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Aline Benson Date

Evaluating the HIV Continuum of Care and Metabolic Indicators at Grady IDP

By

Aline Benson

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Evaluating the HIV Continuum of Care and Metabolic Indicators at Grady IDP

By

Aline Benson

B.S., Appalachian State University, 2014

Thesis Committee Chair: Vincent Marconi, M.D.

An abstract of

A thesis submitted to the Faculty of the

Rollins School of Public Health of Emory University

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Abstract

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By Aline Benson

The Grady Infectious Disease Program (IDP) Ponce Clinic is one of the largest outpatient HIV clinics in the United States. IDP garners most of its funding, which provides free health care to people living with HIV (PLWH) in the Southeast, from the Ryan White Care Act. This assessment analyzed clinical quality and process indicators focusing on the HIV care continuum and metabolic disorders against Ryan White standard metrics for the HIV care continuum and standard diabetes mellitus (DM) metabolic metrics for patients at IDP between the years 2013 to 2017. Results showed suboptimal retention in care, but for those retained in care, there was exceptionally high rates of antiretroviral treatment (ART) prescription and virologic suppression. This showed room for improvement in retaining PLWH patients in care over long periods, as well as getting patients to adhere to ART. Metabolic indicator results showed high compliance for those patients who had A1C tests completed, and mid-range compliance for blood pressure and cholesterol lab compliance. While there are decent levels of compliance for the metabolic indicators, most labs were not ordered as much as they should be, with A1C labs hovering between 600 and 1,100 labs ordered. Thus, the need for more routine screening and metabolic testing is highlighted by this assessment.

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About IDP

The Ponce Center of the Grady Health System Infectious Disease Program (IDP) is one of the nation's largest clinics dedicated solely to serving people living with HIV (PLWH). The clinic started in 1986 at the Main Grady Hospital in Downtown Atlanta and in 1993 moved to its current location on Ponce de Leon Avenue in Midtown Atlanta. Since then, IDP has played a pivotal role in treating Atlanta's most marginalized populations. Emory University physicians and Grady advance practice providers care for over 6,000 patients per year (UNAIDS, 2017). IDP is host to various clinics and resources that work together to better serve its patients. Some of the services offered by IDP are pediatric health, mental health, legal assistance, and education classes, among a multitude of other resources.

In 2016, 69.7% of the patients seen at IDP lived within 250% of the national poverty limit, 40.6% were uninsured, and 90.5% of clients were racial/ethnic minorities. The IDP clientele is majority male (72.2%) and African-American (81.7%). A large portion of patients (46.3%) self-report as men who have sex with men (MSM), one of the largest risk groups for HIV (IDP, 2016).

The IDP is almost exclusively funded through the Ryan White Comprehensive Aids Resource Emergency (CARE) Act, which was enacted in 1990 to provide comprehensive care for underinsured and uninsured PLWH (HRSA, 2016a). Grantees of Ryan White funding must report on quality indicators as well as process indicators (HRSA, 2016b). Since IDP gets consistent funding from Ryan White, an assessment of quality and process indicators is required each year. The purpose of this assessment is to use the Ryan White guidelines to perform a quality assessment of the HIV continuum of care and Diabetes Mellitus (DM) continuum of care

indicators. These metrics include the number of patients in care, the number of patients on treatment and the number of patients who are virally suppressed at IDP. A quality assessment of metabolic disorders in the IDP patient population is also of critical importance, due to the fact that PLWH have a higher prevalence of diabetes mellitus (DM) and cardiovascular disease (CVD). For this reason, a metabolic disorders assessment would include the ABC goals which are control of A1C, blood pressure and cholesterol (Colasanti et al., 2018). The goal of this project is to evaluate the HIV care continuum and ABC control at IDP over the course of five years (2013-2017) using cross-sectional analysis methods.

HIV Continuum of Care

The HIV Continuum of Care was originally defined by Dr. Edward Gardner et al. in 2011 as a spectrum of care to better acknowledge and understand the countless obstacles that contribute to poor engagement in HIV treatment. This review defined the stages of care into the following steps: HIV infection, HIV diagnosed, linked to HIV care, retained in HIV care, need antiretroviral therapy (ART), on ART, and lastly adherent or undetectable (Gardner, McLees, Steiner, del Rio, & Burman, 2011). Those who were infected with HIV are not necessarily aware of their HIV status and need to seek out HIV testing. The official start of the treatment spectrum would begin when a patient is diagnosed with HIV by testing positive for HIV antibodies. Patients are then, either passively or actively, referred to HIV treatment and care. At this stage patients can have a visit with a HIV care provider but are not considered retained in care until there are follow-up visits. These patients are thereafter classified as being retained in care, defined as having at least one medical visit (inpatient, outpatient, or labs) in each 6-month period of a 24-month measurement period that are $\geq$60 days apart (HRSA, 2017). Those in care receive ART according to national guidelines. At the time of Gardner's review the CD4 count

threshold for initiating ART was less than or equal to 350 copies/µl of blood. However, as of 2017 CD4 thresholds have been eliminated; and now all patients who test positive for HIV should be initiated on ART in order to decrease morbidity and mortality (USDHHS, 2017). Patients who adhere to their treatment should achieve viral suppression which is the final stage in the spectrum of care. Viral suppression is defined as a HIV-1 plasma viral load RNA assay having less than 200 copies/ml (HRSA, 2017).

Diabetes Mellitus

Non-communicable diseases such as diabetes mellitus (DM) are becoming more frequent for PLWH as the introduction of ART has transformed HIV into a chronic illness. This is especially true for those PLWH who are taking protease inhibitor-based ART. These antiretrovirals have known adverse effects on insulin resistance and impaired glucose intolerance (Brown et al., 2005). PLWH have 1.6 times adjusted prevalence of DM when compared to the general US population DM prevalence. In a study including a representative US sample, PLWH had a 3.8 higher prevalence of DM than those without HIV (Hernandez-Romieu, Garg, Rosenberg, Thompson-Paul, & Skarbinski, 2017). DM is linked to increased risk of cardiovascular disease (CVD) due to similar risk factors such as hypertension and hyperlipidemia. According to Goldberg (2000), DM patients "have a 2-to-3-fold increased risk of CVD compared to individuals without DM" (Goldberg, 2000). To monitor and improve outcomes for people in the US living with DM a care continuum, based on the above-mentioned HIV Care Continuum, was created. The treatment goals for the metabolic disorders are referred to as ABC control where **A** is achieving an A1c of less than 7%, **B** is achieving a systolic blood pressure (SBP) of less than 140 mmHg with a diastolic blood pressure (DBP) of less than 90 mmHg, and **C** is having cholesterol levels (defined as low-density-lipids or LDL) of less than

100 mg/dL (Colasanti et al., 2018). For PLWH, this continuum can be used in conjunction with the above-outlined HIV care continuum to ensure patients are achieving their best possible health.

Quality and Process Improvement

Quality and process improvement methods are key to any operation, including health care. In health care, process improvement methods are aimed at improving the flow of patients, appointment schedules, time in waiting rooms, efficient charting etc. Quality improvement methods in health care focus on improving actual patient outcomes such as improving mortality rates in hospitals due to coinfections. Examples of the quality improvement measures that are assessed for HIV outcomes are the number of PLWH who are on treatment out of the total number of PLWH at the clinic considered in care, and the number of PLWH who are virally suppressed out of the total number of PLWH considered in care. In contrast process improvement measures that can be assessed are the number of PLWH at the clinic who are considered in care, the percentage of patients who have viral loads, A1C levels, etc. Quality improvement measures for DM could include how many of the clinic's PLWH patients considered in care have achieved the proper levels of ABC control.

There are various methodologies and management techniques involved in quality improvement, but methods that have been largely integrated and adapted into health care settings are Lean and Six Sigma. Both methods have been adopted from the manufacturing sector. Six Sigma and Lean have the same end goal in sight, which is to create more efficient systems and improve quality of these systems, however the methods use different ideologies to achieve this outcome (Schweikhart & Dembe, 2009). Six Sigma's main focus is to create uniform processes with less variations, or defects, through statistical methods. Six Sigma uses the DMAIC

improvement model, **D**efine the problem, **M**easure defects, **A**nalyze conditions under which defects occur, **I**mprove by testing changes to reduce defects, and **C**ontrol results, to determine how to maintain improved outcomes. Lean focuses on reducing waste that does not add value to the product for the customer. Steps for Lean are to specify value via the customer, identify the value stream of the product, make product flow continuously, and manage toward perfection (Boaden, Harvey, Hannibal, & Proudlove, 2008). These methodologies which were largely introduced for factory production systems, but their value to the health care industry is indisputable. These methods have been adapted to fit a person-centered industry such as health care.

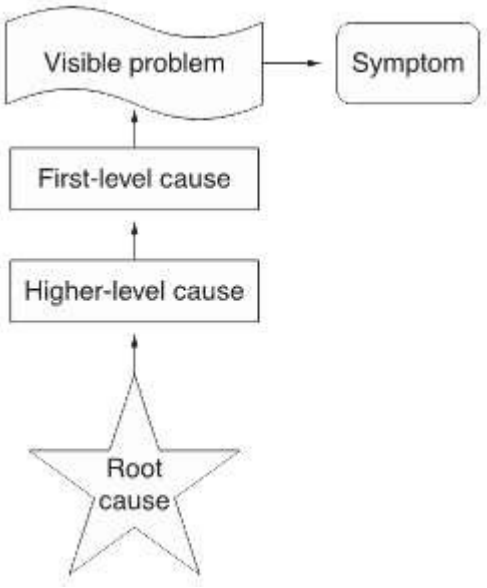


Figure 1. Root Cause Analysis Diagram. Source: ASQ.org

Root Cause Analysis (RCA) is another useful method for quality improvement. RCA aims to identify why an event, an incident that is unwanted or has adverse consequences, occurred to prevent the event from happening again. According to Rooney and Heuvel (2004), root causes are defined as: "1. Specific underlying causes, 2. Those that can be reasonably identified, 3. Those that management has control to fix, and 4. Those for which effective recommendations for preventing recurrences can be generated"(J. Rooney, 2004). There are four major steps to the root cause analysis process which are, data collection, causal factor charting, root cause identification and generating recommendations and implementation (J. Rooney, 2004). The process is used to take the blame for error off individual behavior and hold the systems and processes accountable for adverse individual behaviors. This

is achieved by looking at the event in question and asking why such an event occurred down until the root cause of the event is uncovered. RCA works best when done as a group investigation into an adverse event that has occurred (Pederson M.D., 2014). Figure 1 shows how looking at the causes of a 'symptom' or adverse event and asking why at different levels can help users of RCA identify root causes that need to be removed or improved on.

Fishbone diagrams, or Ishikawa Diagrams, are a tool that can be used for cause analysis. Its purpose is to identify many possible causes for a problem or situation without focusing heavily on the solution to the problem. The diagram has the problem statement situated on one end as the "head" of this fish. Then from there branches shoot off for each category of causes for the problem, i.e. people, materials, environment. Then by asking "why?" about the major causes, sub-causes are created. The resulting diagram resembles the skeleton of a fish, as shown in Figure 2, hence the name "Fishbone Diagram" ("Fishbone (Ishikawa) Diagram,").

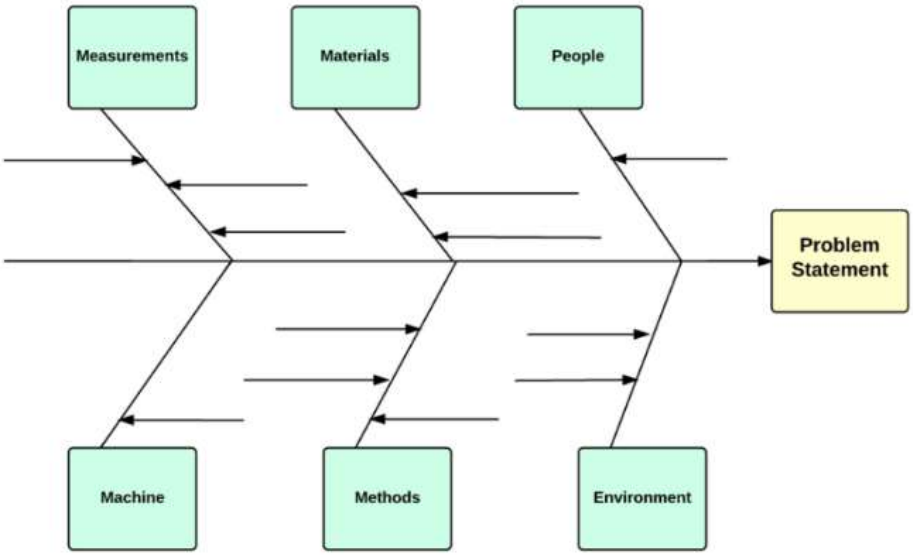


Figure 2. Fishbone Diagram. Source: lucidchart.com

The Institute for Healthcare Improvement (IHI) has adapted the Six Sigma and Lean methodologies into IHI Quality Improvement (QI) with W. Edward Deming as the main contributor. The goal of IHI QI is to "formulate and codify generalizable knowledge that, when applied in other systems, can yield predictable improvements"(Marshall, Pronovost, & Dixon-Woods, 2013). A key element that makes IHI QI so useful in healthcare is the use of content experts, who work in the system and are familiar with its processes and outcomes, and subject matter experts. Changes are proposed through the expertise and input of content and subject matter experts and are tested through the Plan-Do-Study-Act (PDSA) cycle (Scoville R., 2014).

The Plan-Do-Study-Act (PDSA) cycle provides an iterative process for changes in the system to take place and be amended. The PDSA cycle starts with establishing aims, how to measure those aims and what changes can be tested to work towards those aims. PDSA is used to test those changes that were put forth with a small unit of change in order to improve systems without having to overhaul an entire system only to find out the change was ineffective. The Plan phase needs to be adjusted according to past outcomes and outcomes of their own PDSA cycles. Clinics can research the literature to see interventions used to improve similar clinic outcomes or develop solutions of their own. Interventions borrowed from other clinics need to be adapted and operationalized to fit the local context, personnel, patients and environment. Past solutions and the knowledge of clinic operations from providers and supporting staff combine to create initial changes in the PDSA cycle. After the first iteration of the Do Phase, the Study phase will allow the clinical team to see if any changes were found from the small change made in the first cycle. Clinics can then Act according to the previous cycle outcomes based on findings in the Study phase. Clinics should ask the question 'Was the intended objective met by making the change in the first PDSA?' If not, then a different approach should be used in the

next PDSA cycle. If a change was seen, the same intervention can be used and tweaked to create greater change on a larger scale (Boaden et al., 2008; Gerald J. Langley, 2009; Improvement, 2019; Scoville R., 2014). A PDSA worksheet put together by the Institute for Healthcare Improvement can be found in Appendix A.

Methods

HIV Continuum of Care

The data used for both the HIV and Diabetes analyses were gathered by IDP data experts. Data were obtained from the Emory CFAR HIV Disease Registry which has IRB approval to extract data from the electronic health record to perform quality assurance and process improvement assessments of the clinic. Data were extracted for the period beginning March 19, 2010 and ending May 14, 2018. However, the period of interest for this assessment began January 1, 2013 and ended December 31, 2017. The data sets were then mapped, cleaned and analyzed by a Master of Public Health candidate and prepared for the Grady IDP. The stages for the HIV care continuum are defined using the HIV/AIDS Bureau's Performance Measures that guide the Ryan White and Global HIV/AIDS Programs and IDP operations. While there are numerous stages in the spectrum of care put forth by Gardener et al. (2011), this report will focus on three critical stages of the continuum of care: retention in care, receipt of ART, and virologic suppression. Throughout the methods section various data sets will be mentioned; they are listed below for reference.

- Demographic Data Set – cleaned data set of unique IDP patients who interacted with IDP at some point between March 19, 2010 and May 14, 2018

- Lab Visit Data Set – all HIV, DM and STI labs ordered on IDP patients between March 19, 2010 to May 14, 2018
- Prescription Data Set –all prescriptions ordered for IDP patients between March 19, 2010 to May 14, 2018
- Blood Pressure Data Set – all blood pressure measures taken on IDP patients March 19, 2010 to May 14, 2018
- Alive and In Care Data Sets (AIC)– all observations considered retained in care for each year of interest
- Alive and On Treatment Data Sets (AOT) – all observations considered on treatment for each year of interest
- Alive and Virally Suppressed (AVS) – all observations considered virally suppressed for each year of interest

The global goals for HIV control at all stages of the HIV care continuum are 90-90-90 ("90-90-90: Treatment for All," 2019). 90-90-90 refers to 90% of those PLWH will know their status, 90% of those who know their status will be on ART and 90% of those who are on ART will be virologically suppressed. This assessment replaced the first goal with whether or not patients who were living were retained in care by the Ryan White standards.

The HIV care continuum analysis had three main aims:

Aim 1: *Find those who were alive in care each year from 2013-2017* – defined as those patients who had an HIV, DM, or STI lab visit at IDP in both the first six months and last six months of the year of interest

Aim 2: *Find those who were on treatment each year from 2013 -2017* – defined as those patients who were prescribed ART to the IDP pharmacy at any time in the year of interest

Aim 3: *Find those who were virally suppressed each year from 2013-2017* – defined as those patients who had any viral load lab in the year of interest with less that log 2.0 copies/mL

SAS software version 9 (SAS Institute, Cary, NC) was used to restrict and clean the demographic data set. Patients were excluded if their status variable was set as 'deceased' or they had a death date at the time of the data pull in June 2018. There were 12 patients who were excluded because they died after the period of interest, post 2017, and did not have any labs in the years of interest. Patients over the age of one hundred were considered deceased as IDP staff did not know of any patients over one hundred years of age. Three patients over the age of ninety were considered deceased because they had no visits in the time period of interest and were outliers. Two patients over the age of ninety were kept in the demographic data set because they had visits during the time of interest. If ethnicity was missing in the original data, ethnicity was set to unknown. This resulted in 11,853 total unique, alive patients at IDP from March 19, 2010 to May 14, 2018. This base demographic data set was used and merged to subsequent HIV care continuum and metabolic lab data sets.

For the first phase of the HIV care continuum, Aim 1, lab dates for any HIV, DM or STI lab (VL, A1C, HCV, etc.) during each patient's visits at IDP were used to determine if patients from the demographic data set would be considered in care. For the purposes of comparing on a year to year basis the criteria to meet was having a lab visit in both six-month periods of a year. The number of interest was that of unique patients who had a visit in each six-month period. SAS software was used to merge the demographic data set and the lab visit data set. SAS was

then used to create two indicator variables, each representing whether an observation (i.e. patient visit) occurred in the first or second six-month period, respectively. The data sets were exported from SAS software as .dta files for further cleaning and management in STATA version 15 (StataCorp, College Station, TX). STATA software was used to collapse the observations using the maximum of the visit one and visit two variables by person key (a unique patient identifier), as many patients had more than one visit during each period. This gave the unique number of patients in care per year. A new variable called "In care" was created to identify those patients with a visit in both the first six months and the second six months of the year. These patients were considered retained in care and were found by using the count command in STATA software. This was done for each year from 2013 to 2017 and fulfilled Aim 1.

Next, Aim 2 was addressed by merging the demographic data set and the prescription data set by person key in SAS software. Prescription data from IDP were used as there was no way to capture prescription pick-up data from pharmacies outside of the clinic, which a large portion of patients use. If a patient was prescribed ART once during a year they were considered on treatment. SAS software was used to restrict the data by year using the variable "ordering date", which represents the date the prescription was ordered. The unique year data sets were then exported from SAS software as a .dta file for use in STATA software. In STATA software, a one-to-many merge of the AIC to the AOT data sets created the in the combined AIC/AOT data sets. Duplicate person keys were dropped to get the unique number of patients considered on ART without the in care restrictions. Patients were then dropped if they were not considered in care to find the number of patients who were a subset of those in care.

Lastly, Aim 3 was addressed by merging the demographic data set and the lab data set by person key in SAS software. The variable "HIV log 10 copies/mL" was used. If the patient had

a viral load test of less than 2.0 log copies/mL at any point in time during the year of interest they were considered virally suppressed. SAS software was used to restrict the data by year using the variable "lab date". Each year-specific data set was then exported from SAS software as a .dta file for use in STATA software. In STATA software, a one-to-many merge of the AIC/AOT merged data sets to the AVS data sets was done to create the full continuum data set. Duplicates of person keys were dropped to get the unique number of patients considered virologically suppressed without the in care and on ART restrictions. Patients were then kept in the data set if they met the in care and on ART variables from the previous data set to find the number of patients who were a subset of those on treatment. These processes gives us the number of patients at IDP complying to the stage of interest out of the number of patients at IDP complying to the preceding HIV continuum stage, as well as the number of patients complying to each stage out of the total number of IDP patients per year.

Metabolic Indicators

The original data pull did not include blood pressure measurements for the observations. To obtain these measurements, an additional data pull was performed to obtain a data set without the common identifier of person key to merge on. To accommodate this limitation, the blood pressure data set was merged to the demographics data set using the unique medical record number identifier. This was done using STATA software's function of a many-to-one merge of the blood pressure data set to the demographic data set. All data steps in the metabolic indicators (MI) methods were completed in STATA software.

The metabolic indicators analysis had three main aims:

Aim 1: *Find those who were HbA1C compliant each year from 2013-2017* – compliance is defined as having any HbA1C lab in the year of interest that was less than 7%

Aim 2: *Find those who were blood pressure compliant each year from 2013 -2017* – compliance is defined as having any blood pressure measurement of less than 140/90 during the year of interest

Aim 3: *Find those who were LDL cholesterol compliant each year from 2013-2017* – compliance is defined as having any LDL lab in the year of interest that was less than 100 mg/dL

The Hemoglobin A1C and Cholesterol data observations required some cleaning before being able to ascertain the numbers of interest. First the lab visit data set was merged to the demographics data set using a many-to-one merge in STATA software. Dates were then restricted to those of interest, which again were January 1, 2013 through December 31, 2017. Labs that were not of interest were dropped so that the resulting data set only included 'Cholesterol, LDL-calculated' and 'HGB A1C %'. There were a few A1C results that included qualifiers such as ">" or "<". These data points were changed to a value considered right outside of the detection limit of the HbA1C assay, which was found to be 4-16% in the literature (Liu et al., 2008). Numbers below the limit of detection were set at 3% and those above were set at 17%. The same had to be done for the cholesterol results, where the range from the literature was found to be 5-300 mg/dL ("EnzyChrom™ HDL and LDL/VLDL Assay Kit ", 2019). The various observations with a negative value or others below the limit of detection were set at 4 mg/dL, and those above the limit of detection were set at 301 mg/dL.

Aims 1 and 3 were achieved by parsing out data by year through a restriction of the lab date to the year of interest. To find the unique number of patients, duplicates were dropped using the unique identifier, person key. A new variable was created, "A", to define A1C control. A was set to 1 if the result fell under the threshold for control (7%) and set as zero for anything above the threshold. Another new variable, "C", was created to define cholesterol control. "C" was set to 1 if the result fell under the threshold for control (100 mg/dL) and zero for anything above the threshold.

The blood pressure (BP) data was found by year through restriction of "contact date" to the year of interest. Duplicates were dropped by person key to find the unique number of individuals with a blood pressure measure. Two new variables were created, one for systolic BP and one for diastolic BP, to ensure that each fell under the threshold for control (140 for systolic and 90 for diastolic). A new variable was created for overall BP control (less than 140/90) and those complying to both systolic and diastolic measures were marked as 1 and those not complying to either were marked as 0, fulfilling Aim 2.

A1C, BP, LDL data were then merged together using the unique identifier, person key, in a 1:1 merge in STATA software. Counts were then found for total unique patients with metabolic labs done. Then counts were done by indicator to find the number of patients who complied to each indicator separately. Lastly, the data set with all metabolic indicators merged together was merged with the AIC one-year data set to find the number of patients who complied to the metabolic indicators and were considered in care within the HIV care continuum.

Results

Demographics

Table 1. Demographics of the demographic data set used for this assessment. One observation had an unknown gender, race, and ethnicity and was not included in this table. The population was largely male (73%) and black/African-American (82.4%). The majority of the population was not Hispanic/Latino (94). The average age was 46.3 years (13) and women were slightly older than males (48 years vs. 45.7).

	Male	***Female***	***Overall***
Gender - n (%)	8,656 (73)	3,196 (27)	11,852 (100)
Age - mean (STD)	45.7 (12.8)	48 (13.2)	46.3 (13)
Race - n (%)			
Black/African-American	6,957 (80.4)	2813 (88)	9,770 (82.4)
White	1,104 (12.8)	162 (5.1)	1,266 (10.7)
Other	524 (6.1)	199 (6.2)	723 (6.1)
Unknown	71 (0.6)	22 (0.7)	93 (0.8)
Ethnicity - n (%)			
Not Hispanic/Latino	8,142 (94.1)	3,001 (93.9)	11,143 (94)
Hispanic/Latino	362 (4.2)	125 (3.9)	487 (4.1)
Unknown	152 (1.8)	70 (2.2)	222 (1.9)

HIV Continuum of Care

Figure 3 shows us the percentage of patients complying to each stage of the HIV care continuum out of the total number of patients complying to the previous continuum stage for each year with a

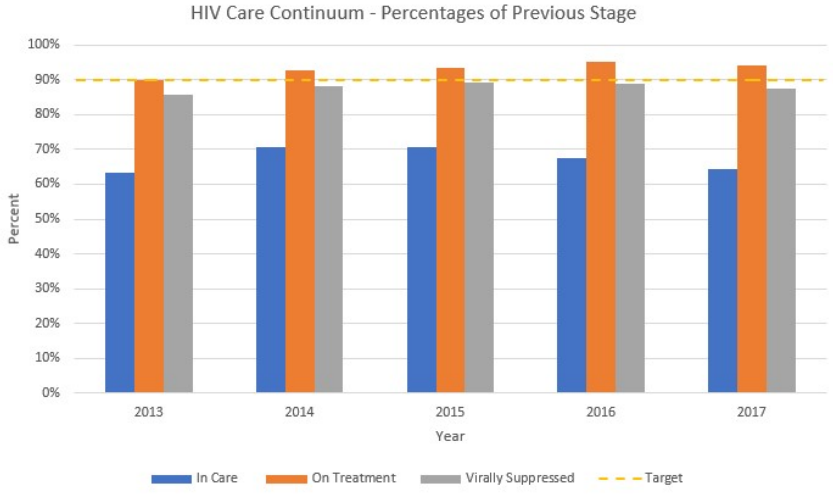


Figure 3. Percentage of patients who are complying to each stage of the continuum of care. Patients considered on ART are a subset of patients in care. Patients who are virologically suppressed are a subset of those on ART.

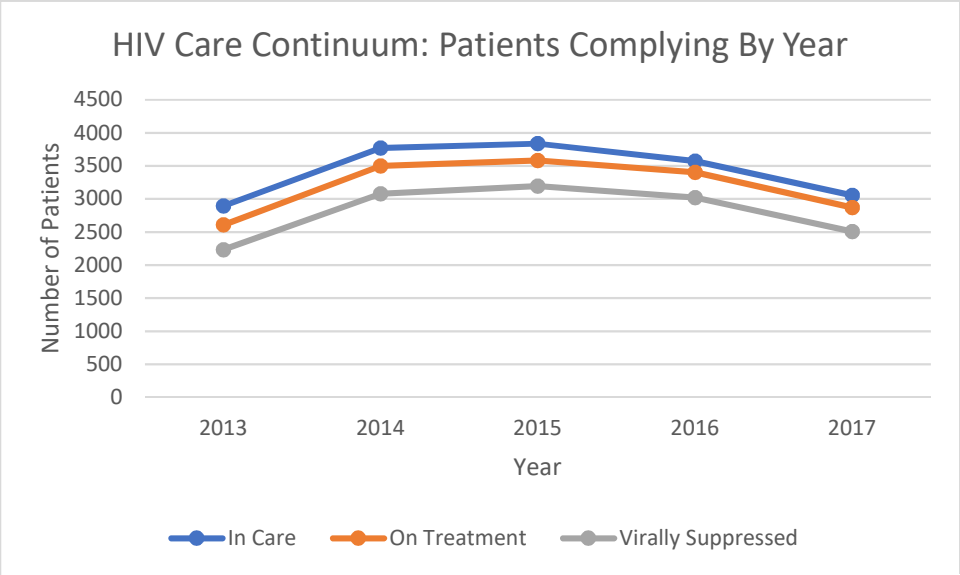


Figure 4. Trend overtime of the number of patients complying to each stage of the continuum of care. Patients considered on ART are a subset of patients in care. Patients who are virologically suppressed are a subset of those on ART.

target line at ninety percent to represent the 90-90-90 goals. This tells us that for the years 2013-2017, those patients who were alive and considered in care fell roughly between sixty and seventy percent. Figure 3 also shows that all years had a roughly ninety percent and above compliance for those who are in care and on ART. Lastly, Figure 3 shows us that between eighty and ninety percent of patients considered in care and on ART are virologically suppressed. Figure 4 shows us the trend of the number of patients complying with each stage of the continuum which are subsets of the preceding care continuum stage. This appears to show an increasing trend from 2013 to 2014, but subsequent years level off and begin to decrease.

Figure 5 shows us the total number of IDP patients complying to each phase of the HIV continuum per year out of the total number of clinic patients per year, with a target line at ninety percent to represent the 90-90-90 goals. In care numbers for all five years hover between sixty and seventy percent, the same as those in Figure 3. The percentages of those on ART (ordered at IDP pharmacy), across the clinic as a whole, not just of those who are considered in care by Ryan White standards, are lower, falling between fifty-five and sixty-five percent. Lastly the proportion of patients considered virologically suppressed across all clinic patients is lower as well, between fifty and sixty percent.

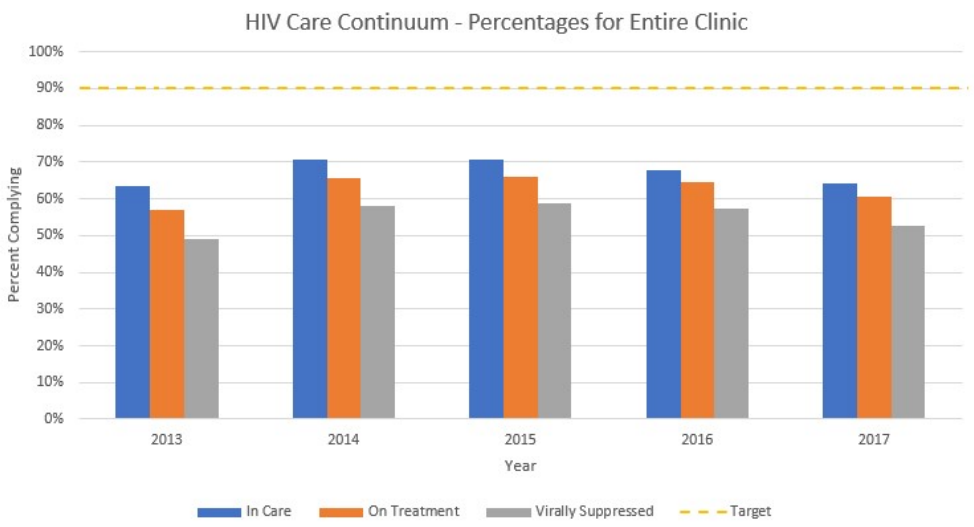


Figure 5. Percentage of patients considered complying to each stage of the HIV Continuum of Care at IDP Clinic. Percentages are unique and are not subsets of previous continuum stages.

Figure 6 depicts the number of patients who met the criteria of this assessment for each stage of the HIV care continuum for the percentages displayed in Figure 3. The first bar in each year is the number of total clinic patients who had a visit in the year of interest. The numbers for this graph are found in column one of Table 1.

Table 2. Number of patients complying to each stage of the HIV Care Continuum as well as total number of patients at each stage without restrictions and with previous stage restrictions. Guidelines used for those in care are patients with one visit in each 6-month period of a year, those on treatment are those

with a prescription for ARTs in each year, and those virally suppressed are those with a viral load of less than 200 copies/mL of blood.

Year – HIV Continuum Stage	Total Number of Patients In Clinic With a Visit in Year of Interest	Number of Complying Patients for Each Stage and Year	Number of Complying Patients – In Preceding Stage
2013 – In Care	4564	2895	-
2014 – In Care	5325	3770	-
2015 – In Care	5430	3836	-
2016 – In Care	5281	3572	-
2017 – In Care	4754	3053	-
2013 – On Treatment	4564	2607	2895
2014 – On Treatment	5325	3499	3770
2015 – On Treatment	5430	3583	3836
2016 – On Treatment	5281	3403	3572
2017 – On Treatment	4754	2872	3053
2013 – Virally Suppressed	4564	2234	2607
2014 – Virally Suppressed	5325	3081	3499
2015 – Virally Suppressed	5430	3193	3583
2016 – Virally Suppressed	5281	3023	3403
2017 – Virally Suppressed	4754	2509	2872

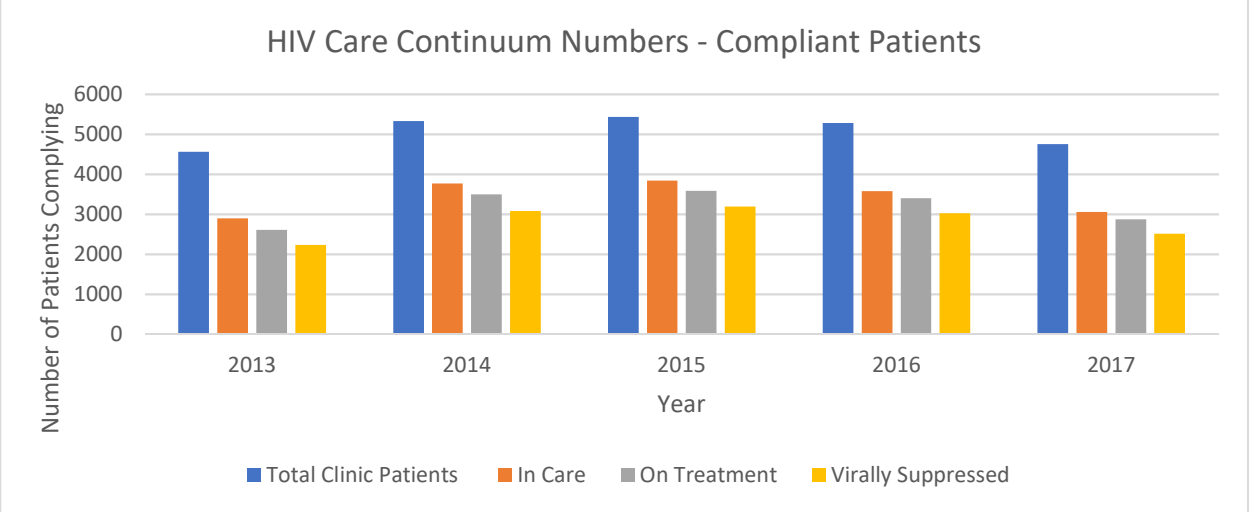


Figure 6. Number of patients who are complying to each stage of the continuum of care by year from 2013-2017. Patients considered on ART are a subset of patients in care. Patients who are virologically suppressed are a subset of those on ART.

Metabolic Indicators

Figure 7 shows us the proportion of patients who are complying to the metabolic guidelines of those patients who are considered in care from the first stage of the HIV Continuum of Care (Table 1). A1C control shows the greatest compliance with the percentage of patients around eighty percent for each year. Cholesterol levels, control measured using Low Density Lipids (LDL) shows less compliance hovering between fifty and fifty-five percent. Lastly, blood pressure shows similar, but slightly higher control than cholesterol with the percentage of compliance ranging from fifty to sixty percent.

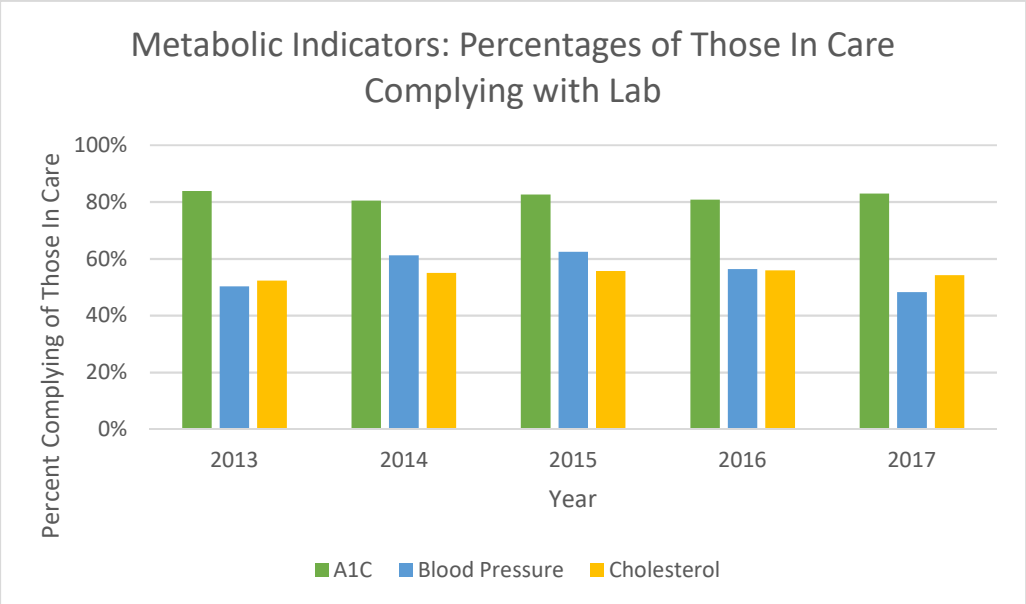


Figure 7. Percentage of patients who comply to metabolic indicator guidelines and are also considered in care from the HIV care continuum (number of complying patients for in care from Table 1) out of the number of patients considered in care who had the lab of interest.

Figure 8 shows similar trends in the three metabolic labs. These percentages are out of the total number of patients who had the specific metabolic labs done (Table 2).

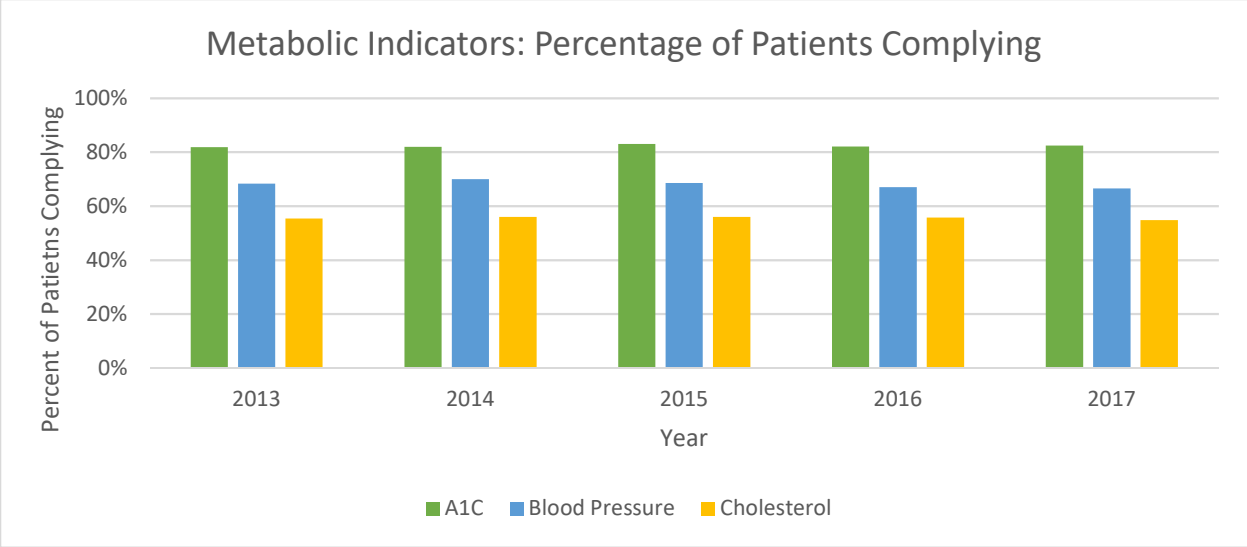


Figure 8. Percentage of patients who are compliant to metabolic indicator guidelines out of those IDP patients who had the metabolic lab tests done. Guidelines are that A1C is less than 7%, Blood Pressure is less than 140/90 and cholesterol (LDL) is less than100 mg/dL.

Table 3. Number of patients at IDP complying to metabolic indicator guidelines, complying to metabolic indicator guidelines and considered in care by HIV Care Continuum, as well as total number of patients with metabolic labs and total number of patients considered in care from HIV Care Continuum without regard to metabolic labs. Guidelines for metabolic indicators are that A1C is less than 7%, Blood Pressure is less than 140/90 and cholesterol (LDL) is less than 100 100mg/dL.

Year - Lab	Total Number Patients In Care	Total Number Patients With Labs	Number of Complying Patients	Number of Complying Patients-In Care
2013 – A1C	2895	653	534	307
2014 – A1C	3770	888	728	458
2015 – A1C	3836	954	792	500
2016 – A1C	3572	1080	887	537
2017 – A1C	3053	1108	913	510
2013 – BP	2895	4822	1547	1813
2014 – BP	3770	5011	3508	2387
2015 – BP	3836	5109	3501	2447
2016 – BP	3572	5333	3572	5905
2017 – BP	3053	5374	3573	5878
2013 – LDL	2895	2462	1364	650

2014 – LDL	3770	3250	1820	1090
2015 – LDL	3836	3095	1732	1133
2016 – LDL	3572	2776	1546	973
2017 – LDL	3053	2499	1368	729

Discussion

HIV Continuum of Care

Grady IDP seems to thrive in keeping those patients who are considered in care, on ART, and virologically suppressed. While the in care metric is not one of the main indicators for the standard 90-90-90 control, the lower percentages here highlight room for improvement when it comes to retaining patients in care, which is a consistent challenge of HIV care across the nation (U.S. Department of Health and Human Services, 2014). In 2015 the CDC found that roughly 57% of PLWH were retained in care; and other studies suggest that up to 50% of PLWH are not retained in care over longer periods (Colasanti et al., 2016; *Selected National HIV Prevention and Care Outcomes in the United States*, 2018). IDP trends for the years 2013-2016 range from sixty to seventy percent of patients being retained in care by the criteria of this assessment, which is slightly higher than these estimates.

Despite the large percentage of patients who are virologically suppressed, there is still room for improvement in these patients. Even if just looking at the cross-sectional yearly data presented there would ideally be higher virologic suppression with strict compliance to ART regimens. While percentages are high for virologic suppression of patients who are also considered in care and on treatment, they are from a cross sectional analysis. Per Colasanti et al. (2016), cross sectional snap shots of yearly data for retention and virologic suppression do not

accurately capture attrition over time. Thus, these high percentages for suppression may overestimate the HIV care continuum compliance at IDP (Colasanti et al., 2016).

Metabolic Indicators

Given the numbers from this assessment, there appears to be high compliance for all IDP patients with A1C guidelines, with an average compliance of about 82% in IDP patients and blood pressure guidelines (~68%). There is mid-range compliance to LDL (~56%) guidelines. It is hard to know if this is an accurate representation of metabolic compliance at IDP due to the lack of tests being ordered each year. Tests should be done for all IDP patients regardless of DM status, but for A1C and LDL labs the total number of patients with the labs fall well below the total number of patients seen at IDP, which is roughly 5,800 (Colasanti, Stahl, Farber, Del Rio, & Armstrong, 2017). Looking at this analysis, less than a fifth of IDP patients are having A1C labs done and only about half of patients are having LDL labs done. Most patients have blood pressure taken, but even for a basic measure taken at every doctor's visit there is room for improvement.

Limitations

This assessment was cross-sectional and does not follow a cohort over time. Due to the cross-sectional nature of the assessment, we cannot conclude whether or not the same patients are being retained in care over time, an analysis which could provide a very different outcome (Colasanti et al., 2016). A cross-sectional assessment also does not lend itself to accounting for "churn" or PLWH who cycle in and out of care which is common in HIV care (Colasanti et al., 2017). This assessment will only allow us to draw conclusions about overall clinic performance and quality metrics. There is also the limitation of the prescription data used for this analysis.

The prescription data available were those prescriptions that are ordered to the IDP pharmacy, thus the on treatment number could be an underestimation of actual patients considered on treatment.

Given the volume of observations for each patient at IDP several limitations arose in this assessment. It was unfeasible in the time frame allotted to ensure that for each patient two visits within each year were more than sixty days apart as required to fit the definition of the Ryan White in care indicator. Thus, the number of those in care could be less than the numbers presented in the results section. The Ryan White definition for in care also included a twenty-four-month period, not twelve-month, but for ease of comparing across each year the twelve-month time frame was used in its place. Twenty-four-month period in care numbers were obtained and can be used for future projects with this data set. Again, given the large amount of observations in this data set and the complexity of overlapping dates, the in care numbers were only found based on lab visits at IDP. Lab visits were chosen because most patients have labs done regularly to measure CD4 counts, viral loads, as well as various metabolic labs. Despite the wide breadth of visits captured under the labs data set, this could over or underestimate the number of patients considered in care. Providers at IDP stated that many patients do not get labs done at IDP, thus these labs would not be captured in IDP's electronic medical records (EMR) and those in care may be underestimated. It was also found that patients often come into IDP for labs, but do not necessarily receive any care, which would overestimate the number of patients in care.

Though control of DM is defined as control of the ABCs, HbA1C, blood pressure and LDL, there is some literature that suggest HbA1C is not the most accurate way to screen for DM in PLWH. Studies have found that "HbA1C underestimated the level of glycemia" which means

that this screening could underestimate the number of patients at IDP who have DM as a co-morbidity (Eckhardt, Holzman, Kwan, Baghdadi, & Aberg, 2012).

Lastly, the indicators for measuring viral load (VL) in PLWH has not been standardized across the health care field, making an accurate measurement for viral suppression the PLWH population hard to capture (Xia, Wiewel, Braunstein, Kersanske, & Torian, 2015). This analysis utilized a liberal indicator, of patients having any VL lab less than 2.0 log copies/mL during the year of interest as virally suppressed, thus the viral suppression numbers might be overestimated. This measure was used as a proxy indicator for the Ryan White viral load suppression indicator which states that the last viral load taken should be less than 200 copies/mL (HRSA, 2017) because of the complexity of the data set. Time did not allow for computing the last visit in each year of interest for all patients. However, this indicator might overestimates virologic suppression just as the Ryan White indicator might and a similar picture is portrayed. There are various different indicators that can be used to measure virologic suppression, the most accurate indicators suggested are those that measure sustained virologic suppression, or those indicators that account for sustained time suppressed (Xia et al., 2015).

Recommendations

HIV Continuum of Care

The barriers to keeping PLWH in care are overwhelming which is why retaining patients in care is an endless battle. There are various individual and systemic level barriers that contribute to the lack of retention in care and the all too common pattern of falling in and out of care. PLWH are often the most vulnerable and poorest populations which often results in "chaotic" or unstable income and housing, and then is compounded by various other individual

level factors such as substance abuse and social support, all of which have been shown to affect retention in care at IDP (Bulsara, Wainberg, & Newton-John, 2018; Colasanti et al., 2017). In other infectious disease clinic settings, negative perceptions regarding patient-provider relationships and overall clinic environment also adversely affected retention in care (Wessinger et al., 2017). Systemic barriers center more around transportation, out of pocket costs, scheduling issues can lend themselves to poor retention in care (Colasanti et al., 2017; Wessinger et al., 2017). The preceding barriers to retention in care are in no way exhaustive but start to break down why this stage in the HIV care continuum is so difficult to control.

Some issues, such as individual stability seem impossible to tackle from a provider standpoint, so care interventions must focus on improving the more attainable variables such as social support, drug abuse treatment, etc. Some studies suggest "predicting" patients who show signs of falling out of care at first encounter, using factors mentioned above, so that the limited resources necessary for resource intense outreach care can be more targeted (Colasanti et al., 2017). Considering social support is a factor in retention in care, creating a community among PLWH could help retain patients in care. Though there are a lack of resources and funding for intensive outreach HIV care having, support groups where retained patients are partnered with those who present as the typical patient falling out of care could create a sense of social and emotional support, a predictor of retention (Bulsara et al., 2018; Hall et al., 2017).

Diabetes Mellitus

To gain a more accurate picture of the metabolic quality metrics, process metrics need to become more standardized for all patient visits. The need for comprehensive care is crucial when it comes to working with patients who have chronic conditions, especially co-morbid chronic conditions, as is the case of patients with HIV and DM. Routine screening for DM is

recommended for patients with HIV (Monroe, Glesby, & Brown, 2015). Leaning in to a more comprehensive screening and care patterns for all patients, not just those who have DM or show signs of pre-diabetes, could prove beneficial to preventing and treating PLWH. However, it has been found that systemic barriers to care such as insurance status, that are persistent in HIV care, also persist in DM care and control, which can be another hurdle for metabolic ABC control (Zhang et al., 2012).

Improving quality metrics for the metabolic indicators is less researched, especially for PLWH where even the screening process yields reduced sensitivity and specificity for PLWH (Galaviz et al., 2018). Studies of the general population showed greater ABC control was usually in the "context of significant medication intensification"(Mehta, Goldfine, Abrahamson, McMullen, & Laffel, 2016), which could prove helpful for patients at IDP if not already being implemented. Diet coupled with physical activity has been shown to reduce progression of diabetes for patients who are pre-diabetic (Haw et al., 2017), and has also been proven to reduce LDL, BP, and A1C significantly in patients with DM (Monroe et al., 2015). Diet and physical activity regimens should be individualized and aim to maintain a five percent or larger weight loss in order to achieve desired effect on diabetes outcomes ("Standards of Medical Care in Diabetes—2019 Abridged for Primary Care Providers," 2019). Given the overwhelming evidence for behavior change's effect on DM, encouraging overall well-being in visits, despite the main focus on HIV care, can have an effect on preventing and treating DM as a co-morbidity (Monroe et al., 2015).

Appendix A

QI Essentials Toolkit:

PDSA Worksheet

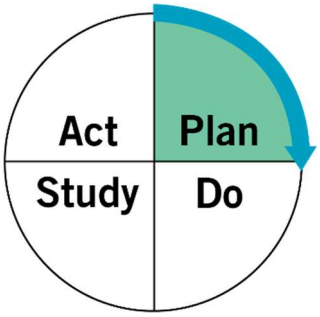
The Plan-Do-Study-Act (PDSA) cycle is a useful tool for documenting a test of change. Running a PDSA cycle is another way of saying testing a change — you develop a plan to test the change (Plan), carry out the test (Do), observe, analyze, and learn from the test (Study), and determine what modifications, if any, to make for the next cycle (Act).

Fill out one PDSA worksheet for each change you test. In most improvement projects, teams will test several different changes, and each change may go through several PDSA cycles as you continue to learn. Keep a file (either electronic or hard copy) of all PDSA cycles for all the changes your team tests.

IHI's QI Essentials Toolkit includes the tools and templates you need to launch and manage a successful improvement project. Each of the nine tools in the toolkit includes a short description, instructions, an example, and a blank template. NOTE: Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

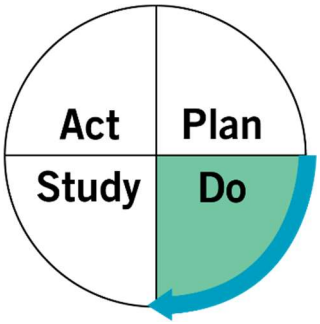
- Cause and Effect Diagram
- Driver Diagram
- Failure Modes and Effects Analysis (FMEA)
- Flowchart
- Histogram
- Pareto Chart
- Project Planning Form
- Run Chart & Control Chart
- Scatter Diagram
- **PDSA Worksheet**

Instructions



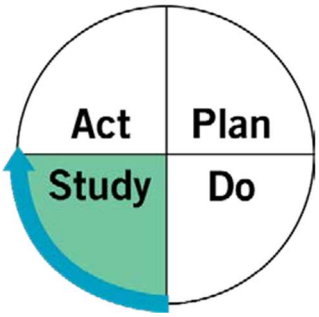
Plan: Plan the test, including a plan for collecting data.

- State the question you want to answer and make a prediction about what you think will happen.
- Develop a plan to test the change. (Who? What? When? Where?)
- Identify what data you will need to collect.



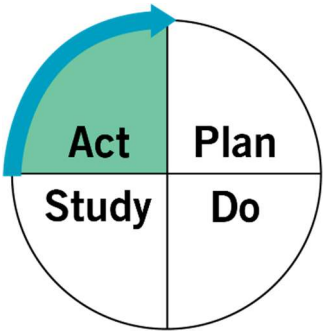
Do: Run the test on a small scale.

- Carry out the test.
- Document problems and unexpected observations.
- Collect and begin to analyze the data.



Study: Analyze the results and compare them to your predictions.

- Complete, as a team, if possible, your analysis of the data.
- Compare the data to your prediction.
- Summarize and reflect on what you learned.



Act: Based on what you learned from the test, make a plan for your next step.

- Adapt (make modifications and run another test), adopt (test the change on a larger scale), or abandon (don't do another test on this change idea).
- Prepare a plan for the next PDSA.

Example: PDSA Worksheet

Objective: Test using Teach-Back (a closed-loop communication model, in which the recipient of information repeats the information back to the speaker) with a small group of patients, in hopes of improving patients' understanding of their care plans.

1. Plan: Plan the test, including a plan for collecting data.

Questions and predictions:

- How much more time will it take to use Teach-Back with patients? It will take more time at first (5 to 10 minutes per patient), but we will start to learn better communication skills and get more efficient.
- Will it be worthwhile? The extra time will feel worthwhile (and possibly prevent future rework).
- What will we do if the act of "teaching back" reveals a patient didn't understand the care plan? If a patient is not able to explain his or her care plan, we will need to explain it again, perhaps in a different way.

Who, what, where, when:

On Monday, each resident will test using Teach-Back with the last patient of the day.

Plan for collecting data:

Each resident will write a brief paragraph about their experience using Teach-Back with the last patient.

2. Do: Run the test on a small scale.

Describe what happened. What data did you collect? What observations did you make?

Three residents attempted Teach-Back at the end of the day on Monday. Two residents did not find anything they needed to ask patients to Teach-Back. Jane found that her patient did not understand the medication schedule for her child. They were able to review it again and, at the end, Jane was confident the mother was going to be able to give the medication as indicated.

3. Study: Analyze the results and compare them to your predictions.

Summarize and reflect on what you learned:

- Prediction: It will take more time at first (5 to 10 minutes per patient), but we will start to learn better communication skills and get more efficient. *Result: Using Teach-Back took about 5 minutes per patient.*
- Prediction: The extra time will feel worthwhile (and possibly prevent future rework). *Result: Jane felt the time she invested in using Teach-Back significantly improved the care experience.*
- Prediction: If a patient is not able to explain his or her care plan, we will need to explain it again, perhaps in a different way. *Result: After a second review of the medication orders, the patient was able to Teach-Back the instructions successfully.*

In addition to the team confirming all three predictions, Jane realized the medication information sheets she had been handing out to parents weren't as clear as she thought. She realized these should be re-written — maybe with the input of some parents.

4. Act: Based on what you learned from the test, make a plan for your next step.

Determine what modifications you should make — adapt, adopt, or abandon:

Jane is planning to use Teach-Back any time she prescribes medication. Although it may take more time, she now understands the importance. The other residents are going to work on using Teach-Back specifically for medications for the next week.

They would like to pull together a team to work on some of the medication information sheets with parent input, but they are first going to gather more information through more interactions in the coming days.

Before filling out the template, first save the file on your computer. Then open and use that version of the tool. Otherwise, your changes will not be saved.

Template: PDSA Worksheet

Objective:

_____

_____

_____

1. Plan: Plan the test, including a plan for collecting data.

Questions and predictions:

_____

_____

_____

_____

_____

Who, what, where, when:

_____

_____

_____

Plan for collecting data:

_____

_____

_____

2. Do: Run the test on a small scale.

Describe what happened. What data did you collect? What observations did you make?

_____

_____

_____

3. Study: Analyze the results and compare them to your predictions.

Summarize and reflect on what you learned:

_____

_____

_____

4. Act: Based on what you learned from the test, make a plan for your next step.

Determine what modifications you should make — adapt, adopt, or abandon:

_____

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_____

Bibliography

90-90-90: Treatment for All. (2019). Retrieved from http://www.unaids.org/en/resources/909090

Boaden, R., Harvey, G., Hannibal, C., & Proudlove, N. (2008). *Quality Improvement: Theory and Practice in Healthcare*.

Brown, T. T., Cole, S. R., Li, X., Kingsley, L. A., Palella, F. J., Riddler, S. A., . . . Dobs, A. S. (2005). Antiretroviral therapy and the prevalence and incidence of diabetes mellitus in the multicenter AIDS cohort study. *Arch Intern Med, 165*(10), 1179-1184. doi:10.1001/archinte.165.10.1179

Bulsara, S. M., Wainberg, M. L., & Newton-John, T. R. O. (2018). Predictors of Adult Retention in HIV Care: A Systematic Review. *AIDS Behav, 22*(3), 752-764. doi:10.1007/s10461-016-1644-y

Colasanti, J., Galaviz, K. I., Christina Mehta, C., Palar, K., Schneider, M. F., Tien, P., . . . Ali, M. K. (2018). Room for Improvement: The HIV-Diabetes Care Continuum Over 15 Years in the Women's Interagency HIV Study. *Open Forum Infect Dis, 5*(6), ofy121. doi:10.1093/ofid/ofy121

Colasanti, J., Kelly, J., Pennisi, E., Hu, Y. J., Root, C., Hughes, D., . . . Armstrong, W. S. (2016). Continuous Retention and Viral Suppression Provide Further Insights Into the HIV Care Continuum Compared to the Cross-sectional HIV Care Cascade. *Clin Infect Dis, 62*(5), 648-654. doi:10.1093/cid/civ941

Colasanti, J., Stahl, N., Farber, E. W., Del Rio, C., & Armstrong, W. S. (2017). An Exploratory Study to Assess Individual and Structural Level Barriers Associated With Poor Retention and Re-engagement in Care Among Persons Living With HIV/AIDS. *J Acquir Immune Defic Syndr, 74 Suppl 2*, S113-s120. doi:10.1097/qai.0000000000001242

Eckhardt, B. J., Holzman, R. S., Kwan, C. K., Baghdadi, J., & Aberg, J. A. (2012). Glycated Hemoglobin A(1c) as screening for diabetes mellitus in HIV-infected individuals. *AIDS Patient Care STDS, 26*(4), 197-201. doi:10.1089/apc.2011.0379

EnzyChrom™ HDL and LDL/VLDL Assay Kit (2019). Retrieved from https://www.bioassaysys.com/HDL-LDL-Assay-Kit-(EHDL-100).html

Fishbone (Ishikawa) Diagram. *Quality Resources.* Retrieved from https://asq.org/quality-resources/fishbone

Galaviz, K. I., Schneider, M. F., Tien, P. C., Mehta, C. C., Ofotokun, I., Colasanti, J., . . . Ali, M. K. (2018). Predicting diabetes risk among HIV-positive and HIV-negative women. *AIDS, 32*(18), 2767-2775. doi:10.1097/qad.0000000000002017

Gardner, E. M., McLees, M. P., Steiner, J. F., del Rio, C., & Burman, W. J. (2011). The Spectrum of Engagement in HIV Care and its Relevance to Test-and-Treat Strategies for Prevention of HIV Infection. *Clinical Infectious Diseases, 52*(6), 793-800. doi:10.1093/cid/ciq243

Gerald J. Langley, R. D. M., Kevin M. Nolan, Thomas W. Nolan, Clifford L. Norman, Lloyd P. Provost. (2009). *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance*. In.

Goldberg, R. B. (2000). Hyperlipidemia and cardiovascular risk factors in patients with type 2 diabetes. *Am J Manag Care, 6*(13 Suppl), S682-691; discussion S692-686.

Hall, B. J., Sou, K. L., Beanland, R., Lacky, M., Tso, L. S., Ma, Q., . . . Tucker, J. D. (2017). Barriers and Facilitators to Interventions Improving Retention in HIV Care: A Qualitative Evidence Meta-Synthesis. *AIDS Behav, 21*(6), 1755-1767. doi:10.1007/s10461-016-1537-0

Haw, J. S., Galaviz, K. I., Straus, A. N., Kowalski, A. J., Magee, M. J., Weber, M. B., . . . Ali, M. K. (2017). Long-term Sustainability of Diabetes Prevention Approaches: A Systematic Review and Meta-analysis of Randomized Clinical Trials. *JAMA internal medicine, 177*(12), 1808-1817. doi:10.1001/jamainternmed.2017.6040

Hernandez-Romieu, A. C., Garg, S., Rosenberg, E. S., Thompson-Paul, A. M., & Skarbinski, J. (2017). Is diabetes prevalence higher among HIV-infected individuals compared with the general

population? Evidence from MMP and NHANES 2009-2010. *BMJ Open Diabetes Res Care, 5*(1), e000304. doi:10.1136/bmjdrc-2016-000304

HRSA. (2016a, October 2016). About the Ryan White HIV/AIDS Program. Retrieved from https://hab.hrsa.gov/about-ryan-white-hivaids-program/about-ryan-white-hivaids-program

HRSA. (2016b, October 2016). Ryan White HIV/AIDS Program Recipient Resources. Retrieved from https://hab.hrsa.gov/program-grants-management/ryan-white-hivaids-program-recipient-resources

HRSA. (2017, March 2017). HIV/AIDS Bureau Performance Measures Retrieved from https://hab.hrsa.gov/sites/default/files/hab/clinical-quality-management/coremeasures.pdf

IDP, G. (2016). Ryan White HIV/AIDS Program Data Report. In G. I. RDR (Ed.): Grady Infectious Disease Clinic.

Improvement, I. f. H. (2019). Science of Improvement: Selecting Changes. Retrieved from http://www.ihi.org/resources/Pages/HowtoImprove/ScienceofImprovementSelectingChanges.aspx

J. Rooney, J. a. N. V. H., L. (2004). Root Cause Analysis for Beginners. *Quality Progress*.

Liu, L., Hood, S., Wang, Y., Bezverkov, R., Dou, C., Datta, A., & Yuan, C. (2008). Direct enzymatic assay for %HbA1c in human whole blood samples. *Clinical Biochemistry, 41*(7), 576-583. doi:https://doi.org/10.1016/j.clinbiochem.2008.01.013

Marshall, M., Pronovost, P., & Dixon-Woods, M. (2013). Promotion of improvement as a science. *Lancet, 381*(9864), 419-421. doi:10.1016/s0140-6736(12)61850-9

Mehta, S. N., Goldfine, A. B., Abrahamson, M. J., McMullen, W., & Laffel, L. M. B. (2016). IMPROVEMENTS IN METABOLIC CONTROL IN ADULTS WITH TYPE 2 DIABETES FOLLOWING REFERRAL TO A DIABETES CENTER, 2005-2010. *Endocrine practice : official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists, 22*(6), 689-698. doi:10.4158/EP151080.OR

Monroe, A. K., Glesby, M. J., & Brown, T. T. (2015). Diagnosing and managing diabetes in HIV-infected patients: current concepts. *Clin Infect Dis, 60*(3), 453-462. doi:10.1093/cid/ciu779

Pederson M.D., J. (Producer). (2014, 01/18/2019). What is Root Cause Analysis and Why is it Valuable? [Video] Retrieved from https://www.youtube.com/watch?v=Ju0yajsb3qU

Schweikhart, S. A., & Dembe, A. E. (2009). The applicability of Lean and Six Sigma techniques to clinical and translational research. *J Investig Med, 57*(7), 748-755. doi:10.2310/JIM.0b013e3181b91b3a

Scoville R., L. K. (2014). Comparing Lean and Quality Improvement. *IHI White Paper*. Retrieved from Available at IHI.org

Selected National HIV Prevention and Care Outcomes in the United States. (2018). Retrieved from https://www.cdc.gov/hiv/pdf/library/factsheets/cdc-hiv-national-hiv-care-outcomes.pdf

Standards of Medical Care in Diabetes—2019 Abridged for Primary Care Providers. (2019). *Clinical Diabetes, 37*(1), 11-34. doi:10.2337/cd18-0105

U.S. Department of Health and Human Services, H. R. a. S. A. (2014). *Guide for HIV/AIDS Care*. In.

UNAIDS. (2017, February 10, 2017). Ponce de Leon Center: a people-centred approach in the heart of the United States HIV epidemic Retrieved from http://www.unaids.org/en/resources/presscentre/featurestories/2017/february/20170210_PoncedeLeon

USDHHS. (2017, October 17, 2017). Guidelines for the Use of Antiretroviral Agents in Adults and Adolescents Living with HIV. Retrieved from https://aidsinfo.nih.gov/guidelines/html/1/adult-and-adolescent-arv/10/initiation-of-antiretroviral-therapy

Wessinger, M. H., Hennink, M. M., Kaiser, B. N., Mangal, J. P., Gokhale, R. H., Ruchin, L., . . . Marconi, V. C. (2017). Retention in HIV care depends on patients' perceptions of the clinic experience. *AIDS Care, 29*(10), 1212-1217. doi:10.1080/09540121.2017.1308465

Xia, Q., Wiewel, E. W., Braunstein, S. L., Kersanske, L. S., & Torian, L. V. (2015). Comparison of indicators measuring the proportion of human immunodeficiency virus-infected persons with a suppressed viral load. *Ann Epidemiol, 25*(4), 226-230. doi:10.1016/j.annepidem.2015.01.014

Zhang, X., Bullard, K. M., Gregg, E. W., Beckles, G. L., Williams, D. E., Barker, L. E., . . . Imperatore, G. (2012). Access to health care and control of ABCs of diabetes. *Diabetes care, 35*(7), 1566-1571. doi:10.2337/dc12-0081