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The Comparative Effect Of Automated Reminders/Recalls Interventions On The Appointments Rate Of Adolescent Wellness Care Visit

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by

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DEDICATION
To my mother, Paule Merhy Sika

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BS, University of Central Oklahoma, 2017

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THE COMPARATIVE EFFECT OF AUTOMATED REMINDERS/RECALLS INTERVENTIONS ON THE APPOINTMENTS RATE OF ADOLESCENT WELLNESS CARE VISIT

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An Adolescent Wellness Care (AWC) visit is an annual preventive doctor visit predestined to assess the overall health of adolescents aged between 12 and 21 years old. Compared to their younger counterparts, adolescents who are using public insurance are at risk of not completing AWC visits due to several factors related to age or providers disparities in their living environment. This research was a quasi-experimental study aiming to compare two methods of automated Reminders/Recalls (RR) interventions, 'phone-only' versus 'phone-and-text', in order to evaluate which method is more effective in helping parents/guardians or young adults to schedule an AWC visit. A control group, characterized by the delivery of in-person telephone calls, was also designed to compare the marginal effect of each automated RR intervention. Recipients of those RR messages were followed-up with over a six-week period in each intervention arm, after entering the study. An overall and subgroup analysis based on Kaplan Meier survival estimates and Cox Proportional Hazard models were respectively performed to compare the hazard of scheduling an AWC visit across the different intervention arms and between the two automated RR interventions. The

models were adjusted for demographical variables such as age, gender and race of the patients. A propensity scores matching analysis was implemented in order to account for selection bias and confounding effect in the study design due to non-randomization. A total of 516 patients were included in the analysis. By the end of the study period, 28.3% of patients in the control group, 31% of patients in the 'phone-only' group and 40.7% of patients in the 'phone-and-text' group scheduled an AWC appointment (P=0.0146). The crude hazard of scheduling an AWC visit was 73% (HR: 1.73, 95 % CI: 1.161 – 2.577) greater in the 'phone-and-text' group as compared to the control group (P=0.0070). The crude hazard of scheduling an AWC visit was 70.5% (HR: 1.705, 95 % CI: 1.157 – 2.513) greater in the 'phone-and-text' group as compared to the 'phone-only' group (P=0.0070). The adjusted hazard of scheduling was 51% (HR:1.510, 95 % CI: 1.014 – 2.249) greater in the 'phone-and-text' group as compared to the 'phone-only' group (P=0.0427). A one-year unit increase in age was associated with a 10.6% (HR: 0.894, 95 % CI: 0.837 – 0.955) decrease in the adjusted hazard of scheduling (P=0.0008) when the overall analysis was performed; and with a 11.3 % (HR: 0.887, 95 % CI: 0.818 – 0.963) decrease in the adjusted hazard of scheduling (P=0.0040) when the subgroup analysis was performed. Results from the propensity scores matching showed that the age and demographical area (based on patient's zip codes) variables prompted some selection bias in the study design. Results from the propensity scores matching also showed that the race variable was a confounding factor in the quasi-experimental study, and that when the overall Cox PH model was adjusted for demographic variables, there was no statistically significant difference in the hazard

of scheduling an AWC visit among the three intervention arms. The combination of automated telephone calls and automated text messages or 'phone-and-text' could be used as an effective tool to help healthcare professionals in the management of the scheduling flow of their patients, especially among their cohorts of children and adolescents. Future research should focus on randomized control trial (RCT) studies aiming to assess the rate of completion for AWC visits while using this combination of automated RR intervention.

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Keywords: Adolescent Wellness Care (AWC), Reminders/Recalls (RR)

Background

Literature Review

Well child check-up (WCC)

Access to health services is a key determinant of every child's development (Otterstrom, 2020). Parents or legal guardians have reported scheduling a medical consultation for their children mostly when they were seriously affected by an illness (Hugenholtz et al., 2009). The U.S. Preventive Services Task force and the American Academy of Pediatrics' Bright Future recommend the establishment of some preventive consultations for children and adolescents (U.S. department of health & human services, 2020). These anticipated consultations refer to well child check-up visits (WCC). For children aged 0 to 15 months of life, 'WCC 0-15 months' are recommended up to six times a year (NCQA.org). As for children aged 3 to 6 years old, 'WCC 3-6 years' are recommended to be performed at least once a year (NCQA.org). Well child check-up from 12 to 21 years of life or Adolescent Wellness Care (AWC) refers to preventive visits specifically addressed towards adolescents and young adults. AWC visits are recommended once annually (NCQA.org).

HEDIS measurements

The National Committee of Quality Assurance (NCQA) is a non-profit organization in charge of measuring the quality of care delivered by healthcare systems across the United States (NCQA.org). Measurement services provided by NCQA are tracked throughout a large database called 'Healthcare Effectiveness Data and Information Set' (HEDIS) (NCQA.org).

HEDIS measurements or metrics are used as a reference by healthcare providers, health plans, and healthcare professionals to assess their performances and to compare their achievements regarding their peers (NCQA.org). Additionally, HEDIS measurements allow providers to realize where they stand in terms of healthcare services provided to patients (NCQA.org). HEDIS metrics are heavily used by health plans to classify claims into categories and subcategories. All the well child check-up visits are classified as HEDIS metrics under the category of pediatric services (NCQA.org). HEDIS pediatric metrics are covered without copayments or deductible plans in some health plans (U.S. Department of Health & Human Services, 2020). On the other hand, they are 100% free of charges in public health plans when completed by providers belonging to the plans' network (healthcare.gov, 2020).

AWC among publicly insured adolescents

Among adolescents using public insurance, AWC visit has the lowest rate of adherence compared to the two other pediatric preventive visits. In public insurance, the national rate of AWC visit was at 53.2% in 2018 compared to 72.1% and 62.8% for 'WCC 3 - 6 years' and 'WCC 0 - 15 months', respectively (NCQA.org). Over these last decades, utilization of well child visits was substantially lower for older children enrolled in public health plans (Bouchery, 2012). The majority of these children live in urban areas where there is a shortage of providers compared to suburban areas (Bouchery, 2012). In addition to this, their parents are no longer committed to take them to healthcare facilities because of transportation constraints, financial constraints, time constraints and especially because their children are older (Bouchery, 2012). However, these adolescents are exposed to several risky behaviors

that might affect their quality of life and their health in the future. Behaviors such as drinking alcohol, using tobacco, using drugs, engaging in sexual misconduct, and avoiding wearing seat belts are part of their daily life (Brach et al., 2003). Parents are sometimes unaware of those risky behaviors or they could feel embarrassed to discuss these concerns with their children. In a study on adolescents' perspectives about their providers, results have shown that adolescents feel more comfortable talking to their providers about their personal life rather than talking to their parents (Coker et al., 2010). An AWC visit provides the opportunity for adolescents to have a private discussion with their physicians (Moreno, 2018). It also helps to prevent unhealthy behaviors, promote healthy decision-making and reduce the likelihood of developing major health issues now and in the future (U.S. department of health & human services, 2020). An AWC visit is a good occasion for adolescents and young people to learn how to utilize the healthcare system when they become adults (U.S. department of health & human services, 2020). Other benefits of an AWC visit consist of nutrition counseling for building a healthy diet during adulthood, physical activity counseling, depression screening, and immunization updates (U.S. department of health & human services, 2020).

Reminders/Recalls Interventions

In the context of AWC visit, public health efforts to increase adherence rates for this HEDIS metric include revolutionary approaches such as Reminders/Recalls (RR) interventions (Lebaron et al., 2004). These RR interventions, either manually or automated, have been commonly used to increase immunization rates among children and adolescents (Daley et al., 2004; Dombkowski et al., 2012; Kempe et al., 2005; Brigham et al., 2012; O'Leary et al.,

2015). RR interventions comprise postcard reminders, in-person calls, outreach interventions, electronic email reminders, automated telephone calls reminders, and automated text messages reminders. Automated RR in particular have been widely adopted by public health professionals due to their low cost and to an increase in trends of cell phone use within minorities and people with low-income (Irons et al., 2015). In the early 2000's, at the emergence of mobile cell phone devices and network carrier companies, prices were not affordable for everyone, especially the underserved communities (Irons et al., 2015). Nowadays, monthly mobile coverage plans are still a financial burden for people living with limited incomes. This situation makes automated RR interventions particularly challenging when it comes to their implementations inside communities with high usage of public insurance (Irons et al., 2015). Despite all these observations, a few studies have reported the success of automated RR interventions in increasing immunizations rates or well child check-up visits rates among publicly insured people (Jacobson et al., 2018). In a randomized control trial (RCT) study focusing on postcard reminders and automated telephone reminders to target adolescents who were overdue for immunizations and well child visits, baseline rates increased by 21% among patients who received postcards ($P < 0.01$ vs control) and by 17% among those who received auto-dialer telephone reminder ($P < 0.05$ vs control) compared to a 13% increase in the control group (Szilagyi, 2013). This study also reported the cost-savings factor observed in the intervention groups. Automated RR interventions have been widely used in *Human Papillomavirus Series* (HPV) vaccine campaigns for adolescents and young adults over the last decades. In an RCT study aiming to assess the effect of phone or text message reminders on receiving HPV vaccine, 48% of adolescents in the automated phone intervention group

versus 40% of adolescents in the phone control (P = 0.340), and 49% of adolescents in the automated text intervention group versus 30% of adolescents in the text control (P = 0.001) had received 3 HPV vaccine doses at the end of the study (Rand et al., 2017). In the efforts of increasing HPV vaccine rates in a cohort of adolescents, another study asked parents to voluntarily enroll into an intervention of receiving text messages reminding them of their children's next HPV dose. At the end of the study follow-up, HPV vaccine receipts occurred among 51.6% of enrolled participants compared to 35% among those who did not enroll (Kharbanda et al., 2011). Another team of researchers, which has evaluated the effectiveness of using motivational text message reminders as opposed to regular text message reminders for HPV vaccines, noticed that 85.71% of adolescents in the control group completed their vaccines versus 88.35% in the motivational condition group and 89% in the regular text message group (Tull et al., 2018). This shows that automated RR interventions can be effective with advanced or simple reminder contents.

Automated RR interventions have some advantages and disadvantages in the overall literature scope. The disadvantages, such as phone numbers issues, are generally out of the researchers' control. However, the implementation of sophisticated study designs related to automated RR interventions such as the combination of automated telephone calls and automated text messages could give hope for improved outcomes in future studies.

Public Health Significance

This thesis is a research centered on comparing the effectiveness of two methods of automated RR interventions for improving the scheduling rates of Adolescent Wellness Care (AWC) visit among a cohort of publicly insured adolescents aged 12 to 21 years old. The literature contains a relevant amount of automated RR interventions related to childhood and adolescent immunizations, but few studies have investigated the effects of automated RR interventions on AWC scheduling/completion rates among adolescents using public insurance. Considering that these visits have the lowest rate of completion among all pediatric preventive visits and since we know that these visits are important for the well-being of every single adolescent especially for those using public insurance and who are at risk of not receiving them, research on this topic is vital. The study proposed in this thesis could contribute to reducing the gap observed in AWC rates among publicly insured adolescents by using two different methods attempting to increase AWC scheduling rates in the primary care settings of a provider located in Texas. The first method consists of a combination of automated telephone calls and automated text messages. The second method consists of automated telephone calls only.

Study Objective

To compare the effectiveness of the combination of automated telephone calls and automated text messages versus automated telephone calls only in order to prompt parents

and guardians of adolescents or young adults, insured with public health plans, to schedule an AWC visit.

Methods

Study Design

A quasi-experimental study evaluates the association between an intervention and an outcome using experiments in which the intervention is not randomly assigned (Schweizer et al., 2016). This type of study was performed to assess whether parents/guardians of adolescents or young people due or overdue for an annual AWC visit within one week will schedule an appointment after receiving distinct types of RR interventions. This research did not permit randomization because each intervention arm was associated with a subset of clinics in which the majority of subjects were nested and were seen as regular patients. Randomization at the patient level would have implied to operate the distinct types of RR interventions within the same clinics. This could trigger some confounding bias (Harris et al., 2006). Although quasi-experimental studies do not allow randomization, they aim to demonstrate causality between an intervention and an outcome by minimizing the confounding effect (Harris et al., 2006). This research was initiated as a quality improvement project held by the Evaluation and Quality Improvement department of a provider located in the state of Texas. The project was executed over a three-months period, from June to September 2020, during which participants entered the study and were then received follow-up over a six-week period.

Three intervention levels were designed for this research. The first level of intervention, consisting of the control group, was non-randomly assigned to clinics with a small population

size in which in-person telephone calls were performed by community health workers (CHW), as part of the clinics' standard of care for reminding patients to schedule an appointment. The second intervention, which consists of automated telephone calls only, was non-randomly assigned to clinics with a medium population size. The third level of intervention, consisting of the combination of automated telephone calls and automated text messages, was non-randomly assigned to clinics with the largest population of patients.

The automated reminders were managed and sent by a single vendor in compliance with HIPAA regulations. This vendor provided an option to opt out for those who did not wish to receive any type of reminders. The language content for the automated RR messages was expressed in English and Spanish. Reminders for patients in the two automated RR interventions were delivered by age category. If patients were aged under 18, the recipients were assumed to be one of the parents or legal guardians. However, if they were aged 18 and above, recipients were assumed to be a pool of young adults seen at the selected clinics. All the reminders contained a prompt about covid-19 to ensure patients' safety and protection. The automated reminder scripts were as followed, with the underlined part being automatically added by the reminder system based on the data that was uploaded:

The telephone reminder script for patients under 18 was: "Hello, this is an appointment reminder from Clinic Name calling for the parents or guardians of first name. We are calling to remind you that first name is due for a well child check-up at Clinic Name. You can request an appointment on our website at www.clinicname.com/patients/appointment or call the clinic to schedule an appointment. Our phone number is clinic phone. Please, disregard this call if you have already completed the visit. For added safety, we have established measures

within our clinics to help protect our patients. For more info, please visit clinicname.com". The telephone reminder script for patients over 18 was: "Hello, this is an appointment reminder from Clinic Name for first name. We are calling to remind first name that you are due for your annual wellness visit at Clinic Name. You can request an appointment on our website at www.clinicname.com/patients/appointment or call the clinic to schedule an appointment. Our phone number is clinic phone. Please, disregard this call if you have already completed the visit. For added safety, we have established measures within our clinics to help protect our patients. For more info, please visit clinicname.com".

The text message reminder script for patients under 18 was: "Your child, first name, is due for a well child check-up at Clinic Name. Appts can be scheduled on our website at www.clinicname.com/patients/appointment or by calling the clinic at clinic phone. Disregard this notice if you have already completed the visit. For added safety, we have established measures within our clinics to help protect our patients. For more info, please visit clinicname.com".

The text message reminder script for patients over 18 was: "First name is due for an annual Wellness visit at Clinic Name. Appts can be scheduled on our website at www.clinicname.com/patients/appointment or by calling the clinic at clinic phone. Disregard this notice if you have already completed the visit. For added safety, we have established measures within our clinics to help protect our patients. For more info, please visit clinicname.com".

Because the reminders contained Protected Health Information (PHI), they were carefully monitored in compliance with HIPAA regulations.

First level of intervention: Control group

This intervention arm consisted of in-person telephone calls made by CHW located at the clinics which were part of the control group. In this group, a CHW contacted eligible parents/guardians or patients to remind them to schedule a visit for their next AWC. Participants in the control group were followed up with within a six-week period to assess whether a visit was scheduled or not. Participants from this group were contacted several times until a visit was scheduled. In cases of successfully scheduled visits, patients were no longer contacted during the follow-up period. Participants in the control group did not receive any automated RR message. The method described in the control group corresponds to the standard of care procedure that was previously applied in all the clinics which are part of this study.

Second level of intervention: Automated telephone call-only ('phone-only')

The second intervention arm consisted of the delivery of automated telephone calls only. Parents/guardians or patients in this group received automated telephone calls on a single day, one week before the patient was due for their annual AWC visit. A maximum of three reminders were sent to each parent/guardian or patient, two weeks apart from each other, until a visit was scheduled. Participants in this group were followed-up with within a six-week period to track whether a visit was scheduled or not. If scheduling occurred, participants

were no longer contacted during the follow-up period.

Third level of intervention: Automated telephone call and automated text message ('phone-and-text')

This intervention arm consisted of the delivery of automated telephone calls and automated text messages. Parents/guardians or patients in this group received one automated text message followed by automated telephone calls reminders, on a single day, to schedule a visit. Both reminders were sent out one week before the patient was due for their annual AWC visit. A maximum of three reminders were sent to each parent/guardian or patient, two weeks apart from each other, until a visit was scheduled. Participants in this group received follow-up within a six-week period to track whether a visit was scheduled or not. In case scheduling occurred, participants were no longer contacted during the follow-up period.

Study Setting

The study was conducted in selected primary care clinics of a healthcare entity located in the state of Texas. Clinics not able to provide services to our target population were excluded. The automated text message reminders were sent between 9:00 AM and 9:00 PM. The automated telephone reminders were sent between 5:30 PM and 9:00 PM. This timing was suggested by the automated reminder system that we used. In 2004, an automated RR intervention conducted by Lebaron et al. had a similar timing and succeeded in increasing immunization baseline rates for children and adolescents by 6 percentage points over control

group. They argued that this timing corresponds to hours where parents/guardians or adults are more likely to read their text messages and answer phone calls (Lebaron et al., 2004).

Study Subjects

To be eligible for this study, adolescents were (1) aged between 12 to 21 years old as of 2020, (2) patients seen at least once at one of the selected clinics, (3) publicly insured, (4) due or overdue for an AWC visit within one week during the period ranging from June to September 2020. Parents/guardians or patients received the reminders throughout their respective phone numbers and had the responsibility to schedule at least one annual AWC visit. If adolescents were 18 years and above, they directly received the reminders, assuming that the phone numbers on file were their own rather than the one of their parents or guardians. The consent of parents/guardians and young adults to receive those reminders was given the day they agreed to become patients of the eligible clinics. During their first encounter at those clinics, participating parents, guardians or patients were required to sign a form named 'Consent for medical treatment, telemedicine, disclosures, and waivers' in which they gave their consent to receive information from the clinics concerning their children's health care or their personal health care by postcard letters, in-person calls or any other transmission channels such as automated telephone calls, and automated text messages.

Study power and sample size

A statistical power analysis was performed to calculate the sample size estimation in each intervention arm of this study. To detect a 15% effect size between the intervention groups and the control group, with $\alpha = 0.05$, a power of 80% and a conservative estimate of 50 % for the rate of scheduling an AWC visit within the intervention groups, a sample size of N=169 subjects per intervention arm was needed (ClinCalc LLC, 2020). This corresponded to a total sample size of 507 subjects. This power analysis is based on a similar analysis that was done in a study published by Rand et al. in 2017 to assess the effect of phone or text message reminders to parents of adolescents on HPV vaccine series completion in Rochester, NY (Rand et al., 2017).

Dataset Description

The data used for this study was extracted from claims of public health plans. These particular claims data used were gap lists for HEDIS quality metrics. Physicians and pediatricians are encouraged by their healthcare institutions to perform a preventive pediatric visit anytime a young patient goes to hospital for a sick visit or an Emergency Department (ED) visit. Public health plans define their customers as having a gap in care anytime their claims' information revealed that they have missed an opportunity to complete a HEDIS metric. In the context of AWC visits, public health plans classify their adolescent customers as having a gap in care if they were eligible for this metric and failed to complete a visit during a measurement year, ranging from January to December. On the contrary, if the adolescents

were able to complete at least one annual AWC visit, public health plans would now classify them as completed cases. The gap lists were regularly updated to identify and track publicly insured adolescents who were due or overdue for an AWC visit within one week. Patients were non-randomly assigned to their respective intervention arms based on their affiliated clinic addresses, retrieved from the gap lists.

Variables definition

Exposure and Study Outcomes

The exposure variable in this study was described by the effect of receiving a RR intervention. This effect was either related to the first, second or third level of the intervention, respectively. The exposure variable was assessed as the primary factor of interest in this study. After being exposed to either of those three distinct effects, parents/guardians or patients were expected to schedule an appointment online or by calling their respective clinic.

Two outcomes were of interest in this study. The first outcome consisted of receipts of scheduled AWC appointment after exposure, a dichotomous variable in the form ‘yes’ or ‘no’. The second outcome consisted of time until scheduling the AWC visit, for which the time origin was the first day when patients entered the study, that is, the day where they received their very first reminder. Time origin was different for every subject because patients have different due dates. This second outcome is a continuous variable with days as a unit. Time in days was collected by subtracting the date when the appointment was scheduled from the time origin’s date. If no such date was available until the end of the study, time in days was collected

by subtracting the last date of the six-week follow-up period from the time origin's date. To verify whether an AWC visit was scheduled and the date on which it was scheduled, patient chart reviews were performed.

Covariates

Demographic covariates were collected in this study, including patient's date of birth, gender, zip code, race, ethnicity and language. The variables: date of birth, gender and zip code, were directly retrieved from the gap lists. On the other hand, the variables: race, ethnicity and language, were collected from computer-derived patient chart reviews. The zip code variable was assigned to demographical areas such as urban, suburban or rural. These categories were derived from the U.S. 2010 census (usda.gov, 2020). The race variable was composed of five distinct categories, which were Caucasians, African Americans, Hispanics, Asians and Others. The ethnicity variable had two categories, which were Not Hispanic nor Latino and Hispanic or Latino. The language variable, consisting of the language into which reminders were sent, included two categories: English and Spanish. These demographic covariates are commonly used in RR interventions studies (Jacobson et al., 2018).

Data Handling and Record keeping

The data was handled by the Principal Investigator (PI) of this study. The PI has been trained in compliance with HIPAA regulations in order to carefully handle PHI. The PI was also in charge of uploading the data into the single vendor system in order to deliver the

reminders. This system was secured and encrypted to ensure sensitive data protection. To record the study outcomes, chart reviews were regularly performed by the PI. The study records were kept in a secured server managed by the Healthcare department of the primary care facility that was of interest in this research.

Human subjects and safety considerations

This study was reviewed and approved by the Committee for Protection of Human Subjects (CPHS) at the University of Texas Health Science Center at Houston because it involved direct contact and interaction with human subjects throughout automated telephone calls and automated text messages reminders. The PI had access to human subject's PHI, in compliance with HIPAA regulations, for generating automated reminders. However, the AWC appointments were hosted by physicians and pediatricians in the eligible clinics as part of their normal duty.

Data analysis

A survival analysis, including Kaplan Meier survival estimates and Cox Proportional Hazard (PH) regression models, was implemented in order to assess which intervention level was the most effective in reducing the time to schedule a visit. The survival function known as $S(x)$ is the probability of an individual surviving an event until time x (Dietz et al., 2003). In this study, we defined the survival function $S(x)$ as the probability of an individual not scheduling an AWC visit until time x, where x corresponds to time in number of days, and the

event corresponds to scheduling an AWC visit. It is expressed as: $S(x) = \int_x^{\infty} f(x)\, dx$ (Dietz et al., 2003) when x is a continuous variable and $f(x)$ is the probability density function (pdf) of the distribution of $S(x)$. Note that $S(x) = 1 - F(x) = 1 - P(X \leq x)$ (Dietz et al., 2003). The hazard function is the chance that an individual experiences an event in the next instant of time. It is expressed as $h(x) = f(x)/S(x)$ (Dietz et al., 2003). In this study, the hazard function $h(x)$ corresponds to the chance that an individual schedules a visit in the next instantaneous hours or days following the reception of a RR message. All the subjects who did not schedule a visit until the end of the follow-up period were considered as type I right censored observations. When an individual is considered as a type I right censored observation, it means that the individual did not experience the event until the end of the study, but he/she may experience it later after the study (Dietz et al., 2003).

The data analysis was performed in SAS 9.4 and R, English versions.

Overall analysis

A descriptive analysis was implemented in order to assess the quality of the data and present the crude estimates and inferences. Fisher's exact test, Chi-square test and Analysis of Variance (ANOVA) were conducted for hypothesis testing regarding categorical and continuous variables respectively. To compare the scheduling trends over time across the intervention levels, an unadjusted Kaplan-Meier survival analysis was performed. In this context, a log-rank test for trend was initiated to test the hypothesis that the survival function $S(x)$ was significantly different among the groups. A log-rank for trend test is a nonparametric

test used in survival analysis across ordered group (Bland. Et al., 2004; Altman, 1991). It tests the null hypothesis ($H_0: S_1(t) = S_2(t) \ldots = S_k(t)$) vs.: $H_1: S_1(t) \leq S_2(t) \ldots \leq S_k(t)$ or $H_1: S_1(t) \geq S_2(t) \ldots \geq S_k(t)$ where k is the number of samples or groups for all $t \leq \tau$ (Klein et al., 1997). In this study, the log-rank test for trend associated with the second alternative above was of interest, and $k = 3$ (control, 'phone-only', 'phone-and-text'). Under the null hypothesis, the $Z - score$ test statistic for the log-rank test for trend is expressed as:

$$Z = \frac{\sum_{j=1}^{k} a_j v_j}{\sqrt{\{\sum_{j=1}^{k} \sum_{l=1}^{k} a_j a_l V_{jl}\}}}$$

where $a_1 < a_2 < \cdots < a_k$ is a sequence of scores associated with the k samples (Klein et al., 1997).

An unadjusted Cox PH model was used to compare the crude hazard of scheduling an AWC visit among the three intervention levels, considering the control group as the reference. Similarly, a Cox PH regression model, adjusted for age, gender, and race, was conducted to compare the hazard of scheduling an AWC visit among the three intervention levels using control group as the reference. A Pearson correlation test was conducted to assess multicollinearity between the covariates. Multicollinearity was detected between language and ethnicity variables, race and ethnicity variables, demographical area and the exposure variables. In general, multicollinearity was observed with variables of the same type and confounding effect between exposure and other covariates was observed because the study was not randomized at the patients' level due to its quasi-experimental nature. Therefore, only age, race, gender and exposure were the covariates used for building the adjusted Cox PH regression

model for this overall analysis. The proportional hazard assumption was not violated for the adjusted Cox PH model.

Subgroup Analysis

A subgroup analysis was performed in order to compare the scheduling trends between the automated RR intervention levels ('phone-only' versus 'phone-and-text'). First, an unadjusted Kaplan Meier survival analysis was conducted, and a log-rank test aiming to compare the survival curves over time between both groups was initiated (Bland et al., 2004). Next, an unadjusted Cox PH model was fitted to compare the crude hazard of scheduling an AWC visit among both automated RR interventions, using the 'phone-only' group as the reference. A second Cox PH model, adjusted for age, gender, and race was conducted to compare the hazard of scheduling between the 'phone-only' group versus the 'phone-and-text' group, using the 'phone-only' group as the reference. Similar to the general analysis age, race and gender were the variables used for building the adjusted PH Cox regression model for this subgroup analysis. The proportional hazard assumption was not violated for the adjusted model.

Propensity scores matching analysis

To minimize the effect of selection bias due to non-randomization, we conducted a propensity scores matching aiming to mimic RCT studies by balancing observed covariates between subjects in control and exposure groups (Gant et al., 2017; Faries et al., 2010). A

propensity scores is the conditional probability that a subject receives 'treatment' or 'exposure' given the subject's observed covariates (Gant et al., 2017). These covariates might be correlated to the exposure variable and therefore might become confounding factors, causing results that could hide the true association or effect size between the exposure variable and the outcome of interest. To avoid this situation and the bias attached to it, weighted propensity scores were calculated in R using the TWANG (Toolkit for Weighting and Analysis of Nonequivalent Groups) package (Ridgeway et al., 2020), and matched by intervention or exposure level with the covariates age and demographical area. These variables were selected because they were suspected to trigger selection bias and confounding effects regarding the exposure variable. Weighted propensity scores from the matching analysis were used to assess the distribution of age and demographical area variables across the three levels of intervention. Under the same circumstances, an overall analysis related to Cox PH regression model, adjusted for race and gender, was initiated in order to assess the weighted hazard of scheduling an AWC among the three levels of intervention. This particular model was adjusted for race and gender only, because the variables age and demographical area were used to calculate and match the weighted propensity scores across the exposure variable. Likewise, the propensity scores matching was performed at the subgroup analysis level.

Results

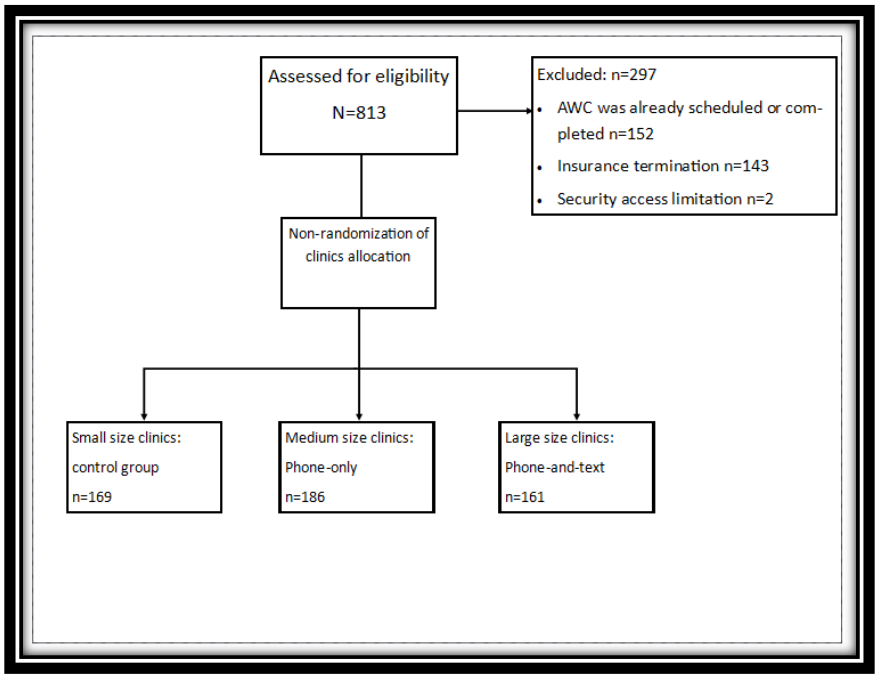

Figure 1: Consort diagram

Demographic results

Figure 1 summarizes the study design and its inclusion-exclusion criteria. 813 patients were eligible for the study. Out of this number, 152 were excluded because they had already scheduled or completed an AWC visit prior to the study's start date and another 145 were excluded due to termination of insurance or security limit access. This left a total sample size of N=516 to conduct the analysis. Patients demographics summarized across the different levels of intervention can be found in Table 1. Patients in the control group were older compared to those in the automated RR levels of intervention (the mean age was 16.9 in control group, 15.9 in 'phone-only' group and 15 in 'phone-and-text' group, $P < 0.0001$). The percentage of adolescents under 18 were bigger than that for over 18 in all three groups with

the biggest difference in the 'phone-and-text' group (82.6% vs 17.4%, P < 0.0001). Figure 2 illustrates the difference in age (P<0.0001) across the three levels of intervention. Subjects living in urban areas were the majority for both 'phone-and-text' (62.1%) and control groups (61.5%) while the suburban cases accounted for the majority of cases in the 'phone-only' group (54.8%). Also, cases from the rural areas were the smallest proportions for all the three groups (14.3% vs 10.7% vs 8.6%). There were no demographic differences in gender, race, ethnicity and language among the three intervention arms.

Table 1: Demographics summary (N=516)

Variable	Control (N=169)	Phone-only (N=186)	Phone-and-Text (N=161)	P-value
Age, mean	16.9	15.9	15.0	< 0.0001*
Age category, N (%)				
Under 18	90 (53.2)	139 (74.7)	133 (82.6)	< 0.0001**
Over 18	79 (46.8)	47 (25.3)	28 (17.4)	
Gender, N (%)				
Male+	69 (40.8)	85 (45.7)	81 (50.3)	0.224**
Female	100 (59.2)	101 (54.3)	80 (49.7)	
Race, N (%)				
Caucasian	20 (11.8)	29 (15.6)	13 (8.1)	0.0745***
African American	108 (63.9)	95 (51.1)	86 (53.4)	
Hispanic	21 (12.4)	27 (14.5)	29 (18.0)	
Asian	3 (1.8)	3 (1.6)	6 (3.7)	
Other	17 (10.1)	32 (17.2)	27 (16.8)	
Ethnicity, N (%)				
Not Hispanic nor Latino	128 (75.7)	137 (73.7)	121 (75.2)	0.8976**
Hispanic or Latino	41 (24.3)	49 (26.3)	40 (24.8)	
Language, N (%)				
English	158 (93.5)	179 (96.2)	151 (93.8)	0.4535**
Spanish	11 (6.5)	7 (3.8)	10 (6.2)	
Demographical area, N (%)				
Urban	104 (61.5)	68 (36.6)	100 (62.1)	<0.0001**
Suburban	47 (27.8)	102 (54.8)	38 (23.6)	
Rural	18 (10.7)	16 (8.6)	23 (14.3)	

P < 0.05 indicates a statistically significant difference.
*P-value from Anova test, **P-value from Chi-square test, ***P-value from Fisher's Exact test.

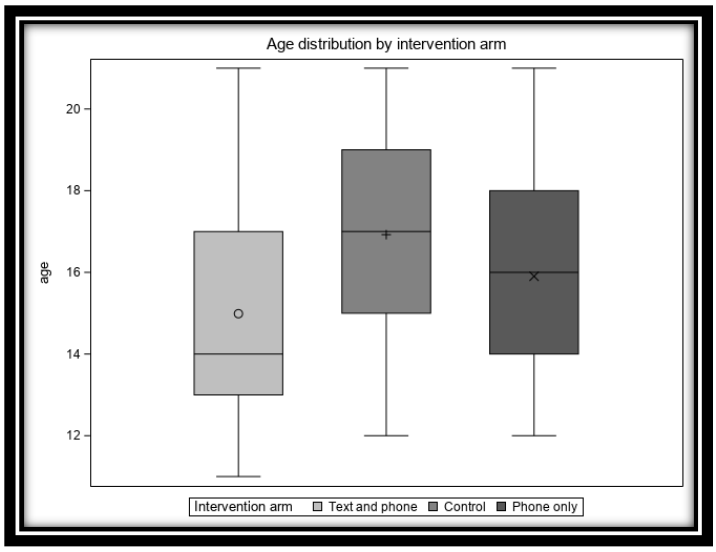

Figure 2: Boxplot distribution of age by intervention arm

Scheduling rates by intervention level

The overall summary of the scheduling rates by intervention level is available in Table 2. By the end of the observation period, 28.3% of patients in the control group, 31% of patients in the 'phone-only' group and 40.7% of patients in the 'phone-and-text' group had scheduled an AWC appointment (P=0.0146). The scheduling rates across the intervention levels are presented in Figure 3. The mean time until scheduling an appointment was smaller in the 'phone-and-text' group, followed by the 'phone-only' group and the control group respectively (the mean time until scheduling was 12.4 days in 'phone-and-text' group, 17.2 days in the 'phone-only' group, and 18.3 days in the control group, P=0.0162).

Table 2: Scheduling rates by intervention level (N=516)

Outcome	**Control (N=169)**	**Phone-only (N=186)**	**Phone & Text (N=161)**	**P-value**
Scheduled appointment, N (%)	41 (28.3)	45 (31.0)	59 (40.7)	0.0146*
Time until scheduling (mean)	18.3	17.2	12.4	0.0162**

P <0.05 indicates a statistically significant difference.
*P-value from chi-square test, **P-value from Anova test

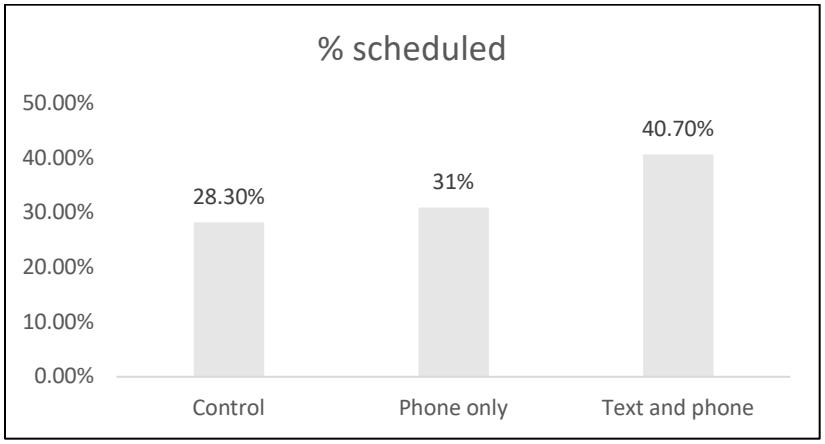

Figure 3: Scheduled appointment rates by intervention level

Results from the Overall analysis

A marginal model defined by unadjusted Cox PH regression, using the total sample size stratified by the exposure variable, was performed. The results from this analysis are presented in table 3. From the table, the crude hazard of scheduling an AWC visit was 73% (HR:1.730, 95 % CI: 1.161 – 2.577) greater in the 'phone-and-text' group as compared to the control group (P=0.0070). No statistically significant difference was observed in the crude hazard of scheduling an AWC visit in the 'phone-only' group versus the control group. Results from the standard log-rank test aiming to compare Kaplan Meier survival curves or non-scheduling curves among the intervention levels were significant (P=0.0046). In the same context, results from the log-rank test for trend test were statistically significant (P=0.0027), indicating that hazard of scheduling an AWC visit was significantly slower in the control group, followed by the 'phone-only' group and the 'phone-and-text' group, respectively. An illustration of the hierarchical difference from the log-rank test for trend is provided in Figure 4 throughout the plots of some Kaplan Meier survival curves.

Another Cox PH regression model using the total sample size stratified by exposure variable and adjusted for age, gender and race was executed. Results from the analysis are presented in table 3. From the table, a one-year unit increase in age is associated with a 10.6% (HR:0.894, 95 % CI: 0.837 – 0.955) decrease in the adjusted hazard of scheduling over time (P=0.0008), controlling for intervention levels, gender and race. When the Cox PH regression model was adjusted for age, race and gender, no statistically significant difference in the adjusted hazard of scheduling an AWC was observed among the different levels of intervention. Likewise, no statistically significant difference was observed in the adjusted hazard of scheduling an AWC visit among gender and race while controlling for other variables in the model.

Table 3: Cox PH overall analysis results

Marginal Model			
Unadjusted Hazard of Scheduling	**Hazard Ratio**	**95 % CI**	**P-value**
Intervention level (ref = 'Control')			
'phone-only'	1.005	(0.658 - 1.535)	0.9803
'phone-and-text'	1.730	(1.161 - 2.577)	0.0070
Adjusted Model			
Adjusted Hazard of Scheduling	**Hazard Ratio**	**95 % CI**	**P-value**
Intervention level (ref = 'Control')			
'phone-only'	0.895	(0.582 - 1.377)	0.6141
'phone-and-text'	1.383	(0.912 - 2.097)	0.1267
Age	0.894	(0.837 - 0.955)	0.0008
Gender (ref = 'Male')	0.995	(0.717 - 1.382)	0.9783
Race (ref = 'Caucasian')			
'African American'	1.070	(0.614 - 1.866)	0.8114
'Asian'	0.842	(0.243 - 2.921)	0.7863
'Hispanic'	1.629	(0.874 - 3.035)	0.1244
'Other'	1.062	(0.543 - 2.078)	0.8612

$P < 0.05$ indicates significant difference.

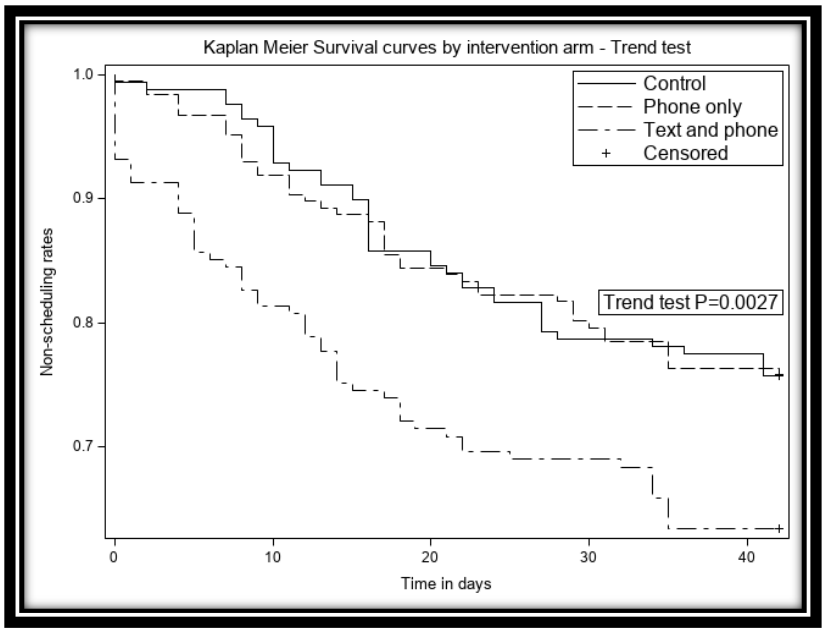

Figure 4: Kaplan Meier Survival curves by intervention arm

Results from the subgroup analysis

A marginal model defined by unadjusted Cox PH regression, using a subset of the main dataset containing information only for the automated RR interventions levels ('phone-only' and 'phone-and-text'), was implemented. The total sample size for the data subset was n=347. The results from the analysis are presented in table 4. From the table, the crude hazard of scheduling an AWC visit was 70.5% (HR: 1.705, 95 % CI: 1.157 – 2.513) greater in the 'phone-and-text' group as compared to the 'phone-only' group (P=0.0070). A log-rank test was achieved to compare the Kaplan-Meier survival curves or non-scheduling curves across time between both groups. The log-rank test was significant (P=0.0060), indicating a significant difference in the hazard of scheduling an AWC visit over time between the 'phone-only' group and 'phone-and-text' group. A visualization of that difference throughout some Kaplan Meier survival curves is provided in Figure 5.

Another Cox PH regression model using the same subset of data and adjusted for age, gender and race was executed. Results from this model are presented in table 4. According to that table, a one-year unit increase in age is associated with a 11.3% decrease in the adjusted hazard of scheduling (HR: 0.887, 95 % CI: 0.818 – 0.963) over time (P=0.0040), controlling for intervention levels, gender and race. The adjusted hazard of scheduling was 51% (HR: 1.510, 95 % CI: 1.014 – 2.249) greater in the 'phone-and-text' group as compared to the 'phone-only' group (P = 0.0427), controlling for age, race and gender. No statistically significant difference in the adjusted hazard of scheduling an AWC visit was observed among gender and race while controlling for other variables in the model.

Table 4: Cox PH subgroup analysis results

Marginal Model			
Unadjusted Hazard of Scheduling	**Hazard Ratio**	**95 % CI**	**P-value**
Intervention level (ref = 'Phone-only')			
'phone-and-text'	1.705	(1.157 - 2.513)	0.0070
Adjusted Model			
Adjusted Hazard of Scheduling	**Hazard Ratio**	**95 % CI**	**P-value**
Intervention level (ref = 'Phone-only')			
'phone-and-text'	1.510	(1.014 - 2.249)	0.0427
Age	0.887	(0.818 - 0.963)	0.0040
Gender (ref = 'Male')	1.143	(0.776 - 1.684)	0.4973
Race (ref = 'Caucasian')			
'African American'	1.133	(0.591 - 2.171)	0.7078
'Asian'	1.122	(0.310 - 4.059)	0.8610
'Hispanic'	1.456	(0.700 - 3.029)	0.3152
'Other'	0.883	(0.401 - 1.948)	0.7587

P < 0.05 indicates significant difference.

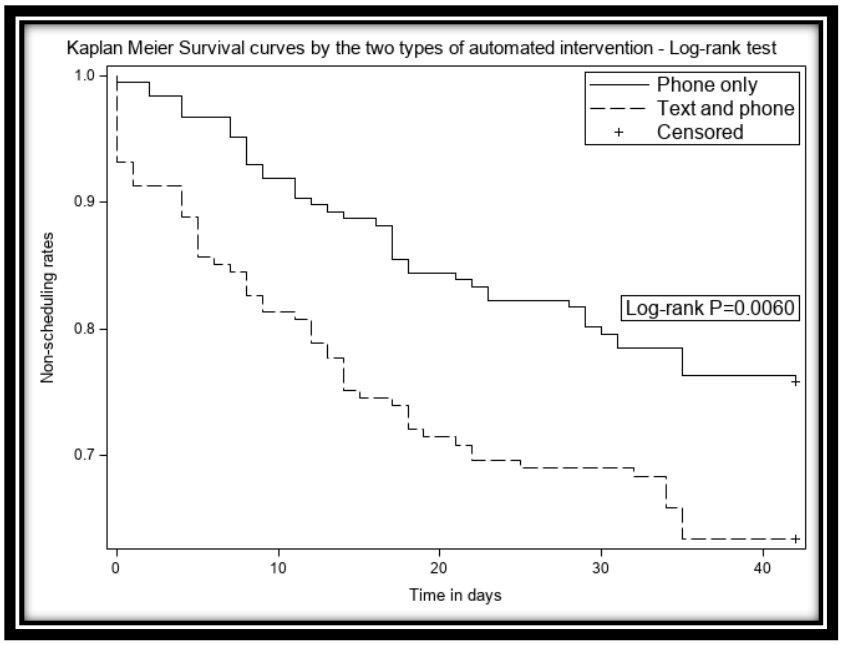

Figure 5: Kaplan Meier Survival curves by the two levels of automated RR interventions

Results from Propensity scores matching analysis

The design of this study did not permit to randomly assign patients into the three different levels of intervention. Hence we observed selection bias, e.g. age difference and location (urban, suburban and rural) among the three intervention groups. From Figure 2, we can see that adolescents who were in the 'phone-and-text' group were significantly younger compared to those in the other two groups. Age distribution was right skewed for this group compared to the symmetric distribution for the control and phone-only groups. Also percentages for cases living in urban, suburban and rural areas were significantly different among the three groups, raising the concern that age and the demographical area variables might be confounded with the exposure group. These findings illustrate possible selection bias in the cohort because no randomization was done in order to control for these variables. These

findings might also explain why the intervention levels or exposure variable was not significant in the overall Cox PH regression model that was adjusted for age, race and gender. In fact, only the age variable was significant in this model, highlighting the bias in the study design due to non-randomization of the data. The comparison of the age and demographical area percentages distribution, before and after the weighted propensity scores calculated and matched based on these two variables, is presented in Table 5. From table 5, we noticed that the mean age was no longer statistically significant within the levels of intervention, following the post-matching procedure (the mean age was 15.9 in the control group, 15.9 in the 'phone-only' group and 15.7 in the 'phone-and-text' group after the post-matching procedure, P = 0.7686). We also noticed that the percentages for subjects living in urban, suburban and rural demographical areas were balanced and no longer statistically significant among the levels of intervention (P=0.8789). The majority of subjects in the control group (53.2%), 'phone-only' group (53.1%) and 'phone-and-text' group (53.3%) were matched to urban demographical area. The smallest proportion of subjects was observed in the suburban demographical area for all the three groups (10.4% vs 10.1% vs 11.9%). From Figure 6, the median age weighted by the propensity matching scores was nearly balanced across each intervention level even though age in the 'phone-and-text' group was left-skewed compared to the other two groups. This finding, thus, exposed the fact that the non-randomization of patients into the different levels of intervention induced some selection bias related to the age distribution and demographical area percentages' distribution. The weighted propensity scores are advantageous in this case scenario to lessen the effect of selection bias due to non-randomization.

The weighted propensity scores were also used to perform another overall Cox PH model adjusted for gender and race in order to compare the hazard of scheduling an AWC visit across the three levels of intervention. Results from the propensity scores matching are presented in Table 6. From the table, results showed that no statistically significant difference in the hazard of scheduling was observed between the exposure and gender variables. The findings related to the exposure variable are similar to the ones found in the overall adjusted analysis. From table 6, the adjusted hazard of scheduling an AWC visit was 1.872 (HR:1.872, 95% CI: 1.472 – 3.426) times more likely to occur among Hispanic (P=0.0005) as compared to Whites, controlling for other variables in the model. No statistically significant difference in the adjusted hazard of scheduling was observed among Africans Americans, Asians and other races as compared to Whites. When comparing results obtained from this adjusted model using weighted propensity scores to the ones obtained from the adjusted model without weighted propensity scores, we noticed that the race variable became significant among Hispanics. This finding, related to the race variable, could highlight the fact that race was a potential confounder in the unweighted model due to some selection bias attached to it. This propensity matching scores was helpful in detecting the true association which existed between the hazard of scheduling an AWC visit and the intervention levels or exposure variable, when the overall Cox PH model was adjusted demographic variables. The propensity scores matching that was performed at the subgroup analysis level led to the same conclusions as the ones obtained in the adjusted and unadjusted subgroup analysis.

Table 5: Mean age and demographic area summary before and after propensity scores matching

	Pre-matching				Post-matching			
Variable	**Control**	**Phone-Only**	**Phone & Text**	**p-value**	**Control**	**Phone-Only**	**Phone & Text**	**p-value**
Age (mean)	16.9	15.9	15	<0.0001*	15.9	15.9	15.7	0.7686*
Demographical area, N (%)								
Urban	104 (61.5)	68 (36.6)	100 (62.1)		271 (53.2)	269 (53.1)	261 (53.3)	
Suburban	47 (27.8)	102 (54.8)	38 (23.6)	<0.0001**	53 (10.4)	51 (10.1)	58 (11.9)	0.8789**
Rural	18 (10.7)	16 (8.6)	23 (14.3)		185 (36.4)	186 (36.8)	170 (34.8)	

P < 0.05 indicates statistically significance
*P-value from Anova test, **P-value from chi-square test

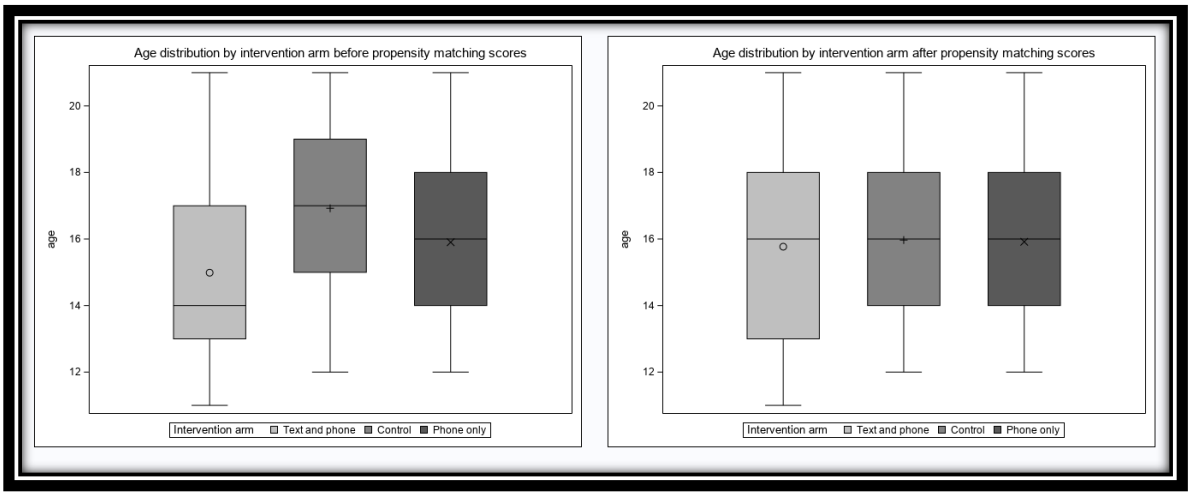

Figure 6: Age distribution before and after propensity matching scores

Table 6: Adjusted Cox PH overall analysis results from propensity scores matching

Adjusted Hazard of Scheduling	Hazard Ratio	95 % CI	P-value
Intervention level (ref = 'Control')			
'phone-only'	0.886	(0.695 - 1.129)	0.3259
'phone-and-text'	1.183	(0.937 - 1.494)	0.1578
Gender (ref = 'Male')	1.003	(0.828 - 1.216)	0.9721
Race (ref = 'Caucasian')			
African American	0.978	(0.709 - 1.349)	0.8920
Asian	0.884	(0.469 – 1.663)	0.7015
Hispanic	1.872	(1.315 – 2.663)	0.0005
Other	1.137	(0.778 – 1.662)	0.5069

$P < 0.05$ indicates significant difference.

Discussion

By the end of the study, the rate of scheduling an AWC visit was significantly greater in the 'phone-and-text' group, followed by the 'phone-only' group and the control group, respectively. This indicates that the use of automated telephone calls and automated text messages could be effective in reminding parents/guardians and young adults to set up an AWC appointment with their affiliated clinics. When the overall analysis was adjusted for age, gender and race, only the age variable was significantly associated with the hazard of scheduling an appointment. This association was inversely related with the hazard of scheduling an AWC visit. This implied that if patients were younger; they were more likely to have a scheduled visit compared to as if they were older. This could be explained by the fact that because younger children have the tendency to live with at least one of their parents/guardians, those last ones had a self-efficacy in scheduling an appointment for their children. However, older adolescents or young adults who are now able to decide for themselves were less likely to implement self-efficacy in scheduling an appointment. The

exposure variable was not significant in the adjusted overall analysis. This could be explained by the non-randomization of our study design which has caused selection bias within the age and demographical area variables. The propensity scores matching analysis whose goal was to simulate results obtained if our study was an RCT, allowed to confirm that age and demographical area variables were confounding factors within the adjusted overall analysis. The confounding effect of these two variables is visible in table 5 which shows the difference in the distribution of age and demographic area percentages among the three intervention levels, before and after propensity matching. In addition to this, the propensity scores matching allowed to detect that race was a confounding factor since the overall adjusted model derived from it, revealed that the hazard of scheduling a visit was significantly greater among Hispanic patients as compared to White patients. The variable race was not significant in the adjusted overall analysis, but it became significant when that same model was weighted using propensity scores. This observation could ascertain that race was a potential confounding variable due to selection bias caused by non-randomization of the data. In the unweighted overall adjusted model, the confounding effect of race was hiding its true association with the hazard of scheduling a visit. The propensity scores matching also highlighted the fact that the exposure variable would have had no significant effect in the hazard of scheduling a visit given that our study was randomized and adjusted for demographical variables. Therefore, based on results obtained from the overall adjusted analysis and from the propensity scores matching analysis, the exposure variable was actually not significantly associated with the hazard of scheduling a visit, controlling for demographical variables in the model. The propensity scores matching also demonstrated that, in our quasi-experimental study design, patient's age, race

and demographical areas were the primary decisive factors for scheduling a visit at every level of exposure. The propensity scores matching was also useful to capture some hidden confounders which could have never been detected except if there was randomization.

From the unadjusted overall analysis, the exposure variable was significant at the 'phone-and-text' level indicating that the adjusted hazard of scheduling an AWC visit was significantly greater in that group as compared to the control group. The exposure variable in the unadjusted overall analysis had a significant effect on the hazard of scheduling a visit, unlike the non-significant effect observed in the overall adjusted analysis. These different results could be interpreted by the absence of confounding factors in the unadjusted overall analysis. When such factors were not included in the analysis, the effect of selection bias and confounding was inexistent. This allowed to capture that a statistically significant difference in the crude hazard of scheduling existed between the 'phone-and-text' group versus control group; but not between the 'phone-only' group versus control group.

Results obtained from the adjusted subgroup analysis showed that the exposure variable was significantly associated with the hazard of scheduling a visit. This could tell that subjects in the 'phone-and-text' group were significantly more rapid to schedule an AWC visit compare to those in the 'phone-only' group. The age variable was inversely and significantly associated with the hazard of scheduling a visit as well. Those results obtained from the adjusted subgroup analysis are showing one more time that the combination of automated telephone calls and automated text messages could be used as an adequate method to help patients in scheduling an AWC visit as compared to the use of automated telephone

calls only. This also shows that when subjects receive automated telephone calls only, they might not pick up their phones if they do not know the telephone number due to an increase in scamming calls over the last decades in the United States (DeLiema et al., 2017). However, when automated telephone calls are supported by automated text messages, it is probably evident that subjects would at least receive the message in order for them to schedule a visit. In this study, patients in the 'phone-and-text' group received automated text messages in the morning and this was followed by automated telephone calls in the evening. That is, if patients were to miss the telephone calls, suddenly hang-up the calls or if the calls were delivered into their voice mail, they would have at least received the RR information throughout the automated text messages. The automated text messages might help to minimize the uncontrolled issues encountered during the delivery of the automated telephone calls. The exposure variable was significantly associated with the crude hazard of scheduling in the unadjusted subgroup analysis, same as in the adjusted subgroup analysis. To date, there was no study published about the effectiveness of combining automated telephone calls and automated text messages in RR interventions.

Strengths and Limitations

This research has some strengths and limitations. Starting with strengths, the design of this study permitted to order the intervention arms in terms of levels, going from the least intense to the most intense. This ordering allowed to see that rates of scheduling an AWC visit increased as the intervention level increased, going from control intervention level to

'phone-and-text' intervention level. Secondly, another strength of this study was seen throughout the unique feature of the participating sample size. In fact, all subjects who were eligible for this study were insured with public insurance meaning that most of them were at risk of not scheduling and completing their AWC visit. This study permitted to directly reach out to them in order to give them an opportunity to close their gap in care regarding AWC visit. Be that as it may, automated RR interventions have not always proven to be successful. Many limitations were observed in this study. The first limitation consists of contacting issues related to the non-accuracy of individuals' telephone numbers. When sending the automated RR messages, the system notified us about some patients having wrong or incorrect phone numbers. Patient chart scrubbing was performed to regularly update those numbers. This situation could have caused us to never have reached out to some subjects in reality since their telephone numbers on file were outdated or recorded in a wrongful way. Phone numbers issues constitute a true barrier in the field of automated RR interventions. In a systematic review study about barriers observed in RR interventions, researchers found out that wrong phone numbers, unresponsive phone numbers and constant changes of phone numbers were identified as barriers leading to nonsignificant increase in baseline rates (Szilagyi et al., 2006). In addition to these barriers, healthcare providers and institutions have also doubted the effectiveness of automated RR interventions because they believe that it might be very difficult to track the trajectory of reminders once they were sent out (Pereira et al., 2012). For this main reason, they tend to be more conservative and prefer to rely on their usual standard of care for reaching out to patients who are due for any type of appointment (Pereira et al., 2012). Other concerns related to automated RR reminders such as privacy equity have been

raised by several patients who received those reminders (Ames et al., 2017). Patients were wondering whether it was safe to have their personal information or their children's personal information disclosed to those reminders; especially if they could not remember having given their consent for such actions (Ames et al., 2017). Another limitation to this study was about language barriers. Some subjects were non-English or non-Spanish speakers, instead they were Vietnamese, Arabic or Swahili speakers. The reminder system that we used to send automated RR messages to recipients could only send them in English or Spanish. Due to this limitation, patients who were not speaking the system-preferred languages could have missed an opportunity to schedule an AWC visit. The quasi-experimental characteristic of this study design was also a barrier because subjects were non-randomly assigned to their intervention arms. This situation has caused selection bias and confounding effects to occur. Due to this study design, multicollinearity was almost unavoidable among covariates of the same type such as the exposure variable and the demographical area variable. Randomization at the patients' level could have fixed issues related to the study design. Finally, a limitation was perceived throughout the collected outcome for this study. Most of the studies related to automated RR interventions utilized receipt of completed appointments as their main outcome (Szilagyi et al., 2012). This outcome ensures the guaranty that the appointment truly took place at the doctor's office. In our study, receipt of scheduled appointments was utilized as the main outcome. It was collected by doing manual and programming chart review. However, this outcome did not guarantee that the visit truly took place. In this study's cohort, subjects were likely to cancel or reschedule their appointment after scheduling an AWC visit following the RR interventions. This shows that our collected outcome did not reflect the real

completion trends of appointment rates across the different levels of intervention. Such outcome was collected due to the limited timeline available for this research. The follow-up period of six weeks was relatively small and allowed us to collect a short-term outcome consisting of receipts of scheduled appointments rather than receipt of completed appointments. Future research on this topic must focus on longer follow-up periods and randomization at the patients' level in order to easily collect outcomes related to receipt of completed appointments.

Conclusion

The goal of this research was to compare the effectiveness of two methods of automated RR interventions which are 'phone-only' and 'phone-and-text' in order to evaluate which method was the most effective in helping parents/guardians and young adults to schedule an AWC visit. When comparing both automated RR interventions, the combination of automated telephone calls and automated text messages was the most effective method in a timely manner and in terms of high scheduling rates. Both automated RR interventions were also compared to a control group involving in-person telephone calls performed by CHW for scheduling purposes, and results have shown that the combination of automated telephone calls and automated text messages was the most effective method in a timely manner and in terms of better scheduling rates achievements as compared to the one used in the control group. Primary care facilities which are aiming to implement automated RR interventions programs could rely on the use of the combination of automated telephone calls and automated text messages in order to reach out to their cohort of children and adolescents. This could help to easily close

HEDIS metric gaps related to a younger population of patients, who are using public insurance and who are at risk of not closing their gaps for pediatrics metrics such as, childhood immunizations, adolescent immunizations, HPV vaccines and flu shot vaccines. This type of intervention could be extended to older cohorts in the short and long-term. Implementing such intervention could also help to boost patients' scheduling rates more rapidly and effectively remind them about their healthcare agenda. Future research should focus on RCT studies which are investigating on the rates of completion of AWC visits, when automated RR interventions such as the combination of automated telephone calls and automated text messages are implemented in primary care facilities and other public health facilities as well.

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