabolic monitoring between phases 1, 2, 3?

Question 2. Was the difference in adherence rates between phases 1, 2 and 3 statistically significant?

Data source for questions 1 and 2: 428 randomly selected charts over 33-month period.

Method for questions 1 and 2: Data was provided by The University Health System Quality Improvement Department as an Excel spreadsheet. It was entered into SPSS Version 24 Statistical Software. The variability of the three phases as well as the normality of the distribution was explored to determine the right statistic to compare the groups.

Question 3. How often was the smart rule firing per month in relation to all patients who met eligibility criteria for metabolic monitoring?

***Data Source*:** All inpatient adult psychiatric hospital records from January 9, 2020 to January 20, 2020.

***Method*:** This report was requested from The University Health System data analytics department. After a multi-step process the request was approved on October 10, 2019, issued report #C649475 and a data analyst assigned. On about December 15, 2019, data analyst determined it was not possible to produce the report because when the smart rule fires, as it does not leave any type of trace in the patient record. Data analyst referred me to a second analyst who designed the smart rule.

A meeting was held with second analyst in his offsite office on January 7, 2020. He described how he designed the rule after trying many possible methods. He ultimately found the best way was to first identify patients taking scheduled psychotropic medications from list provided to him by inpatient pharmacist (aripiprazole, asenapine, brexpiprazole, cariprazine, chlorpromazine, clozapine, fluphenazine, haloperidol, iloperidone, loxipine, olanzapine, paliperidone, perphenazine, pimozide, quetiapine, risperidone, thioridazine, thiothixenie, triluoperazine, ziprasidone, lurasidone). Once patients were identified, they must have seven metabolic results available (BMI, HcA1C, BP, cholesterol, HDL, LDL, triglycerides). If selected patients had less than seven results, the smart rule fired.

The analyst had developed an audit report for the program in the event that people questioned its functioning. The report included how many times the smart rule fired for the child and adult inpatient psychiatry units. It did not include outpatient psychiatry.

To determine how many of these patients were on the adult psychiatry unit, the hand written log of adult admissions was compared to the report. Eighteen of the patients were found to be children (50 smart rule fires), nine were adults (27 smart rule fires).

The data analyst originally assigned to report #C649475 was able to produce a report of how many scheduled antipsychotics were prescribed on adult psychiatry during that same time period. By combining these two reports, question three was answered.

Question 4. Was there one or more element of the metabolic panel routinely not being ordered, thus preventing the full panel from being completed? If so, what were provider attitudes toward barriers and facilitators to panel completion?

***Data Source*:** A Qualtrics survey was developed and disseminated by email to determine provider attitudes toward ordering least often completed elements of the metabolic panel.

***Method**:* Answers to questions 1 and 2 showed that the lipid panel was the least often ordered component of a full metabolic panel. An anonymous Qualtrics web-based survey was constructed and distributed to providers on the psychiatric unit to determine their attitudes toward lipid screening. Face validity of the survey was determined by asking two attending physicians, one pharmacist, one resident and two nurse practitioners to take survey prototypes. Feedback was incorporated into the final survey. For example, several people wanted to be sure there was a "feel very strongly" option for the answers. One physician felt the wording should be presented in positive terms rather than negative terms ("I feel comfortable…" rather than "I feel uncomfortable…") Fifty-five surveys were ultimately sent out via email on December 9, 2019. Eighteen responses were received. On December 13, 2019 a reminder was sent out. Twenty-two responses were received.

Two attending physicians (9% of respondents), 17 residents (77%), and three nurse practitioners (14%) responded. Seventeen respondents had last worked on the unit in 2019 (77%), 4 had last worked there in 2018 and one had not worked there since 2017.

Question 5. What was the completion rate by nurses/care technicians of metabolic screening panel orders?

Data Source: To answer this question a report was requested from The University Health System data analytics department. This request ultimately had to go through a multi stage approval process. It was approved October 21, 2019 as report #C649477 and a data analyst was assigned.

***Method*:** Report from data analytics was delivered about December 1, 2019. Multiple discussions and drafts of the report followed, for example, to remove point of care testing which was not an accepted CMS parameter. The report sample was the entire adult inpatient psychiatric unit between January 1, 2017 and December 31, 2019. Initial resuts showed 22.25% of metabolic labs ordered during this time period were either cancelled or discontinued (no lab result). Discussions with laboratory personnel and data analyst determined that labs could be cancelled or discontinued for multiple reasons, such as cancelled by the provider, patient discharge, or patient refusal. Reasons are to be captured in a text box that was often not filled in.

A new report was requested that filtered out point of care testing, removal of completed labs, and addition of text boxes to show reasons for discontinuation. The new report was delivered January 6, 2020. This report covered a one year time period (December 1, 2019 to January 1, 2020). Manual examination of the report revealed that HbA1c and lipid panel labs are often ordered and discontinued multiple times during a patient's stay (reason unknown) (See

Figure A11). The report was reissued for a 3 year time period, with final results in the Results section.

Approval of Project

Approval of this program evaluation was granted by QAPI chairman on May 15, 2019.

Protection of Human Subjects

This proposal was submitted to the University Health System IRB for determination of the need for human subject protection. The study did not meet the definition of human subject research and no IRB review or approval was required for the study (Appendix E).

Results

Question 1.

What was the difference in adherence to guidelines for metabolic monitoring between phases 1, 2, 3?

Phase 1: Monitoring only: January 2017 through August 2017 = 8 months of data.

Phase 2: Inpatient pharmacist began verbal reminders to providers to order metabolic monitoring on eligible patients: September 2017 through October 18 = 14 months of data.

Phase 3: Smart rule initiated, pharmacist reported reduced verbal reminders. November 2018 through September 2019 = 11 months of data. (University Health System inpatient psychiatry pharmacist, personal communication, June 3, 2019)

Results: Phase 1: Blood pressure and weight monitoring 100%, HbA1c 91%, lipid testing 40%.

Phase 2: Blood pressure and weight monitoring 100%, HbA1c 99%, lipid testing 76%.

Phase 3: Blood pressure and weight monitoring 100%, HbA1c 100%, lipid testing, 89%.

Interpretation: Lipid testing was consistently the least frequently ordered component of metabolic testing. However, it increased with pharmacist reminders. Gains in adherence to lipid testing continued to improve with the initiation of the smart rule, while reducing time spent by the inpatient pharmacist reminding providers. Figure A6 is a bar graph illustrating the changes in lipid testing. Figure A7 is a detailed illustration of monthly testing levels of both HbA1c and lipids.

Question 2. Was the difference in adherence rates between phases 1, 2 and 3 statistically significant?

Results: Assumptions for ANOVA were met for lipids. These are: interval or higher level of measurement, random sampling, and independence of observations (individual patients). Assumption of normal distribution was violated but ANOVA is robust against this if sample size is above 30 (Pallant, 2016, p. 208), we have 33. However, based on the skewed distribution, when testing for homogeneity of variances, Levene statistic for median should be used (Brown & Forsythe, 1974). The assumption for homogeneity of variance was met. An ANOVA was used to compare rates of completed HbA1c and lipid panels over the three phases of intervention. The data for lipid testing met the assumption for Levine's test for homogeneity of variances.

ANOVA results for the lipid panel showed there was a significant difference between phase 1 (monitoring only) and phase 2 (hiring an inpatient pharmacist). Rates of compliance increased from 40% to 76% ($p = .000$, 95% CI -52.5 to -19.02). There was not a statistically significant difference between phase 2 (hiring an inpatient pharmacist) and phase 3 (pharmacist with smart rule, ($p = .098$, 95% CI -28.50 to 1.98). Variability of testing rates was reduced with use of the smart rule.

Data for HbA1c violated assumptions of normal distribution and homogeneity of variances. If both of these are violated, the non-parametric substitute for an ANOVA should be used. A Kruskal-Wallis test was used after meeting both assumptions of random samples and independent observations. Results showed a significant difference between phases one and two (91% to 99%, p =.000, statistic 18.05, df 2), but no significant difference between phases two and three (99% to 100%, p=.691, statistic 18.05, df 2).

Interpretation: The smart rule was able to maintain rates of provider compliance. It is important to note that improved rates were maintained despite monthly rotation of residents. Lipid testing showed reduced variability with initiation of the computer smart rule (Figure A8).

Question 3. How often was the smart rule firing per month in relation to all patients who met eligibility criteria for metabolic monitoring?

Results: Between January 9, 2019 to January 20, 2019 the smart rule fired on inpatient psychiatry 27 times for nine patients. The average number of times it fired per patient was three, but some providers had to be reminded up to seven times (smart rule fires) before they met the requirement. During that same time period, 52 antipsychotics were ordered for 28 patients.

Interpretation: When taken in conjunction with the increase in provider adherence to guidelines, one may conclude that the rule was working appropriately to give providers repeated reminders until the guideline was met. However, this could not be verified without opening individual charts.

Question 4. Was there one or more element of the metabolic panel routinely not being ordered, thus preventing the full panel from being completed? If so, what were provider attitudes toward barriers and facilitators to panel completion?

Results: Because this study showed the lipid panel was the least often completed component of the metabolic screen, the Qualtrics questions focused on facilitators and barriers to lipid testing. The anonymous 18 item survey was sent to 51 providers by email. Twenty- two providers responded. This included two attending psychiatrists (six invited), three nurse practitioners (three invited) and seventeen residents (42 invited). Seventeen of the respondents were currently working at the University Health System in 2019. Four had last worked there in 2018, and one had not worked there since 2017.

Awareness of lipid testing requirements was not a barrier, with 95% of respondents saying they are aware of them and 75% agreeing with them. Providers did not find them difficult to use (85%) or feel there was a lack of nursing staff (75%). However, providers were almost evenly divided when asked if they felt lipid testing was an outpatient provider responsibility, with 40% agreeing and 35% disagreeing. Similarly, 55% disagreed that workplace demands such as emergencies were a barrier, while 40% agreed. See Figure A9 for responses to barriers to lipid testing.

One hundred percent of respondents felt the pharmacists' reminders were a facilitator to ordering lipids. Eighty-five percent agreed that the smart rule was a facilitator. Eighty-five percent were confident in their ability to interpret the lab results. Sixty percent of respondents felt that metabolic testing was a high priority. Responses to facilitators to lipid testing are shown in Figure A10.

Interpretation: The findings of the Qualtrics survey were consistent with the other findings of this evaluation. That is, the majority of providers were aware of the guidelines, agreed with them, and considered them to be a high priority. However, reminders were felt to be very important, either from the pharmacist or the smart rule.

Question 5. What was the completion rate by nurses/care technicians of metabolic screening panel orders?

Results: Between January 1, 2017 and December 31, 2019, there were 3,767 labs ordered for metabolic monitoring (lipid and glucose testing). Seventy-two percent were completed and 28% of the orders were cancelled or discontinued. Some patients had the same lab ordered and discontinued multiple times in the same day (Figure A11). However despite the frequent ordering and discontinuing, the metabolic labs were completed during the patient stay 94% of the time prior to a patient's discharge. Six percent were never completed during the patient stay. A limitation of this study was that we do not know the reason the labs were never completed.

Interpretation: In some cases (6%), lack of completion of the metabolic panel may not be the fault of providers. There are many reasons why a lab could be ordered but not obtained on a psychiatric unit. As pointed out in the stakeholder interviews, frequent patient refusal may be a barrier. Patients may be be mistrustful of staff or combative. They are also frequently off the unit for group therapy and psychosocial education. In some cases the patient may amenable to the labs but be discharged before they are obtained.

CDC Program Evaluation Step 5: Justify Conclusions

The CDC framework suggests checking data for errors, assessing results against literature, and documenting potential biases when justifying conclusions. The limitations of the evaluation should be examined. Throughout this evaluation stakeholder were involved and helped assess the data, including attending physicians, the program mentor, and data analysts. In the end, results were consistent with existing literature documenting that lipid levels are the least ordered part of a metabolic panel.

A “lesson learned” was the surprising amount of effort needed to coordinate the different “silos” of information in this large academic hospital. Understanding different definitions, sampling and reporting procedures became a large part of the program evaluation. Face to face interviews with pharmacists, quality improvement personnel, data analysts, administrative assistants, nursing supervisors and attending physicians across multiple facilities was necessary. For example, sampling methods are determined by CMS and carried out by an outside vendor. These are reported on a vendor dashboard but later translated into a University Health System dashboard (QAPI dashboard).

Inconsistencies between the ADA/APA 2004 Guidelines, the CMS reporting requirement guidelines, and data extraction guidelines were encountered. For example, the ADA/APA 2004 Guidelines require fasting lipid testing, but CMS guidelines do not mention fasting.

Ultimately understanding of definitions, data reporting and sampling had to start with the ADA/APA 2004 Guidelines, translated by CMS into the Inpatient Psychiatric Reporting Manual, translated again to University Health System hospital personnel, translated to the outside vendor, back to University Health System personnel, and ultimately to reporting on the QAPI dashboard. How this process was ultimately understood, through this program evaluation, was detailed in Figure A12. The many personnel involved, lack of communication between them, and lack of consistency in definitions was one of the most important lessons learned from this project. This was discussed with the QAPI team on February 20, 2020 and met with general agreement.

Discussion

This systematic program evaluation, utilizing the CDC Six Step Framework, provided detailed data about the effectiveness of the three phases of the quality improvement process used

to increase adherence to the CMS and ADA Guidelines for metabolic monitoring in psychiatric patients.

The Agency for Healthcare Research and Quality (AHRQ, 2020) reported that computer based clinician support systems were initially developed more than 40 years ago. However, they are becoming more and more useful as they become "smarter," that is, more able to make specific recommendations for a patient.

This is consistent with what was found at The University Health System. Although many other methods have been tried to increase provider compliance with metabolic testing, few have had the success the University Health System program did. However, the success was not only due to the smart rule. This program evaluation showed that nursing obtains weight and vital signs 100% of the time. They also are able to obtain 94% of ordered labs, despite a population that could refuse them or sometimes become combative. Also, providers agreed with the ADA/APA 2004 Guidelines and believed these are a priority in the care of this population. The conclusion of this program evaluation was that the addition of an electronic medical record smart rule to the inpatient pharmacist role significantly improved adherence to the ADA/APA Guidelines as most recently indicated by 100% compliance in January 2020.

Strengths and Weaknesses of the Evaluation

The CDC Framework for Program Evaluation was invaluable during this process. It added structure and focus to the effort, from organizing meetings with stakeholders, determining questions to be answered and disseminating results.

In keeping with the framework, some limitations of this particular study were reported here. With regard to questions one and two, although the three intervention phases were divided by time and are different groups of patients, there will be some similarity between the three

groups. For example, the attending doctor and nurse practitioners will be the same and there was a possibility that some resident physicians were the same across the three phases. An additional weakness of the design was that confounding variables may result in differences between the three phases, such as characteristics of the residents, or unit census.

With regard to question three, some patients had antipsychotics ordered but did not have the smart rule fire. It was not possible to know if this was because their metabolic screening was complete.

With regard to question five, a limitation of the study was the inability to determine why 6% of labs were never collected. In addition, the pharmacist brought up the concern that rates of glucose testing may be artificially high because other serum glucose non-fasting labs are being included in HbA1c data, resulting in 100% compliance. It is possible that data extractors are including non-fasting labs, which result in falsely high rates of glucose monitoring (personal communication, inpatient pharmacist, 1/10/20). CMS specifically does not allow any non-fasting glucose measurements, but this was not clear in the CMS paper data extraction tool.

Nursing Practice Implications:

As documented in the literature review, countries including Australia, Canada, the United Kingdom, Spain, China and the U.S. have struggled to increase provider adherence with metabolic screening guidelines. Lipid testing was often the least ordered test, and interventions to increase it were rarely able to reach 60% testing rates, despite staff-intensive efforts (Melamed, Wong, LaChance, Kanji, &Taylor, 2019). The University Health System was able to achieve steadily increasing rates of lipid testing with the last month reported (1/2020) at 100%, while reducing staff involvement. This project showed the importance of program evaluation,

identifying interventions that work, and applying lessons learned to other projects, possibly tobacco cessation or alcohol use screening.

CDC Step Number 6. Ensure Use and Share Lessons

Products of the Scholarly Practice Project

This program evaluation was presented to the University Health System inpatient QAPI team on February 20, 2020. Stakeholder questions were answered. Barriers and facilitators to high rates of monitoring were reported. Recommendations on ways to maintain or improve rates of metabolic monitoring where be made. An executive summary was provided.

Additional products will be a publishable manuscript able to be submitted to Archives of Psychiatric Nursing. Finally, there will be a scholarly presentation to the UVA community and submission of the manuscript to LIBRA.

Additional uses suggested in Step 6 of the CDC framework and carried out over the course of this evaluation were:

- Demonstrating to stakeholders that resources were being well spent and the program was effective
- Comparing outcomes with those of previous years
- Comparing actual outcomes with intended outcomes
- Supporting annual and long-range planning
- Promoting the program
- Identifying partners for collaborations
- Enhancing the image of the program
- Providing direction to program staff
- Identifying training and technical assistance needs (USDHHS, 2011).

Finally, and of highest importance, was documentation of an improved method for identification of metabolic syndrome in patients, so treatment could be started.

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Appendix A

Figure A1. Completed Metabolic Panel by State in 2017

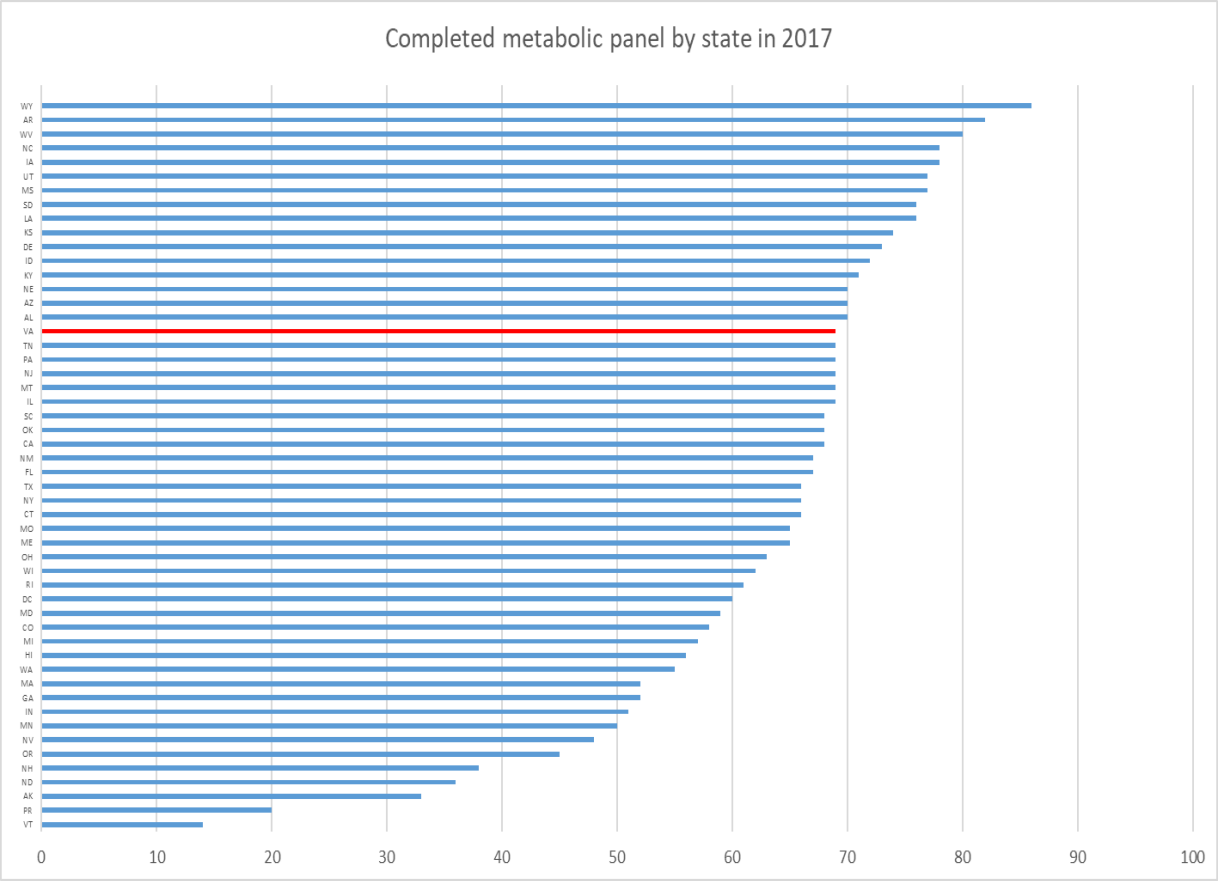


Figure A1. Virginia is the red line, showing less than 70% panel completion. From Medicare.gov Hospital Compare. Psychiatric Unit Services. Retrieved on January 9, 2019 from www.medicare.gov/hospitalcompare

Figure A2. Center for Disease Control and Prevention Six Step Framework

Figure A2. US Department of Health and Human Services, Centers for Disease Control and Prevention, Office of the Director, Office of Strategy and Innovation (2011). *Introduction to program evaluation for public health programs: A self-study guide.*

Figure A3. Hierarchy of Effects (USDHHS, 2011).

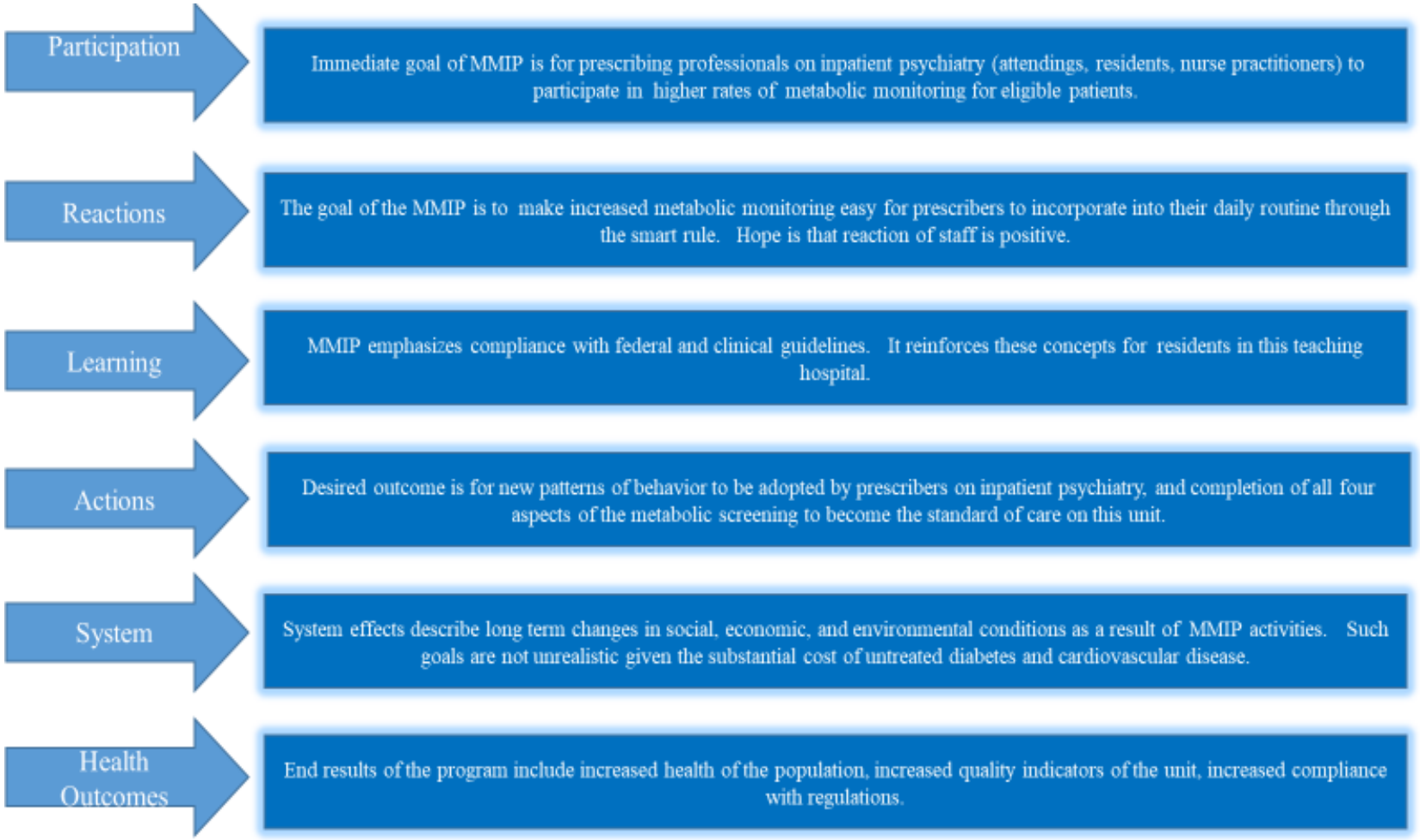


Figure A4. Logic Model of Activities and Outcomes of MMIP (USDHHS, 2011).

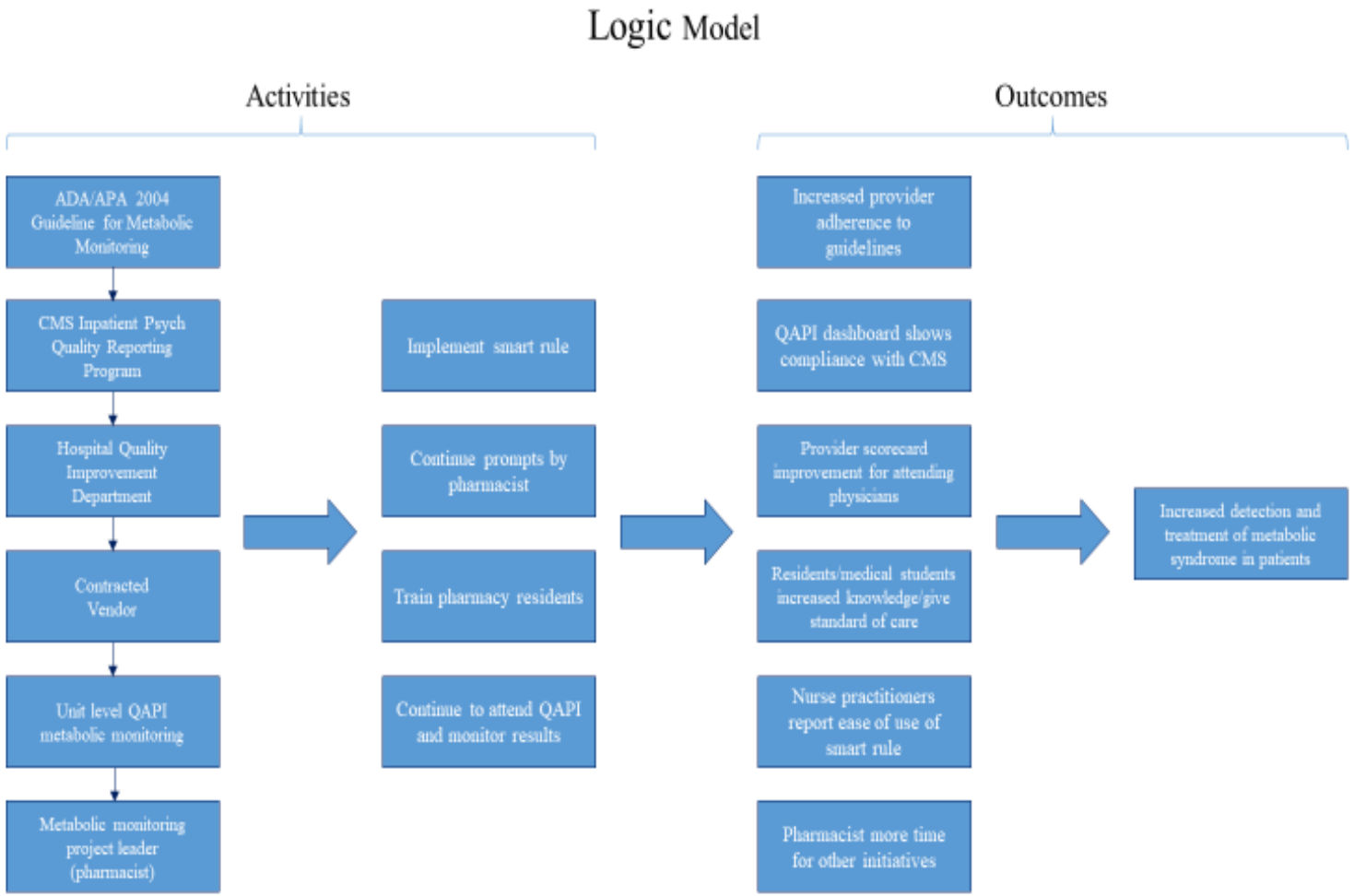


Figure A5: Information Gathering for Question 5.

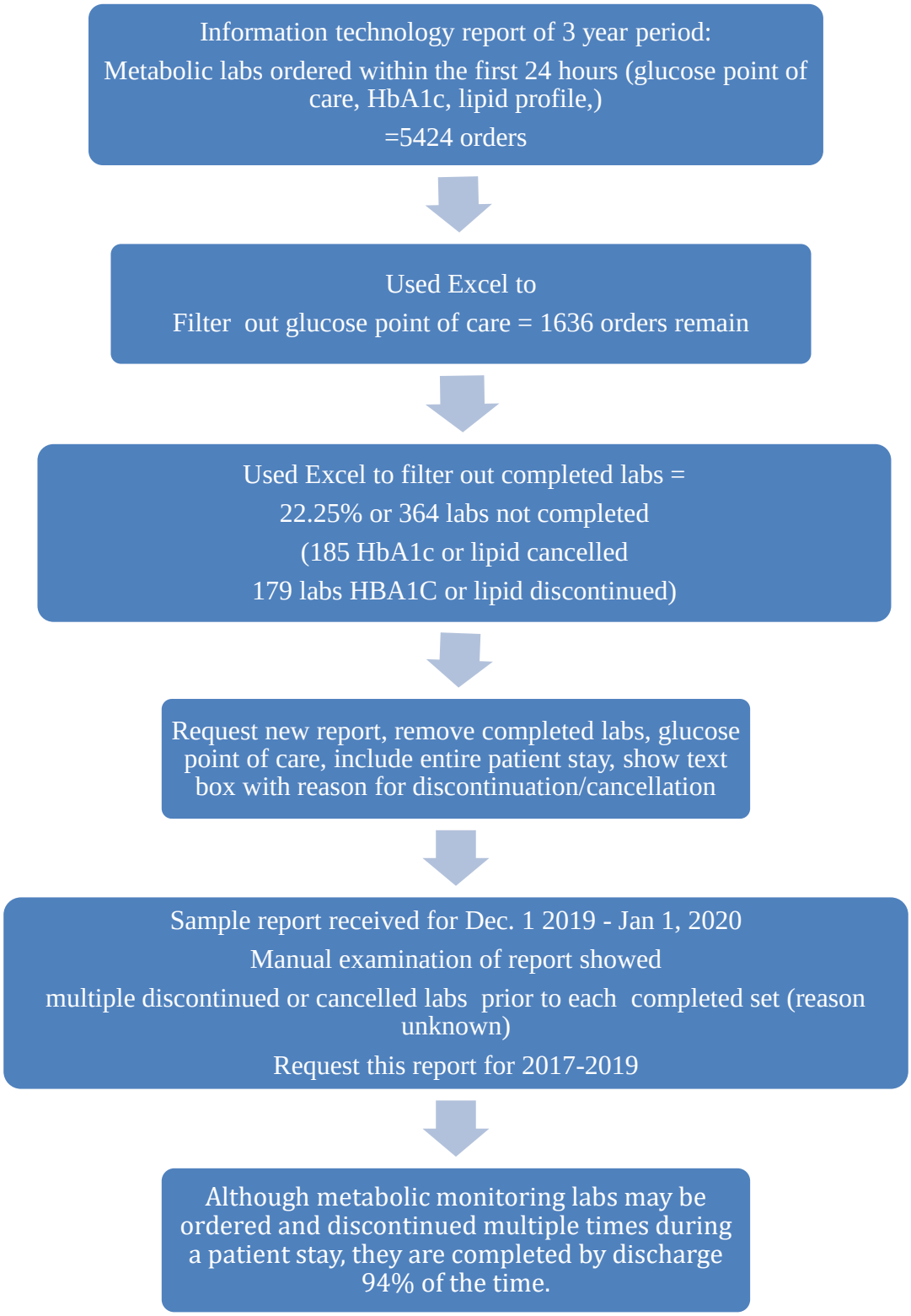


Figure A6. Increase in Lipid Testing by Phase of Intervention

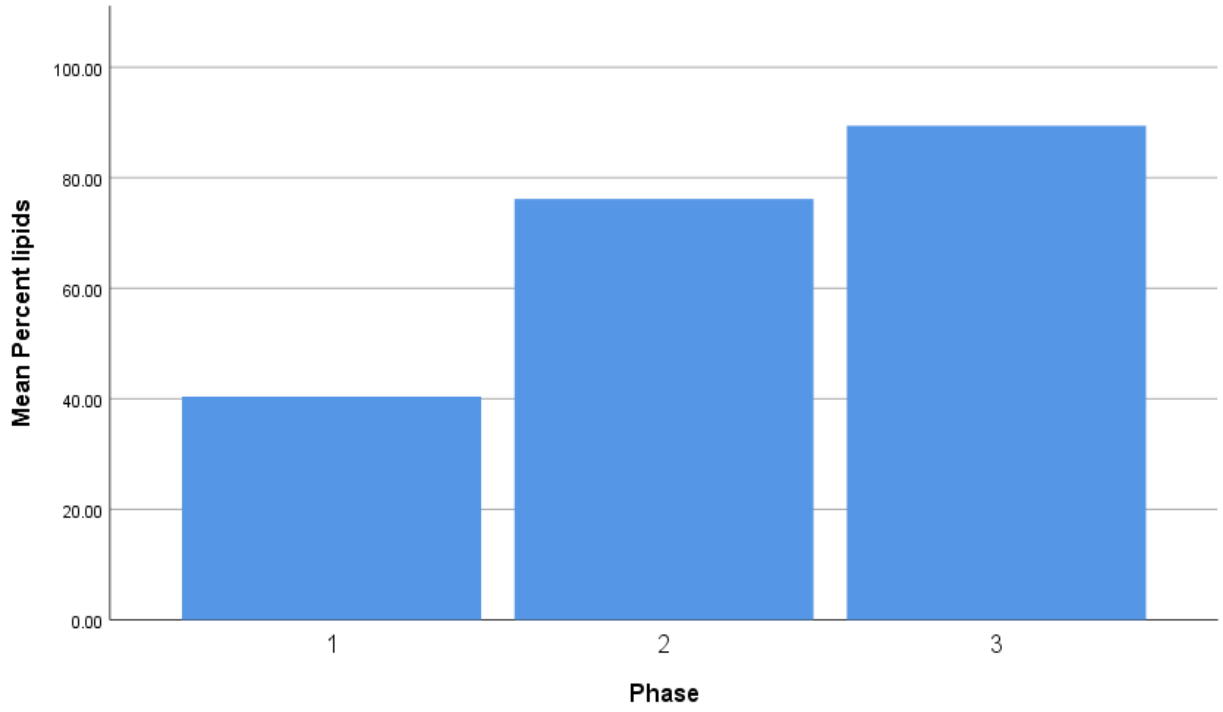


Figure A6. Phase 1: Monitoring only: January 2017 through August 2017. Phase 2, inpatient pharmacist, September 2017 to October 2018. Phase 3, computer smart rule, November 2018 to September 2019.

Figure A7. Provider compliance with testing across the three phases of interventions

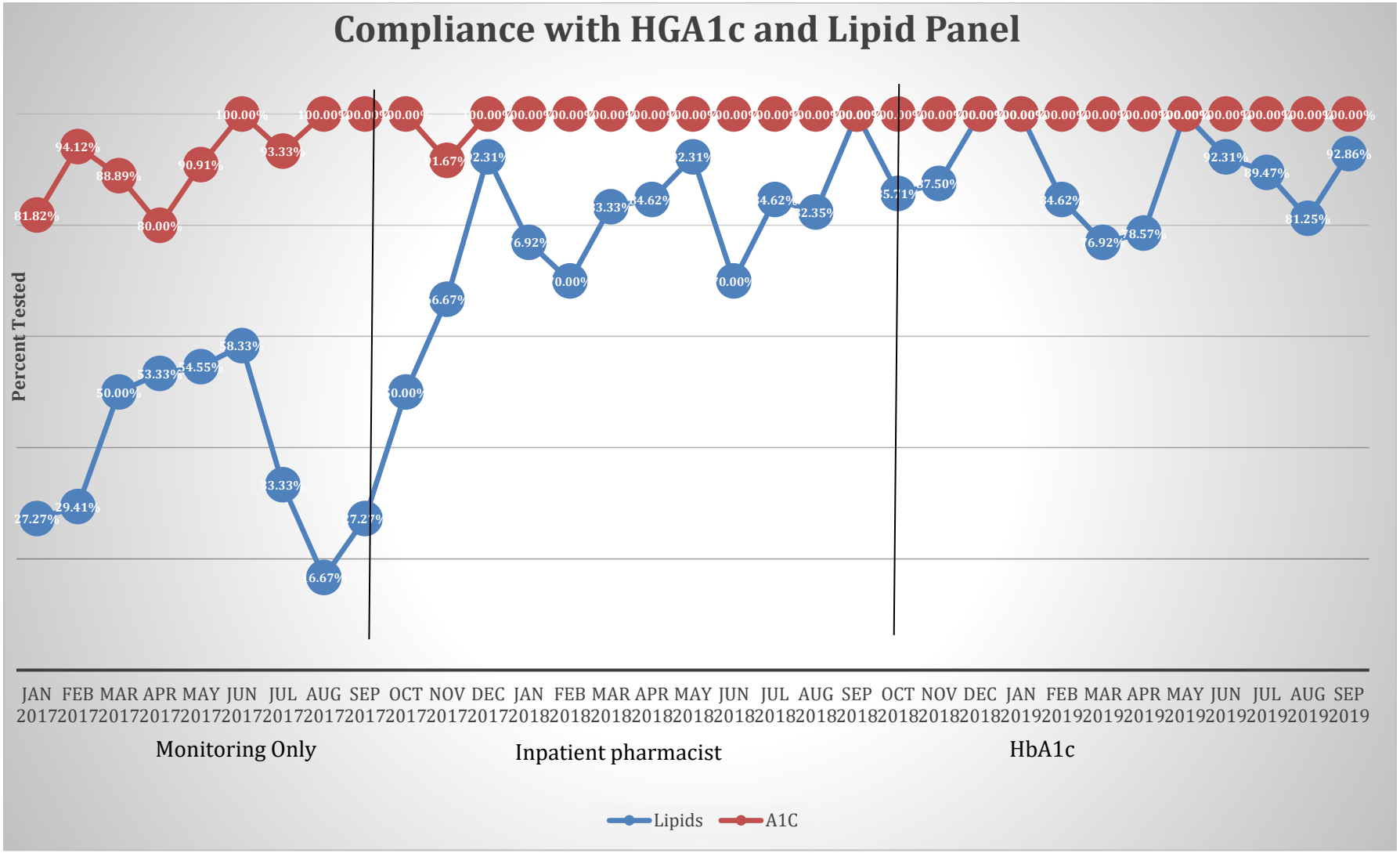


Figure A8. Variability in rates of lipid testing

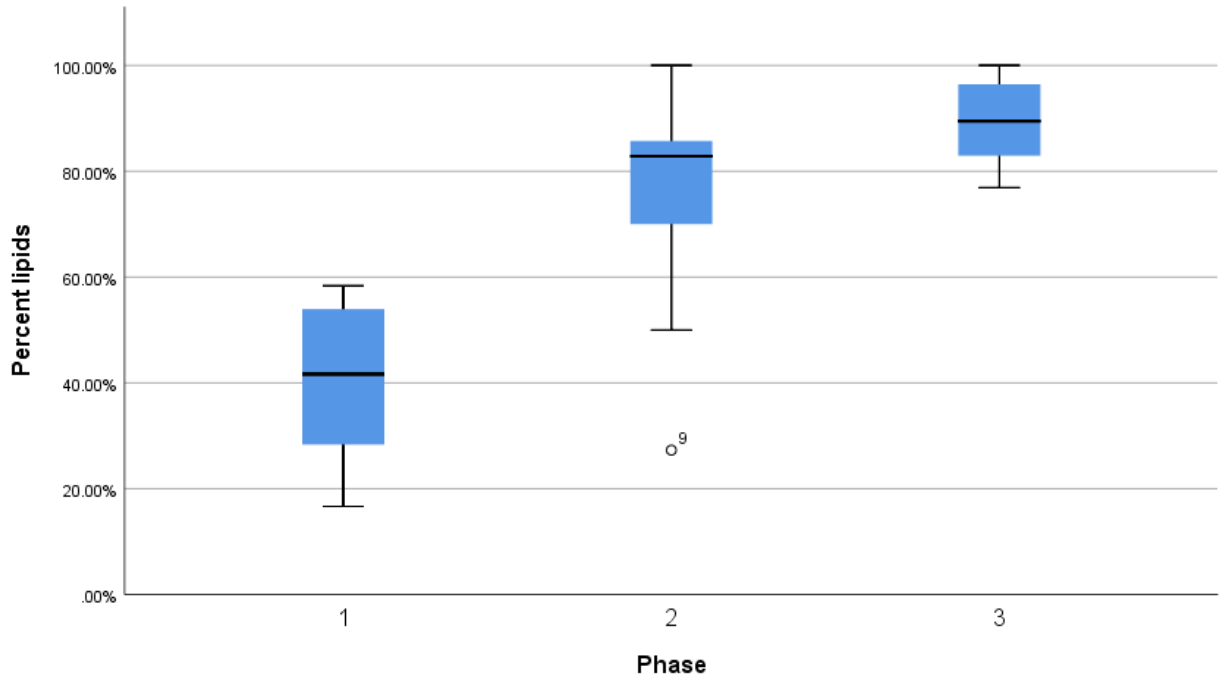


Figure A8. Phase 1: Monitoring only: January 2017 through August 2017. Phase 2, inpatient pharmacist, September 2017 to October 2018. Phase 3, computer smart rule, November 2018 to September 2019.

Figure A9. Qualtrics Survey Results: Barriers to Lipid Testing

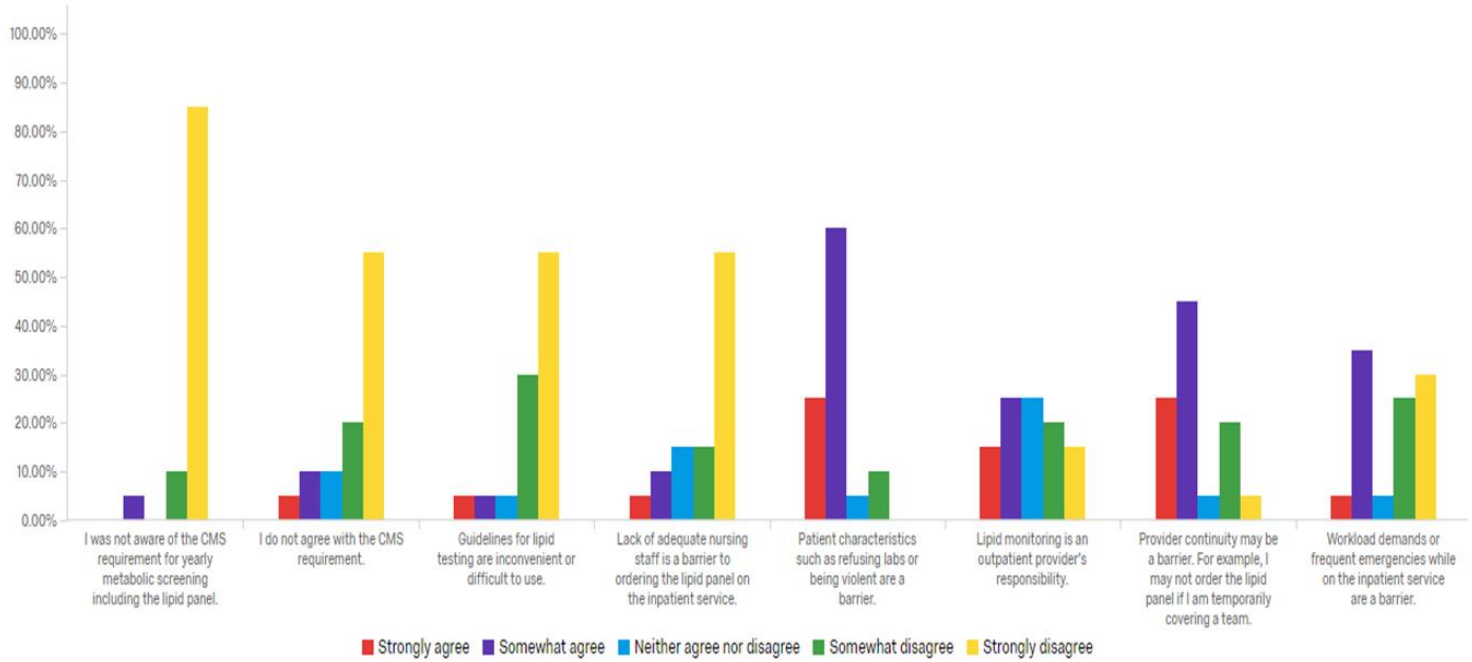


Figure A9. Responses from twenty-two providers including attending physicians, residents, and NPs during December 2019.

Figure A10. Qualtrics Survey Results: Facilitators to Lipid Testing

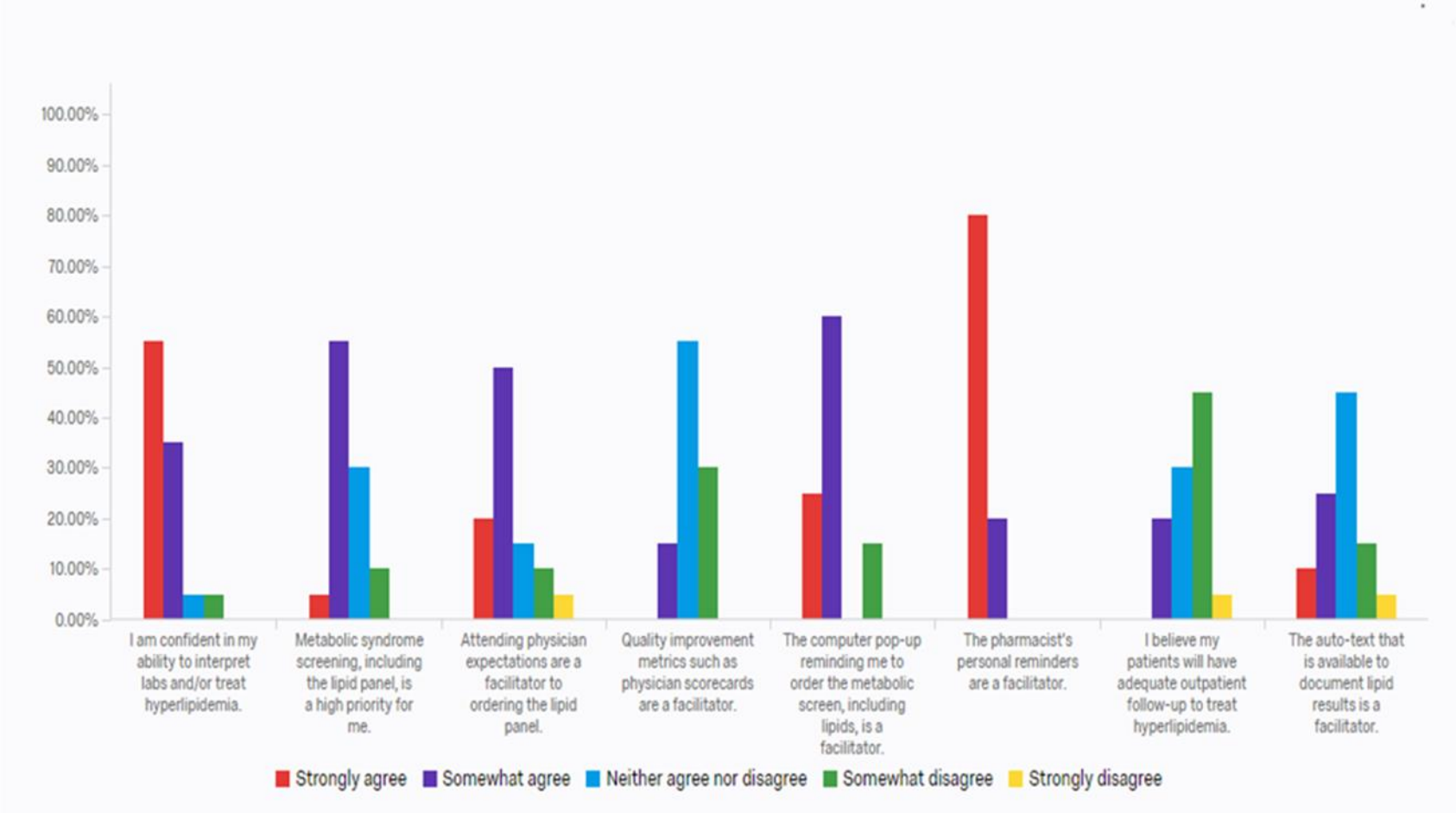


Figure A10. Responses from twenty-two providers including attending physicians, residents, and NPs during December 2019.

Figure A11. Status of Metabolic Monitoring Labs Ordered 2017-2019

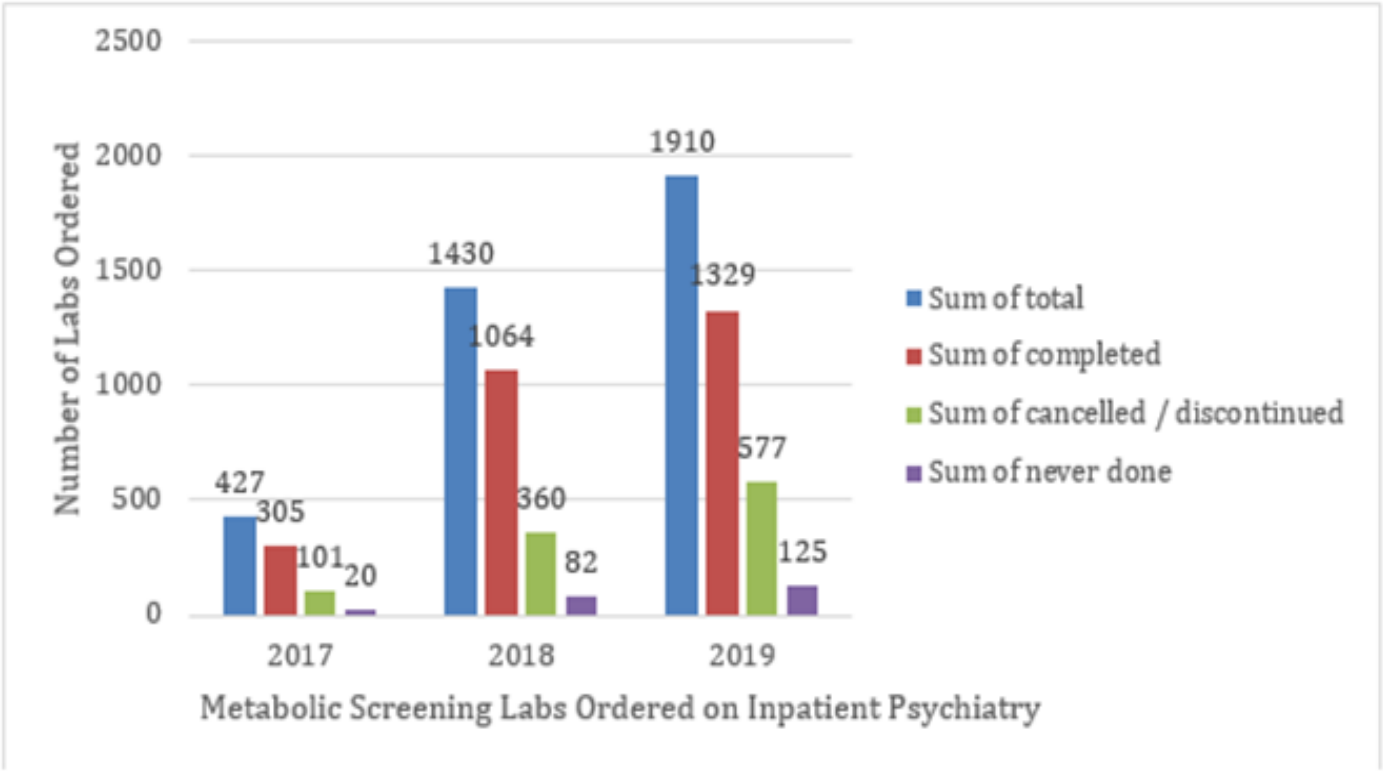


Figure A12. Flow of information gathered for program evaluation. Continued on next page.

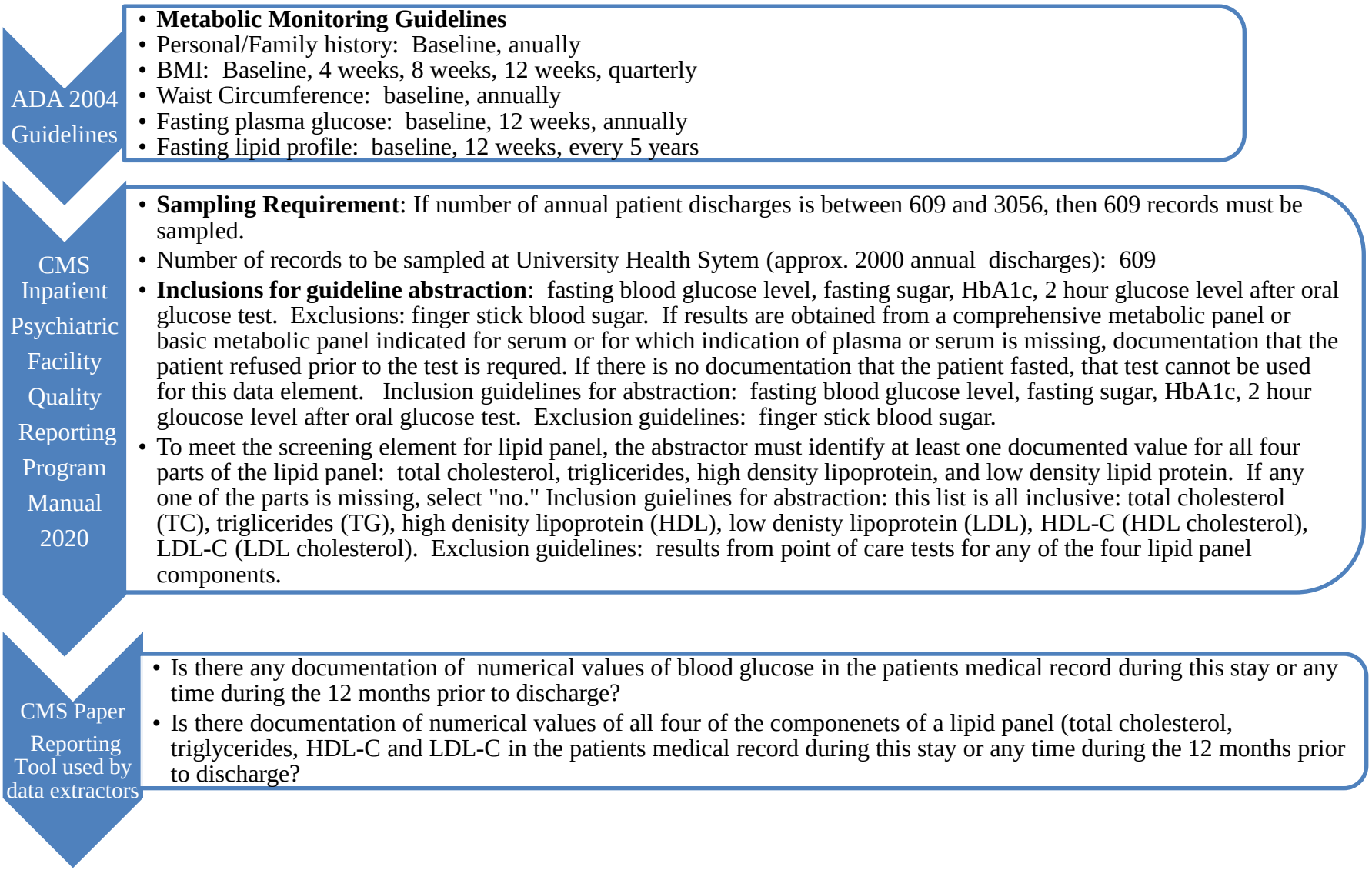
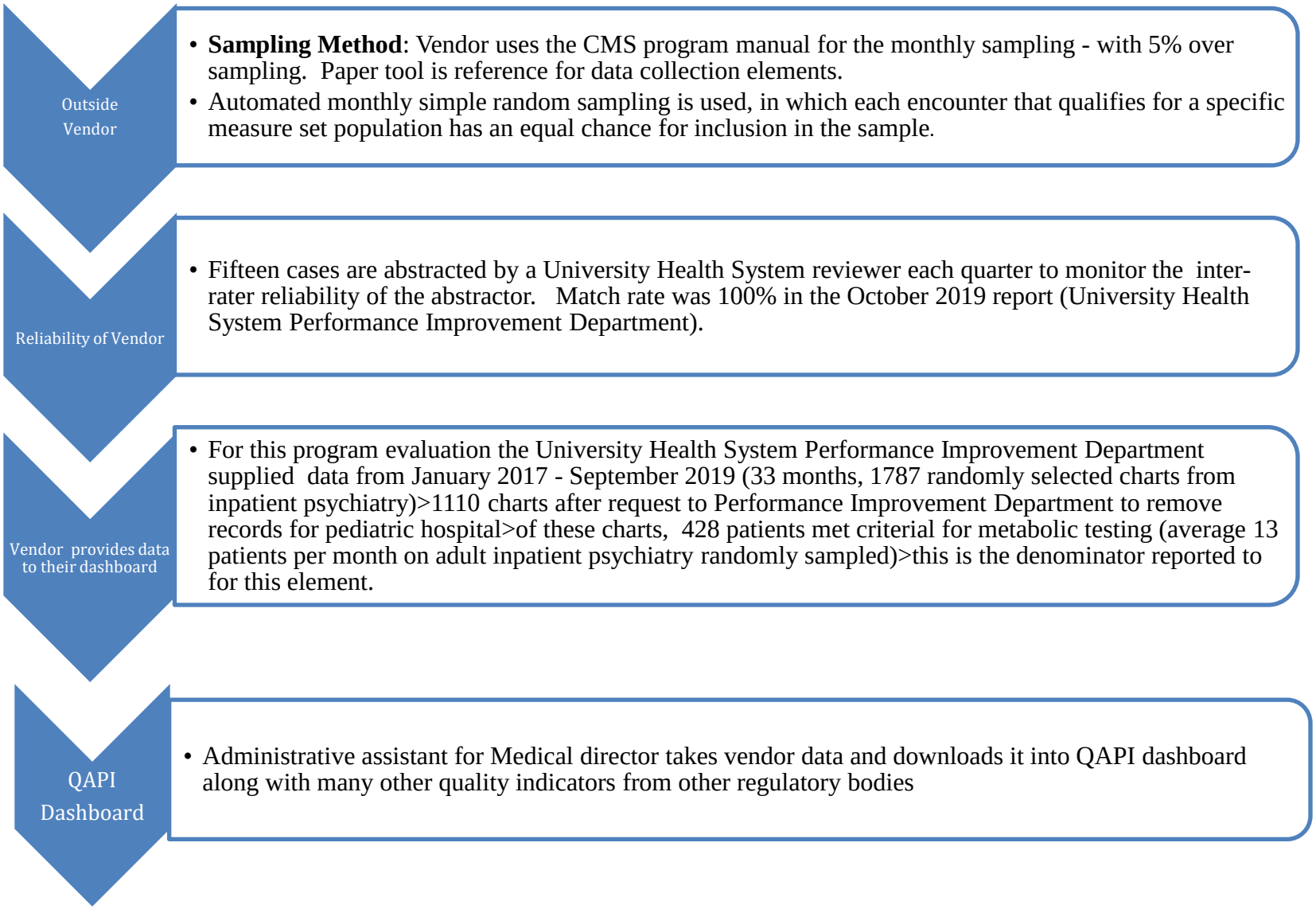


Figure A12. continued. Flow of information gathered for program evaluation



Appendix B: Sample CMS Data Extraction Procedure

CMS Data Extraction Procedure, Inpatient Psychiatric Facility Quality Reporting Manual, blood glucose monitoring element:

To meet the monitoring element for blood glucose, the abstractor must identify at least one documented result of HbA1c, fasting plasma glucose, or plasma glucose after an oral glucose tolerance test.

Suggested data sources: Emergency department record, consultation notes, history and physical, initial assessment form, laboratory reports, nursing graphic sheets, nursing notes.

Inclusion guidelines for abstraction:

Fasting blood glucose level

Fasting sugar

HBA1C

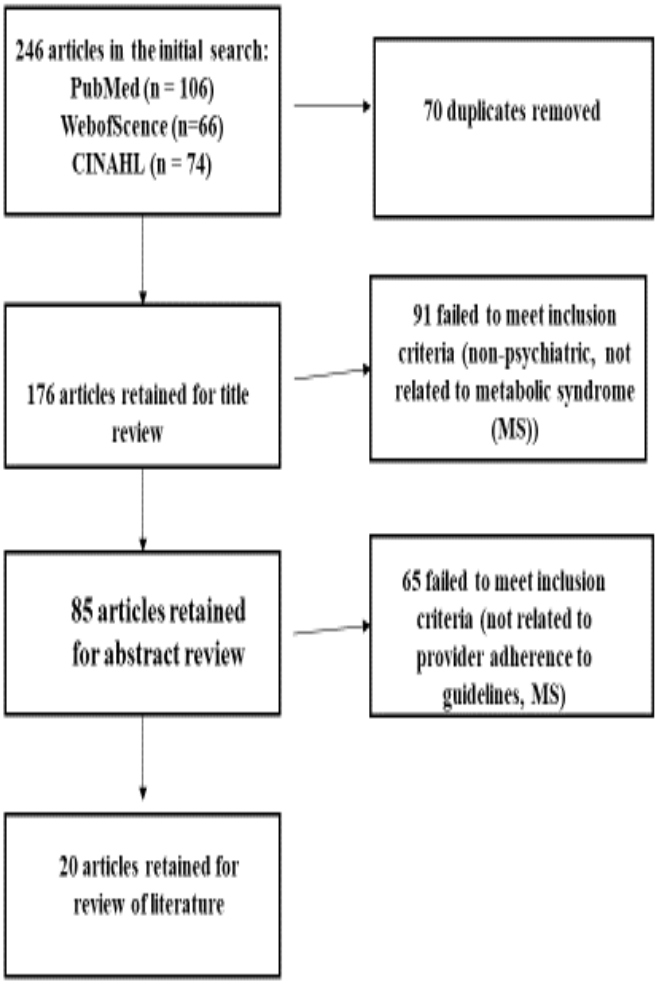
2-hour glucose level after OGTT check formatting per APA

Exclusion Guidelines for Abstraction:

Non-quantitative assessment of glucose test (i.e., normal, abnormal, etc.)

Finger-stick blood sugar (CMS, 2019b, p. 95)

Appendix C. Prisma Table



Appendix D. Literature Review Matrix

Reference	Design, Sample Size	Setting, Subjects, Intervention	Outcomes	Quality and Limitations
Bauer, M., Monteith, S., Geddes, J., & Gitlin, M. (2019). Automation to optimize physician treatment of individual patients: examples in psychiatry. *The Lancet Psychiatry*, *6*(4), 338-349.	Editorial, Review	Discussion of the use of automation in psychiatry: electronic health records, clinical decision tools, e prescribing	Authors emphasize that technology such as computer decision support requires integration of diagnosis, clinical expertise, and patient choice.	Level 5: Narrative Review
Barnes, R. Bhatti, S. Adroer, R., & Paton, C. (2015). Screening for the metabolic side effects of antipsychotic medication: Findings of a 6-year quality improvement programme in the UK. *BMJ*, *5*, doi: 10.1136/bmjopen-2015-007633	Pre- Post design. Pre intervention: 21 outpatient clinics, 1966 patients. Post intervention: 32 outpatient clinics, 1591 patients.	The setting was London outpatient mental health clinics. A quality improvement effort was implemented. Metabolic monitoring was audited 6 times over the course of the study, and clinics were given individualized feedback.	Prior to the intervention 11% of patients had all four aspects of metabolic monitoring completed. After the intervention 34% of patients had all four aspects completed.	Level 2 quasi experimental design No randomization
Castillo, E., Rosati, J., Williams, C., Pessin, N., & Lindy, D. (2015). Metabolic	Pre-Post design,	New York City home visiting teams implemented a quality improvement	The teams were ultimately able to obtain complete metabolic panels on 71% of patients. This	Level II.

syndrome screening and assertive community treatment: A quality improvement study. *Journal of American Psychiatric Nurses Association, 21*(4), 233-243.	n = 199	program to increase metabolic syndrome screening in patient with serious mental illness. The setting was 78 assertive community treatment teams (visit teams) between 2010 and 2011. Intervention included educational sessions for staff, a systematic screening protocol, and outside phlebotomy services.	team was able to show that testing can be done but did not provide for sustainability.	quasi-experimental design, no randomization, No baseline rate reported.
Delmonte, M. T., Bostwick, J. R., Bess, J. D., & Dalack, G. W. (2012). Evaluation of a computer-based intervention to enhance metabolic monitoring in psychiatry inpatients treated with second-generation antipsychotics. *Jounral of Clinical Pharmacy and Therapeutics, 37*, 668-673.	pre-post design n = 171 pre intervention, n = 157 post intervention.	Quality improvement effort in a 22 bed inpatient psychiatric unit at the University of Michigan. A computer based intervention (pop-up) was used to increase rates of metabolic monitoring.	Authors report that random lipid testing went from 28.7% pre-intervention to 74.5% post intervention. Fasting lipid testing went from 18.7% pre intervention to 59.9% post intervention (all p<.0001). They conclude that the implementation of a pop-up alert significantly improved rates of lipid levels for inpatients treated with SGAs, but overall rates remain suboptimal.	Level II quasi experimental No randomization, single site.

Ferrara, M., Mungai, F., Miselli, M., Shiers, D., Curtis, J., & Starace, F. (2015). Strategies to implement physical health monitoring in people affected by severe mental illness: A literature review and introduction to the Italian adaptation of the Positive Cardiometabolic Health Algorithm. *Journal of Psychopathology, 21*, 269-280.	Literature Review Includes 14 articles on strategies to implement physical health monitoring in people with serious mental illness.	Countries included Australia, USA and the UK. Authors provided an overview of strategies implemented in a variety of practice sites to increase monitoring. Mandatory letters to practitioners emphasizing the importance of physical tests, audits, and computerized pop up alerts were examined.	Authors did not provide statistics with regard to the studies, but ultimately reported that while some interventions were successful, screening was generally suboptimal. Authors report a variety of obstacles to screening were discovered, including lack of basic equipment, poor information technology support for recording labs, being overwhelmed with emergencies, and lack of sufficient training or skills.	Level V, Literature Review
Girlanda, F., Fielder, I., Becker, T., Barbui, C., & Koesters, M. (2017). The evidence-practice gap in specialist mental healthcare: a systematic review and meta-analysis of guideline implementation studies. *The British Journal of Psychiatry, 210*, 24-30.	Systematic review and meta-analysis 19 studies, six of which were RCTs.	The studies examined strategies to improve guideline adherence, including distribution of educational material, hiring a nurse manager, evidence-based treatment algorithms, and multifaceted interventions. .	Investigators report that providing a guideline alone did not improve provider performance (OR = 1.01, 95% CI 0.37-2.79). Four studies compared methods to enhance guideline implementation. No statistically significant advantage was found after the strategies (OR = 1.47, 95% CI 0.86- 2.52). The meta-analysis did not reveal a statistically significant effect of guideline implementation strategies compared with usual treatment.	Level 1 Systematic Review and Meta-Analysis including randomized controlled trials.

Girlanda, F., Fiedler, I., Ay, E., Barbui, C., & Koesters, M. (2013). Guideline implementations strategies for specialist mental healthcare. *Current Opinions in Psychiatry*, *26*(4), 365-75. doi: 10.1097/YCO.0b013e328361e7ae.	Systematic review of 19 studies	Authors sought to evaluate studies to determine if guideline implementation had an impact on provider performance.	Authors report the meta-analysis did not reveal a statistically significant effect on guideline implementation strategies compared with usual treatment. Authors report the level of evidence in the studies was low, therefore they were not able to determine which strategies to improve guideline implementation worked best.	Level I, Systematic Review and Meta-Analysis, authors report level of evidence in included studies was low.
Hannssens, L., De Hert, M., Kalnicka, D., Van Winkel, R., Wampers, M., Van Eyck, D., ... Peuskens, J. (2007). Pharmacological treatment of severe dyslipidaemia in patients with schizophrenia. *International Clinical Psychopharmacology*, *22(1*), 43-49.	Before and after design N=46 patients on antipsychotic medication exhibiting severe dyslipidemia	Setting was a university psychiatric hospital in Belgium. Metabolic screening was provided three months before start of statin, when statin treatment was started and three months after statin treatment was initiated. Period of data collection was 2003.	Treatment with statins resulted in a significant decrease in total cholesterol levels, triglyceride levels, LDL cholesterol levels. Statins proved effective in the management of dyslipidemia in patients with schizophrenia treated with antipsychotics.	Level II Quasi experimental Small sample size Single site study Other factors for dyslipidemia such as lifestyle not explored No randomization
D., Rosenblatt, L., Kim, E., Baker, R., Whitehead, R., &	Retrospective cohort analysis	Authors reported on rates of lipid and glucose monitoring before and after the	Baseline lipid testing rates were 8.4% for the pre-guideline	Level II

Newcomer, J. (2009). Prevalence and predictors of lipid and glucose monitoring in commercially insured patients treated with second-deneration antipsychotic agents. *The American Journal of Psychiatry*. doi:10.1176/appi.ajp.2008.08030383	n = 5,787 pre-guideline n = 17,832 post guideline	ADA/APA 2004 Guidelines using a large managed care database.	cohort and 10.5% for the post guideline cohort. Baseline glucose testing rates were 17.9% pre-guideline and 21.8% post guideline. Authors conclude that despite statistically significant improvements after the ADA/APA 2004 guidelines were issued, monitoring for plasma lipids and glucose remained low	Retrospective cohort analysis Large sample size
Kioko, E., Williams, K., & Newhouse, B. (2016). Improving metabolic syndrome screening on patients on second generation antipsychotic medication. *Archives of Psychiatric Nursing*, *30*, 671-677. doi:10.1016/j.apnu.2016.03.004	Before and after design. n = 50 charts pre intervention n = 50 charts post intervention	Outpatient mental health setting at a Midwestern university. Authors introduced a paper tool to increase metabolic syndrome monitoring rates. One hundred charts were randomly chosen from 1000 charts	Findings were that prior to the intervention, 22% of required labs were ordered, but 62% were ordered post intervention ($X^2(2) = 32.67$, $p<.001$). This represented a 56% increase.	Level II Quasi experimental design, randomization used to choose charts
Lee, Dalack, G., Casher, M., Eappen, S., & Bostwick, J. (2016). Persistence of metabolic monitoring for psychiatry inpatients treated with second-generation antipsychotics utilizing a computer-based intervention.	Retrospective chart review n = 129	Authors returned to the Midwestern hospital that had implemented a computer pop-up to increase rates of metabolic monitoring, four years later.	Rates of metabolic monitoring were sustained four years later. Specifically, similar to the original post-alert study population 4 years ago, 71% of patients had both a glucose level and lipid panel available.	Level III Retrospective cohort study Single site No randomization

Journal of Clinical Pharmacological Therapy, *41*(2), 209-213. doi:10.1111/jcpt.12368				
Mitchell, A., Delaffon, V., Vancampfort, D., & Correll, C., De Hert, M. (2011). Guideline concordant monitoring of metabolic risk in people with antipsychotic medication: Systematic review and meta-analysis of monitoring practices. *Psychological Medicine*, *42*(1), 125-147. doi:10.1017/S003329171100105X	Systematic review and meta-analysis 48 studies Pooled data of 71,594 patients	Authors provide a systematic review and meta-analysis of adherence to metabolic screening guidelines in five countries, including the United States.	Most metabolic parameters were measured in less than half of patients (cholesterol, 41.5%, glucose 44.3%, weight 47.9%).	Level I Systematic review and meta-analysis
Mitchell, A. J., & Lord, O. (2010). Do deficits in cardiac care influence high mortality rates in schizophrenia? A systematic review and pooled analysis. *Journal of Psychopharmacology*, *24*(4), 69-80. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/23209089	Systematic Review 23 studies	In eight of nine analyses, screening for illness such as osteoporosis screening, blood pressure monitoring, vaccinations, mammography and cholesterol monitoring was poor.	Lower than average rates of prescribing were evident for statins and other cardiovascular medications.	Level I Systematic review and pooled analysis.
Morrato, E., Campagna, E., Brewer, S., Dickinson, M., Thomas, D., Miller, B., ...	Retrospective Cohort Study	Investigators used Missouri Medicaid	Annual testing rates were found to be 79.6 % for glucose and 41.2% for lipids.	Level II

Lindrooth, R. (2016). Metabolic testing in adults in a state medicaid program receiving antipsychotics: Remaining barriers to achieving population health prevention goals. *JAMA Psychiatry, 73*(2), 721-730	n = 9,317 Medicaid recipients between 2010 and 2012	administrative claims data to examine claims for glucose or lipid testing occurring to within 180 days before or after an antipsychotic prescription claim.	Gaps in metabolic testing were observed in all settings.	Retrospective cohort study Large sample size
Nash, K., Ghinassi, F., Brar, J., Alam, A., Bohan, M., Gopalan, K., ... Chengapppa, R. (2013). The development and implementation of an electronic health record tool for monitoring metabolic syndrome indices in patients with serious mental illness. *Clinical Schizophrenia & Related Psychoses*, 145-153.	Quasi experimental Pre-post study	Five psychiatrists in a Pittsburg clinic reported on a quality improvement effort. They developed and field tested computer prompts to increase metabolic monitoring during outpatient visits.	They report that lipid testing remained at less than 8% throughout the first year. In the second year a patient care associate was hired, and lipid testing moved up to 25% in year two. Laboratory measures stayed in the low 25% range.	No randomization, single site study
Olfson, M., Gerhard, T., Huang, C., Crystal, S., & Stroup, S. (2015).	Cohort study n=1,138,853	Schizophrenia cohort extracted from Medicaid data in 45 states. Period of data collection 2001 - 2007	Compared to the general population, all cause death for schizophrenia cohort was significantly increased, with cardiovascular disease the biggest cause. Excess cardiovascular mortality was evident even in young adults. This highlights the importance of early clinical focus on cardiovascular health	Large sample size Quantitative study

			in the management of schizophrenia.	
Osborn, D., Nazareth, I., Wright, C., & King, M. (2010). Impact of a nurse-led intervention to improve screening for cardiovascular risk factors in people with sevefre mental illnesses. Phase-two cluster randomized feasibility trial of community led health teams. *BioMedCentral, 10*(16).	Cluster randomized feasibility trial Intervention arm n = 59, control arm n = 62.	Authors tested the impact of a nurse led intervention to improve screening in outpatient clinics in the United Kingdom. The intervention lasted six months and targeted improving levels of a variety of metabolic indicators including lipid testing. They implemented a system to monitor the tests and sent prompts to staff if screening had not occurred. A nurse offered screening herself to cover patients who still had not received the complete battery of CVD screening. Six community mental health teams were randomized to receive either a nurse led intervention plus education pack, or education pack A statistician randomly generated treatment allocation numbers to which the researcher and nurse were blind. The nurse was a registered general nurse.	After the trial, CVD had increased in both arms but participants in the intervention arm were significantly more likely to have received cholesterol screening (66.7% vs. 26.9%, OR 6.1, 3.2 – 11.5).	A statistician randomly generated treatment allocation numbers to which the researcher and nurse were blind.

		The education arm was given guidelines and information about cardiovascular disease (CVD).		
Piotrowski, P., Gondek, T. M., Krolicka-Deregowska, A., Misiak, B., Adamowski, T., & Kiejna, A. (2016).	Systematic Review	Current European studies were reviewed addressing mortality rates in schizophrenia Articles included were from 2009 - 2014	26 papers were included in the review. "Schizophrenia patients do not benefit from progress in medicine to the same extent as people not suffering from this disease. "There is a lack of data on the influence of potential interventions to modify potential risk factors (such as high cholesterol levels)	Studies included Denmark, UK, Finland, Sweden, Norway, and the Netherlands.
Zhai, D., Cui, T., Xu, Y., Feng, Y., Wang, X., Yang, Y., ... Zhou, D. (2017).	Cohort study n=32,488	Hospital medical records of an inpatient hospital in China were studied focusing on drug naïve patients with schizophrenia Period of data collection 2008 - 2014	Short term uses of an antipsychotic treatment induced significant changes in lipid metabolic profile. After an average of 22.7 days of antipsychotic exposure, lipid abnormalities were significantly elevated.	Chinese population may not be generalizable to US population

Appendix E. IRB Waiver

TO: Jessica Geen

CC: Jessica Geen

FROM: XXX IRB Panel A

RE: Jessica Geen ; HM20017610 Program Evaluation of a Quality Improvement Intervention to Increase Provider Adherence to National Guidelines for Metabolic Monitoring in Psychiatric Patients

To be subject to the regulations, a study must meet the definitions for BOTH "human subject" AND "research". While your study may fit one of these definitions, it does not fit both. Therefore, your study is not subject to the regulations and no IRB review or approval is required before you proceed with your study.

Section 45 CFR 46.102(l) of the HHS Regulations for the Protection of Human Subjects defines research as " a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge. Activities which meet this definition constitute research for purposes of this policy, whether or not they are conducted or supported under a program which is considered research for other purposes."

Section 45 CFR 46.102(e)(1) of the HHS Regulations for the Protection of Human Subjects defines a human subject *as "a living individual about whom an investigator conducting research:*

- Obtains information or biospecimens through intervention or interaction with the individual, and uses, studies, or analyzes the information or biospecimens; or
- Obtains, uses, studies, analyzes, or generates identifiable private information or identifiable biosp*ecimens."*

Thank you for informing us of the project. If we can be of service with respect to future research studies, please contact us.

If you have any questions, please contact the Office of Research Subjects Protection (ORSP) or the IRB member(s) assigned to this review. Reviewer contact information is available by clicking on the Reviewer's name at the top of the study workspace.

Thank you for your continued collaboration in maintaining XXX commitment to protecting human participants in research.

Appendix F. Qualtrics Survey

Provider Perceptions of Lipid Testing in Patients Taking Antipsychotic Medication During Inpatient Psychiatric Hospitalization at The University Health System.

CMS requires that psychiatric patients taking anti-psychotic medication be screened for metabolic syndrome within the 12 months prior to the patient's date *of discharge*.

The screening consists of HbA1c or blood glucose, lipid panel, blood pressure, and BMI.

The lipid panel is the least ordered component of metabolic screening at the University Health System Inpatient Psychiatry unit and nationwide.

Please answer this anonymous survey on barriers and facilitators to ordering the lipid panel, specifically during your time at The University Health System inpatient psychiatry unit.

The survey should take less than 2 minutes. It is part of a program evaluation for a doctoral project.

Are you an attending physician, resident or NP?

- *Attending*
- *Resident*
- *NP*

1

When did you last work on the University Health System Inpatient Psychiatry service?

- *2019*
- *2018*
- *2017*
- *2016*

The following are barriers to lipid testing:

	Strongly agree	*Somewhat agree*	*Neither agree nor disagree*	*Somewhat disagree*	*Strongly disagree*
I was not aware of the CMS requirement for yearly metabolic					

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
screening including the lipid panel.					
I do not agree with the CMS requirement.	○	○	○	○	○
Guidelines for lipid testing are inconvenient or difficult to use.	○	○	○	○	○
Lack of adequate nursing staff is a barrier to ordering the lipid panel on the inpatient service.	○	○	○	○	○
Patient characteristics such as refusing labs or being violent are a barrier.	○	○	○	○	○
Lipid monitoring is an outpatient provider's responsibility.	○	○	○	○	○
Provider continuity may be a barrier. For example, I may not order the lipid panel if I am temporarily covering a team.	○	○	○	○	○
Workload demands or frequent emergencies while on the inpatient service are a barrier.	○	○	○	○	○

The following are facilitators to lipid testing:

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
I am confident in my ability to interpret labs and/or treat hyperlipidemia.	○	○	○	○	○

	Strongly agree	*Somewhat agree*	*Neither agree nor disagree*	*Somewhat disagree*	*Strongly disagree*
Metabolic syndrome screening, including the lipid panel, is a high priority for me.	○	○	○	○	○
Attending physician expectations are a facilitator to ordering the lipid panel.	○	○	○	○	○
Quality improvement metrics such as physician scorecards are a facilitator.	○	○	○	○	○
The computer pop-up reminding me to order the metabolic screen, including lipids, is a facilitator.	○	○	○	○	○
The pharmacist's personal reminders are a facilitator.	○	○	○	○	○
I believe my patients will have adequate outpatient follow-up to treat hyperlipidemia.	○	○	○	○	○
The auto-text that is available to document lipid results is a facilitator.	○	○	○	○	○

Appendix G

Summary of The University Health System Inpatient Psychiatry Stakeholder Interviews

#	Stakeholders	Interview Response
1.	Medical Director	Reported he is aware that lack of adherence to guidelines for metabolic monitoring is a global problem. Stated interest in seeing if the smart rule has been successful in helping maintain high rates of monitoring. Stated interest in provider attitudes toward metabolic monitoring. Reported that we may need to send out monthly reminders to providers to perform metabolic monitoring.
2.	Director of Nursing	Acknowledged support for the program evaluation. Wanted to know why the Children's Hospital was not part of the project. Inquired about IRB approval.
3.	Inpatient Pharmacist, MMIP Project Leader	Pharmacist reported that the most important outcome of an evaluation would be to determine if the Quality Assessment and Performance Improvement (QAPI) dashboard will continue to reflect high rates of metabolic monitoring as the program continues. She is interested in knowing if the smart rule is

		firing as often as it should. She is interested in knowing which aspect of the metabolic panel is ordered least often. She hopes the evaluation will show the computer prompt is adequate to increase provider compliance with guidelines.
4.	QAPI Chairman/Attending Physician	This attending physician supports an evaluation. He expressed a desire to use technology wherever possible to reduce provider workload. He was interested to see if the evaluation would show that the computer smart rule had effectively reduced workload of the pharmacist.
5.	Professor of Pharmacy	Reports a formal evaluation would be valuable and especially would like quantitative analysis of rates of testing between different phases of the program (no pharmacist, pharmacist only, pharmacist and smart rule). She reported that in the past some physicians verbally complained about metabolic monitoring and she therefore stopped asking them to order it. She remarked that the smart rule seems to have overcome these issues.
6.	Inpatient Psychiatric Nurse Practitioner #1	Reported she would like an evaluation to show if the lipid testing orders could be automated further. Specifically wanted

		to determine if metabolic testing orders could be added to admission orders.
7.	Inpatient Psychiatric Nurse Practitioner #2	Reported she feels an evaluation would be valuable to document success of current program. This provider reported she does not want the current program to change because the current smart rule "tells me exactly what to do."
8.	Psychiatric Resident #1	Resident reported an evaluation would be valuable because she notes ongoing inconsistencies with the ordering of the metabolic panel. She reports "some people order it overnight, some people wait for the team to discuss it, some people let it go." She reports there is a continued reliance on pharmacy to drive metabolic testing. She did not feel the current smart rule was helpful. She reported the metabolic monitoring is especially lax on the weekends. Desired an evaluation to determine how to continue to improve visibility of smart rule, reduce reliance on pharmacist, and increase screening on weekends.
9.	Psychiatric Resident #2	Reported she would be interested in data showing which of the four inpatient teams were most likely to neglect metabolic monitoring. She reported that when she is on a team where

	antipsychotics were used less frequently, she was more likely to forget to order the testing. When she was on the schizophrenia team, she was more likely to remember as almost all patients were on antipsychotics. She reported frequent patient refusal of labs was a problem and she would like to see the evaluation address this. She suggested one way to remedy the problem would be to make metabolic testing part of the daily goals that were discussed for each patient until the goal was achieved.
10. Nurse Manger, QAPI Leader	Reports she would be interested in a program evaluation demonstrating that the Plan, Do, Study, Act (PDSA) cycles that were implemented in the QAPI meetings two years ago were an effective problem solving method. She reports that prior to implementing the PDSA cycles QAPI meetings were less effective at producing quantifiable outcomes.
11. RN	Desires the evaluation to document a problem with timing of ordering labs for metabolic screening. Reports that the best time to draw the labs was the morning after patients are admitted and wanted this to become more standard. Reported patients were more likely to refuse labs on the first day they are here. Alternatively, if they were ordered on the day of

discharge they cause the discharge to be delayed. Interested in an outcome of the evaluation that would recommend labs be clustered on morning after admission.

Note: All interviews were conducted between May-August 2019 at the University Health System

Appendix H - Executive Summary

Introduction: In 2017 CMS Hospital Compare published that 55% of patients at a University Health System inpatient psychiatry unit were receiving mandated metabolic screening. The state average at that time was 69%, with some local hospitals achieving 96%. The unit instituted a three phase quality improvement initiative: 1. Monitoring and reporting rates, 2. Inpatient pharmacist reminders, 3. Initiation of a "smart" computer prompt. In January 2020, 100% of patients on inpatient psychiatry received screening. This was a program evaluation of how the organization improved those rates.

The issue: Psychiatric patients die an average of 20 years earlier than those without mental illness. Cardiovascular disease is the leading cause of death. Psychiatric medications contribute to mortality by causing metabolic syndrome. Guidelines for monitoring metabolic syndrome have been published since 2004 by the American Diabetes Association/American Psychiatric Association. Yet despite trying multiple interventions, countries around the world have struggled to get providers to adhere to guidelines, rarely reaching 60%.

The solution: This evaluation was prepared by a nurse practitioner that worked on the inpatient psychiatry unit. The evaluation was conducted according to the CDC 6 step Framework for Health Program Evaluations. After meeting with stakeholders, the evaluation sought to answer these questions: 1. What was the difference in adherence to guidelines for metabolic monitoring between the three phases of the intervention?

2. Was the difference in adherence rates between phases statistically significant?

3. How often was the smart rule firing per month in relation to all patients who met eligibility criteria for metabolic monitoring?

4. Was there one or more element of the metabolic panel that is routinely not being ordered, thus preventing the full panel from being completed? If so, what were provider attitudes toward barriers and facilitators to panel completion?

5. What was the completion rate by nurses/patient technicians of metabolic screening panel orders?

Prove it. The computer smart rule was able to maintain and improve upon rates of metabolic screening, even after the pharmacist reduced personal reminders. There was no statistically significant difference between pharmacist's personal reminders and the "smart" rule. The smart rule fires repeatedly to prompt providers to order metabolic screening labs. Lipid testing was almost always the element of the four-part screen that prevents a full panel from completion (CMS only acknowledges full panels). The majority of providers agreed with the guidelines and felt they are important, but said prompts are important facilitators. Nurses obtained ordered labs 94% of the time.

Conclusion: A "smart" computer prompt resulted in increased compliance with guidelines for metabolic monitoring, while reducing staff time required.

Appendix I - Manuscript

Manuscript prepared in accordance with instructions for submission to

Archives of Psychiatric Nursing

Program Evaluation of a Quality Improvement Intervention to Increase Provider Adherence to National Guidelines for Metabolic Monitoring in Psychiatric Patients

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UVA

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April 26, 2020

Abstract

Aim: This is a formal evaluation of a quality improvement project that was implemented at The University Health System inpatient psychiatry unit between 2017 and 2019. The project goal was to increase provider adherence to the ADA/APA 2004 Guidelines for metabolic monitoring.

Method: The Centers for Disease Control framework for program evaluation was used. Based on stakeholder feedback, five questions were answered. Reports from the health system data analytics department, a Qualtrics survey and quantitative analysis were employed.

Results: 1. Personal reminders by an inpatient pharmacist increased rates of metabolic monitoring from 40% to 76%. Implementation of a computer "smart" rule further increased rates to 89%. 2. After 11 months, there was no statistical difference in lipid testing between the pharmacist reminders and the computer smart rule ($p = .098$, 95% CI -28.50 to 1.98). Rates were maintained with less monthly variability and with less intervention from the pharmacist after the rule was implemented. 3. The smart rule was found to fire repeatedly until a provider ordered the metabolic labs 4. Lipid testing is the least ordered component of the metabolic panel. Qualtrics survey (n=22) showed providers are aware of the guidelines (95%) and agree with them (75%). They believe the smart rule is a facilitator to adherence (85%).
5. Nurses were able to obtain 94% of labs ordered before patient discharge.

Implication: An automated computer smart rule was able to sustain and improve upon rates of provider compliance with guidelines for metabolic monitoring. This allowed reduced interventions by the inpatient pharmacist.

Key Words: antipsychotic, metabolic monitoring, guidelines, evaluation, computer, automated

Highlights:

- Patients with serious mental illness disorder die on average 25 years earlier than the general population, with cardiovascular disease the leading cause of death.

- Commonly used antipsychotic medications can induce metabolic syndrome, which contributes to early mortality.

- CMS requires that inpatient psychiatric hospitals follow the ADA/APA 2004 Guidelines and monitor body mass index, blood pressure, glucose, and lipid panel in patients taking antipsychotic medication. However, provider compliance rates are often below 60%, with lipid monitoring the least ordered component.

- This is a program evaluation of a quality improvement project at an urban inpatient psychiatric ward that aimed to increase provider compliance with metabolic monitoring guidelines.

- The evaluation showed that addition of a computer smart rule increased rates of monitoring to 89%.

Introduction

Patients with serious mental illness such as schizophrenia and bipolar disorder die on average 25 years earlier than the general population (National Association of State Mental Health Program Directors, Medical Directors Council, 2006). Reasons for this are multifactorial, including high rates of smoking and poor access to medical care. However, since the early 1990s, it has been recognized that the drugs commonly used to treat mania and psychosis can contribute to early mortality (Ferrara et al. 2015). The class of drugs, called atypical antipsychotics, can increase blood sugar, cholesterol, and cause weight gain. This triad of metabolic derangement is called metabolic syndrome. These side effects can start within months of taking the medications, adding serious health consequences to an already vulnerable population (Ferrara et al. 2015).

In 2004, a conference was held with the American Diabetes Association, American Psychiatric Association, American Association of Clinical Endocrinologists, and the North American Association for the Study of Obesity. These organizations published a consensus statement, the first American guidelines (ADA/APA 2004 Guidelines) for regular monitoring and treatment of metabolic syndrome for patients taking atypical antipsychotics. Drugs in this class include olanzapine, ziprasidone, quetiapine, risperidone, and aripiprazole.

The ADA/APA 2004 Guidelines recommend baseline monitoring of body mass index, blood pressure, glucose, and lipid panel. Patients should be screened at three months after the initiation of the antipsychotic and then annually. If the medication was causing adverse effects, the Guidelines recommend switching to another drug in the class. If problems persist (such as serum elevations of glucose, lipids, or weight gain), but the patient is benefitting from the drug, the Guidelines recommended appropriate treatment be initiated, or referral to a specialist.

In 2005, the Centers for Medicaid and Medicare (CMS) required that inpatient psychiatric hospitals follow the ADA/APA 2004 Guidelines for metabolic monitoring. CMS required inpatient psychiatric hospitals report their levels of monitoring as part of a bundle of quality control measures, called the Inpatient Psychiatric Facility Prospective Payment System (IPFPPS) (CMS, 2019a).

Despite the dissemination of the ADA/APA 2004 Guidelines, studies show that provider adherence rates are low. Melamed, Wong, LaChance, Kanji, and Taylor, (2019) published a systematic review of 30 interventions targeted at improving provider compliance with guidelines for metabolic monitoring in patients taking antipsychotic medications. Interventions were associated with an increase in median screening rates for glucose (28% to 65%), lipids (22% to 61%), weight (19% to 67%), and blood pressure (22% to 80%). The authors concluded that additional interventions are needed to address the current guideline-to-practice gap, in which approximately one-third of patients are unscreened for metabolic risk.

A quality improvement program was conducted at the author's practice site to improve adherence to the ADA/APA 2004 Guidelines. The purpose of this scholarly project was to complete a formal program evaluation of the program that was implemented at a university health system between January 2017 and September 2019 to improve adherence to the ADA/APA 2004 Guidelines.

Materials and Methods

The US Department of Health and Human Services (USDHHS) Centers for Disease Control (CDC) Six Step Program Evaluation Framework was used in this program evaluation (USDHHS, 2011).

CDC Framework Step 1. Engage Stakeholders

Eleven stakeholders were interviewed including the Medical Director, Nursing Director for Psychiatry, Nursing Manager for Psychiatry, three physicians, two pharmacists, two nurse practitioners, and one RN. In addition, monthly Quality Assessment and Performance Improvement (QAPI) meetings were attended. Stakeholders were interested in a program evaluation and had specific questions they requested to be answered.

CDC Framework Step 2. Describe the Program

The university health system is an urban academic center. It includes a forty-bed inpatient psychiatric unit.

The program to improve adherence to metabolic monitoring guidelines had three phases:

Phase 1: Monitoring and reporting adherence to guidelines only: January 2017 through August 2017.

Phase 2: Inpatient pharmacist begins verbal reminders to providers to order metabolic monitoring on eligible patients: September 2017 through October 2018.

Phase 3: A computer smart rule was initiated, and pharmacist reports reduced verbal reminders. November 2018 through September 2019.

CDC Framework Step 3. Focus the Evaluation Design

Based on stakeholder feedback, this program evaluation answered five questions:

1. What was the difference in adherence to guidelines for metabolic monitoring between phases 1, 2, 3?

2. Was the difference in adherence rates between phases 1, 2 and 3 statistically significant?

3. How often was the smart rule firing in all patients who have a new prescription for scheduled antipsychotic medications?

4. Was there one or more element of the metabolic panel that was routinely not being ordered, thus preventing the full panel from being completed? If so, what were provider attitudes toward barriers and facilitators to panel completion?

5. What was the completion rate by nurses/patient technicians of metabolic screening panel orders?

CDC framework Step 4. Gather Credible Evidence

Data source for questions 1 and 2. 428 randomly selected charts over 33-month period.

Method for questions 1 and 2. Data was provided by the university health system quality improvement department as an Excel spreadsheet. It was entered into SPSS Version 24 Statistical Software. The variability of the three phases as well as the normality of the distribution was explored to determine the right statistic to compare the groups.

Results question 1.

Phase 1: Blood pressure and weight monitoring 100%, HbA1c 91%, lipid testing 40%.

Phase 2: Blood pressure and weight monitoring 100%, HbA1c 99%, lipid testing 76%.

Phase 3: Blood pressure and weight monitoring 100%, HbA1c 100%, lipid testing, 89%.

Interpretation. Lipid testing was consistently the least frequently ordered component of metabolic testing. However, it increased with pharmacist reminders. Gains in adherence to lipid testing continued to improve with the initiation of the smart rule, while reducing time spent by the inpatient pharmacist reminding providers. Figure A1 is a detailed illustration of monthly testing levels of both HbA1c and lipids.

Results Question 2. ANOVA results for the lipid panel showed there was a significant difference between phase 1 (monitoring only) and phase 2 (hiring an inpatient pharmacist). Rates of compliance increased from 40% to 76% ($p = .000$, 95% CI -52.5 to -19.02). There was

not a statistically significant difference between phase 2 (hiring an inpatient pharmacist) and phase 3 (pharmacist with smart rule, (p = .098, 95% CI -28.50 to 1.98). Variability of testing rates was reduced with use of the smart rule (Figure A2).

Kruskal-Wallis test results for HbA1c showed significant difference between phases one and two (91% to 99%, p =.000, statistic 18.05, df 2), but no significant difference between phases two and three (99% to 100%, p=.691, statistic 18.05, df 2).

Interpretation. The inpatient pharmacist reports that after the introduction of the computer smart rule, she rarely reminded providers to order metabolic testing. Therefore, the smart rule was able to maintain higher rates of provider compliance than a pharmacist with reduced variability. It is important to note that improved rates were maintained despite monthly rotation of residents. Lipid testing showed reduced variability with initiation of the computer smart rule (Figure A10).

Data Source for question 3. All inpatient adult psychiatric hospital records from January 9, 2020 to January 20, 2020.

Method for question 3. The university health system data analytic department triggered their own internal audit system of the smart rule. This had been previously designed in the event the smart rule was questioned. The audit report was then manually examined to determine how often the rule fired for each patient during the audit period.

Results question 3. Between January 9 - 20, 2019 the smart rule fired on inpatient psychiatry 27 times. It only fired for nine patients. The average number of times it fired per patient was three, but some providers had to be reminded up to seven times (smart rule fires) before they met the requirement. During that same time period, 52 antipsychotics were ordered for 28 patients.

Interpretation. When taken in conjunction with the increase in provider adherence to guidelines, one may conclude that the rule is working appropriately to give providers repeated reminders until the guideline is met. However, a limitation of this study is that this cannot be verified without opening individual charts.

Data Source for question 4. A Qualtrics survey was developed and disseminated by email to determine provider attitudes toward ordering least often completed elements of the metabolic panel.

Method for question 4. Answers to questions 1 and 2 showed that the lipid panel is the least often ordered component of a full metabolic panel. An anonymous Qualtrics web-based survey was constructed and distributed to providers on the psychiatric unit to determine their attitudes toward lipid screening. Ultimately twenty-two responses were received.

Results for question 4. Awareness of lipid testing requirements was not a barrier, with 95% of respondents saying they are aware of them and 75% agreeing with them. Providers did not find them difficult to use (85%) feel there is a lack of nursing staff (75%). However, providers were almost evenly divided when asked if they felt lipid testing was an outpatient provider responsibility, with 40% agreeing and 35% disagreeing. Similarly, 55% disagreed that workplace demands such as emergencies were a barrier, while 40% agreed.

One hundred percent of respondents felt the pharmacists' reminders were a facilitator to ordering lipids. Eighty-five percent agreed that the smart rule was a facilitator. Eighty-five percent were confident in their ability to interpret the lab results. Sixty percent of respondents felt that metabolic testing is a high priority.

Interpretation. The findings of the Qualtrics survey are consistent with the other findings of this evaluation. That is, the majority of providers are aware of the guidelines, agree with

them, and consider them to be a high priority. However, reminders are felt to be very important, either by the pharmacist or the smart rule.

Data Source for question 5. Report of metabolic monitoring lab status and results from the entire adult inpatient psychiatric unit between January 1, 2017 and December 31, 2019 was provided by the university health system data analytics department.

Method for question 5. Excel software was used to filter out completed labs. Manual examination of remaining labs was employed to determine reason no result was documented.

Results for question 5. During the report time period 3,767 labs were ordered for metabolic monitoring (lipid and glucose testing). Seventy two percent were completed, 28% were not. Manual examination of the report revealed that HbA1c and lipid panel labs were often ordered and discontinued multiple times during a patient's stay, often within a few minutes of each other. However despite the frequent ordering and discontinuing, the metabolic labs were completed at some point during the patient stay 94% of the time prior to a patient's discharge. Six percent were never completed during the patient stay.

Interpretation. In some cases (6%), lack of completion of the metabolic panel may not be the fault of providers. As stakeholders pointed out during the initial interviews, labs are sometimes not able to be obtained. Patient refusal or patient behavioral issues are potential reasons.

CDC Program Evaluation Step 5. Justify Conclusions

Throughout this evaluation stakeholder were involved and helped assess the data, including attending physicians, the program mentor, and data analysts. Results were consistent with existing literature documenting that lipid levels are the least ordered part of a metabolic panel.

CDC Step Number 6. Ensure Use and Share Lessons

This program evaluation was presented to the inpatient QAPI team on February 20, 2020. Stakeholder questions were answered. Barriers and facilitators to high rates of monitoring were reported. Recommendations on ways to maintain or improve rates of metabolic monitoring where be made. An executive summary was provided.

Discussion

The university health system was able to achieve steadily increasing rates of lipid testing with the last month reported (1/2020) at 100%, while reducing staff involvement. This project shows the importance of program evaluation, identifying interventions that work, and applying lessons learned to other projects, possibly tobacco cessation or alcohol use screening.

Although many organizations have tried to increase provider compliance with metabolic testing (Melamed, Wong, LaChance, Kanji, & Taylor, 2019), few have had the success the university health system did. However, the success was not only due to the smart rule. This program evaluation showed that nursing obtains weight and vital signs 100% of the time, and have since monitoring started. They also are able to obtain 94% of ordered labs, despite a population that can refuse them or sometimes become combative. The Qualtrics survey showed providers agree with the ADA/APA 2004 Guidelines and believe they are a priority. All these things brought the university health system to 93% compliance with metabolic testing in September of 2019, and 100% in January 2020, while reducing staff time spent in the effort.

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D R A F T

Figure A1. Provider compliance with testing across the three phases of interventions

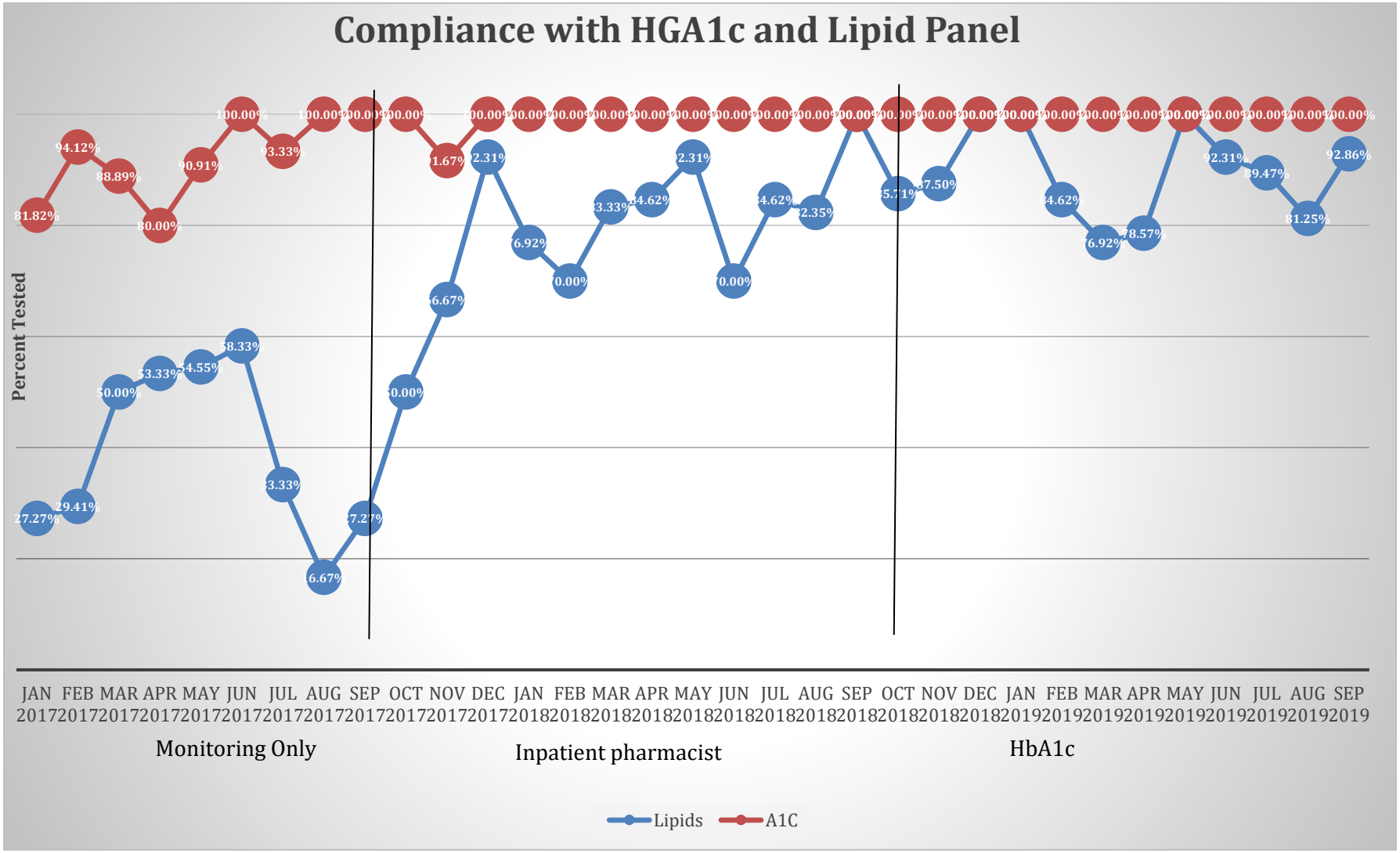

Figure A2. Variability in rates of lipid testing

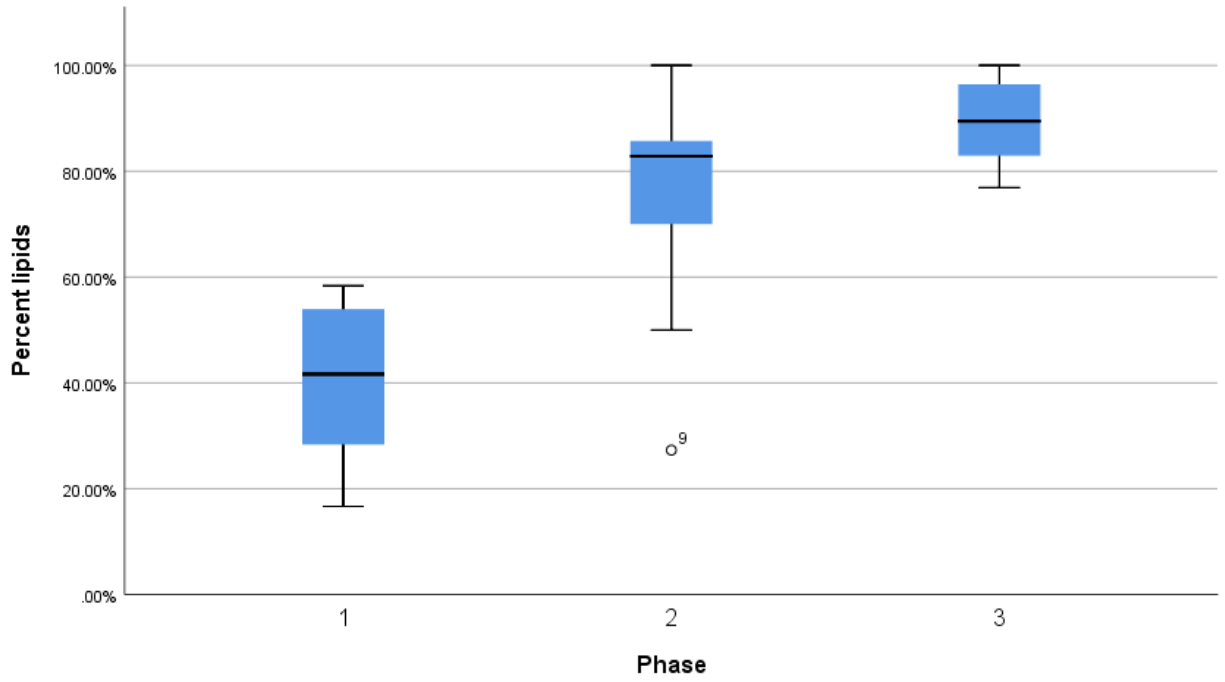

Figure A2. Phase 1: Monitoring only: January 2017 through August 2017. Phase 2, inpatient pharmacist, September 2017 to October 2018. Phase 3, computer smart rule, November 2018 to September 2019