The Duke Hot-Spotting Initiative: Understanding the Role of Medical Students in Improving Patient Outcomes through a Relationship-Based Care Management Program

By

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Abstract

Background: In response to increasing healthcare costs in the United States, the Institute for Healthcare Improvement released the triple aim goals to inspire the creation of programs that would improve quality of care, overall health, and reduce costs simultaneously. Care-management programs are one such initiative that many sites are using to address patient needs. More recently, student-led care management initiatives have been introduced; however, there is limited evidence on the effectiveness of these programs for improving patient outcomes.

Objective: The Duke Hot Spotting Initiative (DHSI) is a student-led program started in 2015 aimed at addressing health disparities and high health care costs through a relationship-based care management model. The purpose of this analysis is to examine the effect of the DHSI initiative on specific patient health and utilization outcomes.

Methods: This is retrospective review of the past three phases of the DHSI program in Durham, North Carolina. Eligible DHSI patients were those enrolled in preexisting care-management programs at Duke Outpatient Clinic. Mean hemoglobin A1c (HbA1c) and blood pressure readings were compared from the end of the 6-month pre-intervention period to the end of the 6-month intervention period and use as surrogates for type II diabetes mellitus (T2DM) and hypertension respectively. Emergency department (ED) utilization rates and no-show rates were also compared over this time period.

Findings: Twenty-nine participants were included in this analysis. Mean hemoglobin A1c values decreased from 9.0 to 8.3 ($p = 0.249$) and systolic blood pressure (SBP) decreased from 142 to 137 mmHg ($p = 0.494$) ED utilization rates decreased by 20% ($p = 0.970$) while no-show rates increased by 20% ($p = 0.239$).

Conclusions: These results demonstrate that student-led navigation under the supervision of a care manager has had a non-statistical yet clinically significant improvement in measures of HbA1c, SBP, and ED utilization rates. The enrollment of patients from previous care-management programs may diminish the full benefit that students have on patient outcomes. This analysis shows that such a model of care-management led by students is a promising strategy. Future studies could measure outcomes in a larger patient sample and also assess qualitative outcomes such as well-being and achievement of patient-specific health goals.

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Introduction

The Care Management Model

The 2008, the Institute for Healthcare Improvement (IHI) introduced the triple aim that innovative solutions to improve the healthcare system need to simultaneously "improving the experience of care, improving health of populations, and reducing per capita costs of health care[1]." The aims further emphasized the need for an "integrator" that can establish bonds with patients and families, redesign the current primary care practices, practice population and financial management, and still be integrated in to the greater health setting[1].

A number of new programs and initiatives have since been created including Patient Centered Medical Homes and community-based clinics, but one in particular seemed to expand quickly: care management programs. The components of care management programs include (1) identification, stratification, and prioritization of patients who have both increased risk and greatest potential for improvement, (2) multi-disciplinary, patient-specific, patient-engaging interventions (3) systematic program evaluation of effectiveness and (4) payment support of providers and patients who engage in the program to establish accountability[2–4]. The exact structure, protocol, and even the term "care management" varies from site to site but the end goal is the same: improve each patient's quality of health while reducing the need for unnecessary and expensive medical interventions[3].

Strategies & Populations

Care management programs have significant variation in their target populations and interventions. In one example, nurse care managers engaged patients with depression using self-management support strategies[5]. In another setting, patients with congestive heart failure underwent a home health care management program integrated with telehealth strategies[6]. Target populations are discovered by an evidence-based review of patient need and their overall contribution to increasing costs of care. Two large populations that have been recently highlighted are those patients with chronic diseases and those consider to be high healthcare utilizers[7,8]. In 2012, 86% of healthcare spending in the United States was directed towards patients with at least one chronic condition, and 72% was directed towards managing patients with multiple chronic disease[9]. Medicaid data from 2010 shows that the addition of even one chronic condition can increase Medicaid Part A payments by a factor of 5.4, and this

continues to increase with more conditions[10,11]. Meanwhile, the Robert Wood Johnson Foundation reported that in 2008 and 2009, 5% of the sickest patients were causing more than 60% of health care costs[12].

Care Management & Hot Spotting

The use of the "hot-spotting" program to identify patients with high utilization rates was pioneered by Dr. Jeffery Brenner and the Camden Coalition of Healthcare Providers (CCHP) in 2011[13]. Brenner discovered that in six years (2002 to 2008), two low-income complexes in Camden, New Jersey were home to about nine hundred patients who together accounted for four thousand hospital visits adding up to about two hundred million dollars in health-care bills[14].

Brenner worked one on one with Camden primary care physicians and ED doctors to identify the sickest patients and look for patterns that were driving the trend of high utilization. He found that many patients had chronic uncontrolled health diseases that were mainly out of control due to social determinants of health that were never addressed. For some it was lack of consistent transportation, others had poor but correctable vision and could not read their medications.

This was the basis for creating the coalition "out-reach team." In line with the care management principles, each team was interdisciplinary and included a registered nurse, one or two nurse practitioners, a social worker, health outreach doctor, and a family medicine doctor. They visited their patients in any and all settings from the home to the hospital with the goal of understanding and creating personalized innovative solutions to address social determinants that were driving poor health and increased utilization. The thirty-six patients in their pilot program demonstrated a decrease from sixty-two visits per month before joining the program to thirty-seven visits after. Health expenditures similarly decreased by half after the intervention[13]. This program earned Dr. Brenner the MacArthur Genius Grant in 2013 to further the vision and potential of the program to new sites across the United States[15].

The Duke Out-Patient Clinic

When the Duke Outpatient Clinic (DOC) in Durham, North Carolina found that approximately 2% of their patients accounted for nearly 20% of ED visits, the integrated care management approach (described below) seemed most appropriate for intervention. As of October 2015, the was the primary care home for approximately 4,000 patients of whom 58% were insured by Medicaid and another 13%

were uninsured. Among these patients, the four most frequent diagnoses were hypertension, mental health (depression, schizophrenia, etc.), cardiovascular disease and diabetes.

Home-BASE: With these disparities in mind, Dr. Natasha Cunningham and her team developed the HomeBASE (Better Access, Service Enhancement) program in 2013 with the goals of "providing care at the lowest cost, at the most-cost effective sites of service and reducing avoidable inpatient admissions." The HomeBASE program team consisted of a care manager, a nurse practitioner, a med-psych provider, and a social worker. This team worked together identified those patients who were the highest users of emergency and inpatient care by conducting a 6 to 12-month chart review to categorize utilization. Patients were included in the HomeBASE program if they had six or more hospitalizations or ED visits over the course of 6 months or through direct referral by providers[16]. As a part of the behavioral health-focused intervention, each of these patients was then flagged in the medical records, given greater access to the DOC, including same-day appointments and access to nonemergency transportation. Increased access combined with longitudinal monitoring by a care manager who had real-time notification of ED check-ins. Over the course of one year, ED visits reduced by 43%[16]. This combined with a decrease in hospital admissions as well as a 30-day readmission rate led to a net savings of $589,356 in one year.

*HIDOC***:** In March 2017, a second HomeBASE program, Highly Individualized Dedicated Onsite Care, or HIDOC program was launched to include patients who had six ED visits over one year of which at least three resulted in inpatient hospital admissions. The difference between HomeBASE and HIDOC was the primary goal of the program: for HIDOC the goal was to reduce inpatient hospitalizations while for HomeBASE the goal was to reduce ED visits. Thus, the role of the nurse manager differed for HomeBASE is centered on community, social resources, and mental health, while the nurse manager for HIDOC is trained to do hands on care in the clinic. In both programs, the nurses were responsible for case management which included chart reviews, follow up calls, scheduling, refills, and care coordination with providers.

Student-Led Health Initiatives

Can students act as care-managers? Student-run clinics have been essential within a number of medical communities as a way to help underserved populations receive healthcare, while also allowing

medical students to gain exposure working with patients in a community setting and learning clinical skills[17]. There has been a great deal of literature pertaining to the effects of student run clinic on the improving students' overall attitude towards underserved populations as well as literature showing that student run clinics are generally performing well at addressing health outcomes[18,19]. More recently, programs have started to emerge where early medical learners serve as health navigators and care coordinators for patients with diseases across the board, from cancer to obesity[20,21]. Such interventions vary with respect to specific diseases but have the same goal for students to understand and address each individual patient's social determinants of health to improve overall disease state [22] Understanding the ability of such interventions to improve patient outcomes is necessary before expanding to other medical school sites. So far, the literature pertaining to the overall benefit of these interventions is limited and heterogeneous in terms of intervention length, exact role of the care-manager, and outcomes measured. A review of this literature can be found in Appendix B.

The Duke Hot-Spotting Initiative (DHSI)

In 2015, two students, Jerry Lee and Morgan Hardy, from the Duke University School of Medicine created a program that integrated first year medical students into the HomeBASE program. DHSI is a student-run initiative structured as a relationship-based care management model for high risk patients. Our program was developed with the goal to increase patient trust in the healthcare system for the HomeBASE patients while also offering first year students a clinically focused opportunity to become exposed to the reality of the socioeconomic barriers. In addition, our program also aimed to build student skill sets in addressing behavior change for underserved and vulnerable populations.

The program is structured such that over the course of 6 months, a pair of students serve as care managers for one patient. In this role the students are expected to do the following: (1) learn and use motivational interviewing techniques to help patients identify specific, measureable, attainable, realistic, and timely health goals; (2) take responsibility of conducing a needs assessment and connecting their patient to appropriate existing community resources that could help reinforce their goals; (3) follow patient progress and upcoming appointments, as well as document their own interaction in the electronic medical record (EMR); (4) conduct home visits and attend appointment visits at least once a month as appropriate, (5) regularly consult with the nurse care manager or social worker involved with patient's care to coordinate

next steps; and (6) have regular contact with their patients via phone or text on a weekly basis.

To assist with these responsibilities, we created a hot-spotting curriculum where students actively participate in 13 didactic and debrief sessions focused on developing skills such as motivational interviewing, community resources, and navigating mental health. Each year we have also allowed the topic of one session to be decided by the students depending on what they felt was most pertinent to their current patient's needs. These sessions have included understanding insurance coverage and the opioid crisis. An example of the full timeline and syllabus from 2017-2018 is detailed in Appendix A.

The pilot program was conducted in the spring of 2015 with six students in order to troubleshoot difficulties contacting patients and the logistics of the program. The first phase of the full program began in the fall of 2015 with 20 students and 10 patients from the HomeBASE program; the intervention period lasted from November 2015 to May 2016. A review of the first phase of the program found a decrease in rate of ED visits and admissions as well as an increase in Patient Activated Measure® and an increase in students' comfort with AAMC core competencies[23,24]. With these results, the program was poised to enter phase II. Phase II had 16 students and 8 patients from the HomeBASE program with an intervention period from November 2016 to May 2017. Phase III which just completed this spring had 24 students and 12 patients, 5 of these patients were from the HomeBASE program with Marigny Bratcher, RN as their care manager while the remaining 7 patients were from the HIDOC program and were overseen by Holly Causey, PharmD or Jan Dillard, LCSW.

The purpose of this analysis is to observe how DHSI has effected patient health and utilization outcomes since it began in 2015. We hypothesize that due to the confounding of having patients who have already been enrolled in a care-management program, we will not see any significant improvement in patient outcomes and utilization rates from the 6 months they were solely under the responsibility of a care manager verses the 6 months they were working with students under the supervision of a care manager.

Methods

Study Overview & Key Questions:

For this study, a secondary data analysis was conducted to evaluate the effect of the Duke Hot Spotting Initiative Program. Patient outcomes of interest included the following: (1) Utilization numbers for ED visits and no-show rates (2) HbA1c (3) blood pressure readings (SBP & diastolic blood pressure - DBP). This retrospective analysis of a three-year program was deemed exempt by the institutional review board of the Duke University Health System. The following research questions were examined:

1) Do student-led care management interventions lead to a decrease in ED visits and no-show rates during the intervention compared to before?
2) Are patients more likely to have controlled T2DM and hypertension after a student-led care management intervention?

Study Sample

To be eligible for DHSI and this study, patients were (1) active at the Duke Outpatient Clinic in Durham, North Carolina, (2) enrolled in either HomeBase or High Doc programs (3) had a chronic illness or complex social backgrounds as subjectively decided by their care managers, and (4) were receptive to working with student volunteers. During the first two years, all patients (n=26) were participants in the HomeBase program. During the third year of the program, patients were recruited from both the HomeBase program and the HIDOC program. The only exclusion criteria for entering into the Hot Spotting Program was if the patient had a psychiatric illness only (but no other chronic diseases). Patients were included in the data analysis if they participated in all 6 months of the program and had data available via the online EMR (EPIC), both before the program and throughout the intervention period.

All students directly interacting with the patients were first-year medical students enrolled at the Duke University School of Medicine. Students self-selected to apply to the program and were chosen as volunteers by student leadership based upon their responses to the application.

Data Sources

The clinical patient data for this study was obtained through the Duke University Health System EMR, EPIC. Student survey responses were collected anonymously through the Duke Qualtrics site.

Variables

Demographics

Demographic data was collected from the EMR and separated by phase of intervention.

Systolic and Diastolic Blood Pressure

SBP and DBP were defined as the average of the last 3 consecutive blood pressure readings during the pre-intervention period and post-intervention period for each phase of patients. When more than 1 reading was measured during a visit, the value with the highest systolic was recorded. This method was used to estimate towards the null hypothesis.

Hemoglobin A1c

Baseline HbA1c was calculated as any HbA1c collected during the pre-intervention period for each phase group. Similarly, the intervention HbA1c calculated was the final HbA1c recorded during the set intervention time period. Pre-intervention and intervention recordings were separated by at least 3 months.

Utilization Rates

For both the pre-intervention time period and the intervention time period, ED visits and number of no-show visits were calculated by the number of such encounters recorded in the EMR.

Difference in dependent variables among pre-intervention and intervention groups

Statistical comparisons were made between the patient group means for SBP, DBP, HbA1c, and rates of utilization.

Data Analysis

All analyses were performed using Microsoft Excel 2011 and Stata SE v. 16 (College Station, TX). An alpha level of 0.05 was used as the metric for statistical significance.

Patient Characteristics by Phase

Patient characterizations were recorded for each phase of the intervention. The means and standard deviations were recorded for the continuous variables, while proportions were recorded for categorical variables. ANOVA and chi-squared tests were used to compare the characteristics across each phase of the intervention.

Diabetes control, hypertension control, healthcare utilization rates

HbA1c served as a proxy for T2DM control, while SBP and DBP were representative of hypertension control. Because those diagnosed with T2DM and hypertension were a subset of the total included population, I tested the means with a Wilcoxon signed-rank test because I could not assume normality given the small sample size. The Wilcoxon signed-rank test produced a z-statistic. I also used a Wilcoxon signed-rank test to analyze utilization rates because though there was a slightly greater sample size, the data did not assume a normal distribution. In order to test for significance by phase of intervention, I then used the Kruskal-Wallis test on the difference in pre- and post- intervention mean HbA1c, SBP, and DBP.

Given the non-normal distribution of the count data, I then used a Poisson regression model to assess the relationship between ED visits during the intervention period with the pre-intervention data. I confirmed the use of model by checking for over-dispersion of the data with a Goodness of Fit analysis. The results of this analysis showed that this model was appropriate. Potential confounders included age, gender, and phase of intervention. Because of the limited sample size and the assumptions of the Poisson regression, I only included the phase of intervention and gender in the final model as potential confounders. I attempted to use a Poisson regression model on count of no shows as well; however, there was significant over-dispersion even after accounting for all of the potential confounders. Instead, I used a negative binomial regression model for over-dispersion in the no-shows. Due to the even smaller sample size of individuals diagnosed with T2DM and hypertension, I was unable to use any forms of linear or logistic regression to assess the relationship in variables for these outcomes.

Results

Patient Demographics

The patient demographics for all three phases are detailed in Tables 1 and 2. A total of 29 patients were included in this study. 9, 8, and 12 patients completed phases I, II, and III of the intervention respectively. Across all three phases, there were no statistical differences in age at time of starting pre-intervention, gender, or race distribution. There was also no difference in the distribution of individuals diagnosed with T2DM and hypertension, or the baseline HbA1c levels and blood pressure readings. Of the 29 patients, the average age was 53 years, with 16 identifying as female (55.17%) and the rest as male. All but one patient was African American. Fifteen of the 29 were at least diagnosed with T2DM, and 19 of the 29 were at least diagnosed with hypertension.10 patients were diagnosed with both chronic illnesses and 5 were diagnosed with neither. The average HbA1c was 8.8% at the intervention time period with an average blood pressure reading of 142.2 systolic and 79.9 diastolic.

Diabetic Control

Table 3 shows the change in HbA1c from pre-to post- intervention. Only the 13 (of 15) patients with T2DM who had both pre- and end-intervention HbA1c measures and were included in the analysis. Patients post-intervention had a non-significant decrease in HbA1c from 9.0 ±2.5 period to 8.3 ±1.2 ($z = 1.154$, $p= 0.249$). This represents a rate of change decrease by 7%. The Kruskal-Wallis test showed that there was no difference in diabetic control across the phases ($p =0.802$).

Hypertensive Control

Systolic blood pressure decreased from 142.2 ± 19.4 at to 137.5 ± 13.9 at the end of the intervention period ($z = 0.684$, $p=0.494$). This decrease was nonsignificant. This represents an average SBP decrease of 3.2% with individual rate of changes ranging from a 32% decrease to a 26% increase. There was no significant difference in diastolic BP readings from 79.9 ±12.1 to 80.0 ±11.3 $z = -0.141$, $p=0.888$). The Kruskal-Wallis test showed that there was no difference in hypertensive control across the phases ($p =0.137$, $p=0.412$).

Utilization Rates

ED visits decreased from an average of 3.8 ± 3.3 from pre-intervention to an average of 3.0 ± 2.5 post-intervention. ($z= 0.037$, $p = 0.970$), representing a 21% decrease in ED visits. The fully adjusted

Poisson regression model by phase showed a significant relationship (p = 0.018) between pre- and post-intervention counts for ED visits when accounting for phase and gender as potential confounders.

The number of no-shows increased from an average from 4.6 ± 3.0 during the pre-intervention period to an average of 5.5 ± 4.9 during the intervention period (z= -1.178, p = 0.239*);* this represents a 20% increase from the pre-intervention period. The fully adjusted negative binomial regression model by phase showed a significant relationship between pre- and intervention no show counts after confounding for phase and gender.

Discussion

This analysis of the Duke Hot-Spotting Initiative demonstrates that having medical students added to the care of patients with complex socioeconomic and medical backgrounds does not significantly improve their health outcomes over a six-month time period. though there is evidence of clinically significant improvements.

The students and care managers involved in the care of this program are not instructed to focus efforts on controlling blood pressure or diabetes. Instead, the students are given the role of patient navigators and care managers with a goal of helping the patient get reconnected with the health care system and take their own initiative to seek out change and improve their own health. We examined this effect on health of this program by measuring both chronic disease state markers as well as healthcare utilization rates.

Looking first at the effect of this program on chronic disease states, it is notable to mention that having T2DM or hypertension as a chronic disease was not an eligibility requirement for the program, and there were five patients who did not have either diagnosis. Comparing patient characteristics across phases of the intervention revealed that while most demographic information such as age, race, and gender was distributed evenly, patients in phase II had worse diabetes control at baseline and patients in phase III had higher blood pressure at baseline. None of these observations were statistically significant, however, but raise concern about confounding due to differences in baseline health patients enrolled at different phases and (potentially) differences in their ability to make changes that could improve their chronic disease state.

For those who were included in the analysis, pre-intervention measures of both HbA1c (>6.5) and SBP (> 140 mmHg) were in the uncontrolled range. With an average decease in HbA1c from 9 to 8.3 post-intervention (7% decrease), this change is clinically meaningful even though it was not statistically significant. Similarly, the decrease in SBP by 5 mmHg (or 3%) may be clinically relevant given that the mean SBP at the end of the intervention period falls under some recommendation guidelines which look for SBP <140. In terms of utilization rates, the results show a non-statistically significant decrease in ED utilization rates (21%) as well as an increase in no-show rates (20%). There was a statistically significant correlation between the no-show rates prior to intervention and during the intervention.

This discrepancy requires further exploration. One theory for this increase, could be an overall increase in outpatient utilization as the patients become more connected to the health care system. If patients were not used to going to more appointments, the patients may become overwhelmed and less inclined to go, less likely to get consistent transportation, and less like to fit in the appointments with other commitments even if the students assist with the process. The number of appointments generally increases for patients enrolled in a care-management program. These results offer an opportunity for future students to particularly sit down with their patient to look over the upcoming schedule and determine how in-line these appointments are with the patient's overall goals. There is a significant relationship between pre- and post-intervention no-show rates, indicating that perhaps a patient-specific targeted intervention should be implemented to improve this behavior. However, an increase in the total number of outpatient visits (a count of which was not available for this analysis) might also account for this difference. Looking at the proportion of missed appointments to attended appointments could further inform why no-show numbers increased.

Another potential reason for the increase in no-show rates may be due to the time of year during which this intervention takes place. The intervention takes place over the holiday months, during which time many students leave Durham and are less likely to follow up with patients who are also less inclined to leave their family and homes during the cold to attend yet another appointment. Further analysis should be conducted to see if there is a trend depending on the time of year. This would be especially informative to help leadership teach the students how to engage with their patient when they are out of town or changing appointment times to a time outside the holiday window.

Together, these results inform how to modify the DHSI program in future years. Not all of the patients have chronic diseases, and other measures should be considered to determine whether the students and patients are able to work together to achieve their stated self-care goals and improvement in addressing specific social determinants of health. Future leadership should consider adding standardized measures whether it is a pre-and post-health needs assessment or measures of patient engagement.

A significant voice missing from this analysis was that of the patients. No qualitative feedback was recorded in a standardized manner during this analysis; however, anecdotal patient reports from the final dinners show an increased satisfaction in the healthcare system and increased trust in their

providers as a result of having the students as health navigators. One patient said "[The students] made me trust my doctors more." Another said: "Lost 35 pounds, I'm going to my doctor's appointments – I was scared of them before. Whenever I would go to the doctor, they would say something was wrong. I learned that these doctors are here to help you, but at the same time you have to help yourself." This anecdotal evidence coupled with quantitative analysis and student survey reports demonstrates that while health outcomes may not be significantly revealing at this time point, further examination of qualitative data such as quality of life or health assessment factors are another area to assess to understand exactly how the student-led initiative contributes to patient care.

In the context of previous published research, these results share some similarities to other student-run navigational programs[20,25–27]. Wee *et al.* (2011) and Gorrindo *et al.* (2014) both showed increased hypertensive and diabetic control as well as increased connection with the health system recorded by screening measures and health care touchpoints respectively. Brown *et al.* (2015) and Lough *et al*. (2011) also both showed improvements in their disease specific outcomes which were body measurement index and smoking cessation respectively. A few key differences are that while this analysis showed improvement in mean HbA1c and BP control, our results were non-significant and the intervention was not specifically targeted towards these diseases. ED visits and no-show rates were not used as measures in the studies we analyzed.

Overall these results were as expected given that this was a non-random sample of patients, most of whom had already been engaged with either the care-managers of the HomeBASE program or the HIDOC program. As these overarching programs are targeting utilization and control of chronic health conditions, the patients were undergoing care management during their pre-intervention time period directly by one care-manager verses directly by two students with oversight from a care-manager during the intervention time period. The ability of the students to help improve chronic disease measures and decrease ED rates demonstrates that students under the supervision of a care manager may provide some additional benefit to patient care and also help ease the overall load of the care managers. These results are however, a model for encouraging future student programs looking to take on a navigational or care management role.

Limitations

This study analysis was limited by a few factors. First, the patients were already enrolled in the HomeBASE and HIDOC programs prior to DHSI which introduces confounding interactions that are difficult to control for. These are structural limitations and are unlikely to be removed given that DHSI is structured around these programs to allow for adequate supervision. Secondly, the way the program is structured also allows for a fair bit of heterogeneity and lack of standardization in terms of how each student pair interacts with their patient, which is difficult to capture in quantitative form. Further records could collect this data by recording how many care-management encounters occur with the students whether in person or over the phone. Given the restraints of the program, we have only been able to have f 8-12 patients in each of the three phases, which resulted in a small overall sample size that further diminished when specifically examining the chronic disease subsets. The small sample size as well as large standards of deviation found in the patient characteristics demonstrate the great variability in baseline health for all of these patients. We also were unable to account for other potential confounders such as education level, income, and marriage status that could also confound the data. Given that some patients have been involved in multiple phases of the program also increases confounding. Post-intervention data was not included in this analysis given that the sample size would include less than 20 patients in total from the first two phases.

Conclusion

An evaluation of the first three phases of the Duke Hot-Spotting Initiative in conjunction with the Duke Outpatient Clinic reveals that this model of student-led navigation under the supervision of a care manager has had a non-statistical yet clinically significant improvement in chronic disease measures of HbA1c, SBP, and ED utilization rates. Confounding factors of having patients from previous care-management programs may diminish the full effect that students have on patient outcomes. Our analysis shows that such a model of care-management led by students could be effectively used in future programs, though further analysis should be conducted to measure qualitative patient well-being as well as achievement of patient-specific health goals.

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Data & Tables

Table 1 – Patient Characteristics by Phase

	Group			
	Phase I	**Phase II**	**Phase III**	**P**
Sample Size (n) (%)	9 (31.03)	8 (27.59)	12 (41.38)	
Age at Pre (yrs)				
Mean (SD)	57.556 (9.275)	48.125 (12.415)	52.75 (16.204)	0.363
Gender				
Male (%)	5 (55.56)	4 (50)	4 (66.67)	
Female (%)	4 (44.44)	4 (50)	8 (33.33)	0.564
Race/Ethnicity				
Black (%)	9 (100)	7 (87.50)	12 (100)	
Other (%)	0 (0)	1 (12.50)	0 (0)	0.257
T2DM diagnosis	4 (44.44)	4 (50)	7 (58.33)	
HTN diagnosis	7 (77.78)	5 (62.50)	7 (55.33)	
Baseline HbA1c	8.900	10.375	7.987	0.429
Baseline SBP (SD)	133 (±13.038)	136.4 (±12.461)	155.429 (±22.781)	0.0613
Baseline DBP (SD)	84.143 (±9.423)	82.2 (±8.927)	74 (±15.895)	0.290

Table 2 – Patient Characteristics in Aggregate

Sample Size (n) (%)	29
Age at Pre (yrs)	
Mean (SD)	52.966 (±13.407)
Gender	
Male (%)	13 (44.83)
Female (%)	16 (55.17)
Race/Ethnicity	
Black (%)	28 (96.55)
Other (%)	1 (3.45)
T2DM diagnosis	15 (51.72)
HTN diagnosis	19 (65.52)
Baseline HbA1c (SD)	8.812 (±2.949)
Baseline SBP (SD)	142.158 (±19.351)
Baseline DBP (SD)	79.895 (±12.391)

Data compiled by myself. Key: SD, standard deviation; pre, six-months before intervention; int, six-months during intervention; HbA1c, hemoglobin A1c; SBP, systolic blood pressure, DBP, diastolic blood pressure; HTN, hypertension; T2DM, type 2 diabetes mellitus. Comparisons were made by ANOVA for continuous variables and a chi-squared for categorical variables. Statistical significance set at $p<0.05$

Table 3 – Change in HbA1c

	HbA1c
Sample Size (n)	13
HbA1c (SD) Pre	9 (±2.525)
HbA1c (SD) Int	8.331(±1.957)
Wilcoxon Signed Rank p	z = 1.154 p > |z| = 0.249
Change in HbA1c (SD) (pre-int)	.669 (±1.957)
% change in HbA1c	-7

Data compiled by myself. Key: SD, standard deviation; HbA1c, hemoglobin A1c; pre, six-months before intervention, int, six-months during intervention Comparisons were made by a Wilcoxon signed-rank test (z-statistic). Statistical significance set at $p<0.05$

Table 4 – Change in HbA1c by Phase

Kruskal-Wallis	
X^2	0.441
p	0.802

Data compiled by myself. Key: HbA1c, hemoglobin A1c; Comparisons were made by a Kruskal-Wallis Test of Differences (X^2). Statistical significance set at $p<0.05$

Table 5 – Change in SBP

	SBP
Sample Size (n)	19
Systolic BP (SD) Pre	142.158 (± 19.351)
Systolic BP (SD) Int	137.474 (± 13.902)
Wilcoxon Signed Rank	z = 0.684
p	p > |z| = 0.494
Change in SBP (SD)	4.684 (± 21.328)
% change in SBP	-3.21%

Data compiled by myself. Key: SD, standard deviation; SBP, systolic blood pressure; pre, six-months before intervention, int, six-months during intervention Comparisons were made by a Wilcoxon signed-rank test (z-statistic). Statistical significance set at $p<0.05$

Table 6 – Change in SBP by Phase

Kruskal-Wallis	
X^2	3.976
p	0.137

Data compiled by myself. Key: SBP, systolic blood pressure; Comparisons were made by a Kruskal-Wallis Test of Differences (X^2). Statistical significance set at $p<0.05$

Table 7 – Change in DBP

	DBP
Sample Size (n)	19
Diastolic BP (SD) Pre	79.894 (±12.096)
Diastolic BP (SD) Int	79.947 (±11.306)
Wilcoxon Signed Rank	z = -0.141
p	p > |z| = 0.888
Change in DBP (SD)	-0.053 (±10.244)
% change in DBP	0.18

Data compiled by myself. Key: SD, standard deviation; DBP, diastolic blood pressure; pre, six-months before intervention, int, six-months during intervention. Comparisons were made by a Wilcoxon signed-rank test (z-statistic). Statistical significance set at $p<0.05$

Table 8 – Change in DBP by Phase

Kruskal-Wallis	
X^2	1.773
p	0.412

Data compiled by myself. Key: DBP, diastolic blood pressure; Comparisons were made by a Kruskal-Wallis Test of Differences (X^2). Statistical significance set at $p<0.05$

Table 9 – Change in ED utilization

	ED Utilization
Sample Size (n)	29
ED visits (SD) Pre	3.759 (±3.259)
ED visits (SD) Int	2.966 (±2.543)
Wilcoxon Signed Rank P	z = 0.037 p > |z| = 0.970
Change in ED visits (SD)	0.793 (±3.458)
% change in ED	21

Data compiled by myself. Key: SD, standard deviation; ED, emergency department; pre, six-months before intervention, int, six-months during intervention. Comparisons were made by a Wilcoxon signed-rank test (z-statistic). Statistical significance set at $p<0.05$

Table 10 – Change in ED utilization Poisson Model

	Unadjusted change in ED visits (95% CI)	p	Fully adjusted change in ED visits (95% CI)	p
Intervention	0.072 (-0.019, 0.164)	0.122	0.083 (0.014, 0.151)	0.018

Data compiled by myself. Key: ED, emergency department; CI, confidence interval. 1. Adjusted for gender, and phase Statistical significance set at $p<0.05$.

Table 11 – Change in No Show Rates

	No Show Rates
Sample Size (n)	29
No Show (SD) Pre	4.55 (±3.054)
No Show (SD) Int	5.483 (±4.896)
Wilcoxon Signed Rank P	z = -1.178 p > |z| = 0.239
Change in No Show (SD)	-0.931 (±3.494)
% change in No Show	20

Data compiled by myself. Key: SD, standard deviation; pre, six-months before intervention, int, six-months during intervention. Comparisons were made by a Wilcoxon signed-rank test (z-statistic). Statistical significance set at $p<0.05$

Table 12 – Change in No Show Rates Negative Binomial Regression Model

	Unadjusted change in no shows (95% CI)	p	Fully adjusted change in no shows[1] (95% CI)	p
Intervention	0.162 (0.105, 0.218)	0.000	0.160 (0.093, 0.227)	0.000

Data compiled by myself. Key: CI, confidence interval. 1. Adjusted for gender and phase. Statistical significance set at $p<0.05$.

Appendix A: DHSI Syllabus 2017-2018

Duke Hotspotting Initiative (DHSI)

Program Overview, Autumn 2017
Duke University School of Medicine

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Program Overview

The cost of medical care is skyrocketing, largely due to expensive, reactive treatments instead of low-cost, preventive care. Despite universal awareness of this issue, healthcare systems and medical education curricula alike have inadequately prepared health practitioners for practicing cost-effective, coordinated and evidenced-based preventive medicine.

The innovative work of Dr. Jeffrey Brenner and the Camden Coalition of Healthcare Providers (CCHP) largely aims to address these issues. Dr. Brenner's work, known as "hotspotting," identifies the highest utilizers of healthcare and intervenes using a targeted, multidisciplinary care management team. His efforts have reduced hospital visits and cut expenditures in half – simply by focusing on the top 5 percent of patients – and ultimately won him the MacArthur genius grant in 2013.

Duke Hotspotting Initiative (DHSI) integrates ongoing hotspotting efforts at Duke within the medical school curriculum. Funded by the AAMC/CCHP/Primary Care Progress Hot Spotting Learning Collaborative, DukeMed Engage, Chancellor's Service Fellowship, and the Albert Schweitzer Foundation, DHSI is an opt-in alternative to the Community Partners program in Practice Course and involves a 6-month commitment for teams of medical students to coordinate the care of a single, medically and socially complex patient. Student teams will work closely with the Duke Outpatient Clinic (DOC and Lincoln Community Health Center (LCHC).

Learning Objectives

DHSI is partnering with DOC to manage the longitudinal care of patients identified by their high re-hospitalization rates, excessive resource utilization, and/or complex medicosocial histories. Our tripartite mission is to (1) improve health outcomes for patients by improving their care coordination; (2) provide students opportunities to learn about the psychosocial dimensions of health and to practice motivational interviewing, patient goal development and healthcare coaching; (3) benefit the health system by lowering the costs of high-utilizers and connecting patients back into healthcare coordination.

By the end of the program, we expect you to demonstrate:

- Medical knowledge of the basic management of common chronic diseases.
- The ability to prepare accurate patient progress notes using electronic medical records.
- Skills in patient presentations applicable to the wards.
- Professionalism in performing responsibilities with respect, compassion and integrity.
- Interpersonal skills to effectively communicate and collaborate with patients, families and healthcare professionals.
- Awareness of and responsiveness to a systems-based practice.
- The capacity for delivering community-oriented health education to underserved populations.
- Knowledge of community resources and an understanding of the social needs and challenges of Durham's population
- Teamwork as a member of a health care team via interprofessional activities.

Student Responsibilities/Expectations

Students carry out responsibilities in pairs, which are assigned at the beginning of the program. Each pair is matched with a high-utilizing patient. Your primary objectives will be to:

1. Understand the patient's story
2. Work with the patient to understand their barriers to good health
3. Help them identify one self-care goal to overcome such barriers

4. Assist them in their progress toward this goal
5. Document patient interactions and progress via progress notes in the electronic medical record
6. Practice regular reflection on your emotional and physical safety, and seek help as needed
7. Take ownership of your experience by engaging in best practice and giving feedback leadership and me

Self-care goals are identified using motivational interviewing techniques and must be specific, measurable, actionable, realistic, and timely (SMART). Examples of self-care goal topics include smoking cessation, dietary changes, or appointment attendance. Additional training and clarification will be provided during the course.

Additional responsibilities include:

- Attending large group sessions
- Submitting weekly summary to student leader and coordinator
- Reviewing patient appointment schedules weekly and coordinating transportation as needed
- Accompanying patients to appointments if appropriate
- Following up after appointments to assess patient knowledge, medication procurement, and the need for scheduling additional appointments
- Coordinating with the School of Nursing students to connect patients with community resources
- Identifying barriers to treatment plans
- Visiting patient homes to assess socioeconomic dynamics, and performing a medication reconciliation when needed
- Communicating patient show and no-show rates to the DOC and student leadership team.

Course Outline

The program is structured around an initial 5-week training session, followed by a period of 7-months in which students engage in care coordination and hotspotting activities.

All meetings will be held from 6-7pm in TSCHE, Classroom 3, with joint sessions in the Learning Hall, unless noted otherwise.

Schedule

Session 1: Introduction to Hotspotting

- Intro to Jeff Brenner and Camden Coalition
- Intro to Home Base Initiative
- Discuss program expectations

Session 2: Introduction to EPIC and HIPAA ******

-EPIC crash course
- HIPAA
- Interpret patient's utilization data, formulate plan

*Session 3: Home Safety and Reporting*******

- Introduction to SOAP notes

- How to write notes for purposes of DHSI
- Communicating with Marigny and the DOC
- Home visit and safety discussion

Outside the Duke Bubble; a Guided Tour of Where Your Patients Live
- Tour of impoverished areas of Durham led by DOC
- Information regarding the Durham health care disparities

Special Session: Dinner with Patients curriculum
- Meet assigned patient
- Set date for first meeting

Session 4: Motivational Interviewing (Guest Speaker Dr. Sheline)**
- Connecting with patients
- Role Play

Session 5: SMART Goals (Guest Speaker Dr. Sheline)
- Identifying patients

Session 6: Community Resources (Guest Speaker Marigny Bratcher))**
- Overview of Durham
- Aunt Bertha website
- Other resources

Session 7: Holiday Considerations
- Debrief patient visits
- Maintaining contact with patient through the holidays

Session 8: Law Student Information Session (Guest Speakers TBA)
- Discussion on Medicare vs. Medicaid
- Resources available through the Law School

Session 9: Mental Illness Considerations

Session 10: Feedback

Session 11: Open Session

Special Session: Graduation Dinner with Patients

**Indicates joint sessions with other APPLE programs

Appendix B: How Student-Led Navigator Interventions Can Affect Patients' Overall Health and Satisfaction: A Literature Review

Introduction:

Many medical schools have started experiential learning programs for early medical students to serve as health navigators and care coordinators[20,21]. The focus of these interventions varies. Some programs are disease focused, such as cancer or obesity, while others target specific subsets of the population, such as low socio-economic status or increased risk for ED admission. These programs consistently have a curricular component for the students as well as a longitudinal student-led intervention with a patient or group of patients. The goal is for students to gain a broader understanding of social determinants of health and also improve patient outcomes[22]. It is crucial to examine the strength of such programs in achieving their patient goals before disseminating this approach to more medical schools. The two aims of this systematic review are first to determine whether these specific interventions can lead to increased health as determined by disease state and interactions with the health care system and secondly to determine whether these interventions lead to increased patient satisfaction.

Methods:

A search was conducted to find literature examining the effectiveness of student-led interventions for 'at-risk' patients in improving patient health and patient satisfaction was conducted with the assistance of a medical librarian using the following databases: MEDLINE/PubMed, EMBASE, Education Full Text, and ERIC. The search terms included MeSH and EMBASE terms with key terms related to medical-student and student–initiated. All searches were conducted on March 27, 2018 and search strategies can be found in Figure B-1. The scope was left broad in order to cover for any sort of longitudinal navigational role and a broad spectrum of outcomes data. Clinicaltrial.gov was consulted to search for ongoing studies related to student-run interventions; however, there were no eligible studies at this time.

Regarding study selection, full eligibility criteria are described in Table B-2. Observational studies as well as randomized and non-randomized controlled trials were eligible for inclusion. Studies had to take place in an outpatient setting whether it was in a clinic or other community site. Studies that were centered around hospital care were excluded. This review includes studies that used longitudinal student-led interventions with underserved populations and measured outcomes related to patient health and patient satisfaction. To be eligible, the intervention had to include a curricular education component and

longitudinal patient interventions; other intervention components could vary, as well as outcomes measured.

All titles and abstracts were initially screened by inclusion criteria by a single reviewer. The remaining articles underwent full-text review for eligibility. For each included study, one investigator extracted information related to populations, intervention (including intervention lengh), comparators, outcomes, setting, and study design. The quality of cohort studies was rated using Newcastle Ottawa Scale[28] (no randomized studies met final inclusion criteria). A modified list of questions and assessment are shown in Appendix B, Table B-3.

Results

Search Results

A total of 631 records were retrieved from all databases. After removal of duplicates, 582 unique citations underwent initial title and abstract screening. 557 records were excluded, leaving 25 studies as potentially relevant and eligible for full-text screening. From these 25 studies, 4 were appropriate for inclusion in the systematic review based on eligibility criteria. See Figure B-2 for PRISMA flow diagram of selection process and reasons for exclusion. No additional studies met eligibility criteria using clinicaltrials.gov. See Table B-2 for review of study characteristics.

Interventions

All four studies were cohort studies in the outpatient setting, two of which were specifically pre-post interventional cohort studies[26,27]. The interventions varied in size from 45 to 274 student volunteers, with one intervention not reporting this number[27]. Only one program had only medical students deploying the intervention while the other two programs had a mixture of medical, nursing, and other graduate students[20,25,26]. All studies also detailed a description of curricular education programs. Some interventions were specifically home-based[25] while others were in a group[20] or clinic setting[26,27]. The interventions were variable in duration, ranging from 10 weeks to 6 months to 1 year.

Patient Population

All studies were specifically targeting patients from low-income backgrounds. They selected their cohort through homeless clinics, public housing records, and community clinics specifically for uninsured and low-income patients. Intervention cohort sizes ranged from 25 to 257 patients. Wee *et al.* (2011) had

209 patients with 355 in the comparator group, and Brown *et al.* (2015) had 25 to start and 21 in the comparator group.

Study Quality

The assessment of quality was conducted using the Newcastle Ottawa Scale (Table B-3)[28]. Two of the four studies were rated poor quality due to limited or absent description of controlling for potential confounding factors[25,26]. The third study was also given a poor rating due to high attrition rate with minimal discussion or description of the causes of attrition[27].

Outcomes

Each study measured and showed improvement in disease-specific outcomes with significance, though each study measured a different outcome (Table B-2). Wee *et al.* (2011) showed an improvement in awareness, treatment and control of hypertension, while Gorrindo *et al.* (2014) showed improved diabetic control. Brown *et al.* (2015) reported a decrease in weight and overall BMI for student-led groups, and Lough *et al*. (2011) showed an increase in smoking abstinence. Three of the four studies recorded some measure of health care utilization or interaction, but only Wee *et al.* measured and reported improvement in patient satisfaction.

Discussion

Overall, the literature base examining the effectiveness of student-led interventions for 'at-risk' patients is small and heterogeneous. However, the results of this review reveal important findings that may help inform future work in this area. First, there continues to be little research done into patient health, utilization, and satisfaction outcomes of student-led programs particularly those that follow a care-management or navigational approach. More information is available regarding disease specific outcomes, less data is collected regarding utilization and satisfaction. This could be due in part to lack of focus on utilization rates thus far. Second, studies that measure disease specific outcomes and utilization are limited by potential selection bias (inability to randomize a sample of patients), lack of control for important confounders, and significant heterogeneity in intervention components and outcomes measured. These limitations are important to consider in the future design and evaluation of student-led interventions in order to increase certainty about the benefit of interventions. Finally, the results of this review (despite the limitations) is promising; even though heterogeneous outcomes were measured,

studies consistently found benefit for programs that involve students that students in targeted care-management interventions.

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Table B-1: Study Inclusion and Exclusion Criteria

Population	Students: Medical Students Patients: Adults identified as 'at risk' through one or more of the following selection methods: 1) clinical judgement, 2) threshold modeling or 3) by a predictive risk tool ***Exclusion Criteria***: Solely mental health care outcomes, any inpatient outcomes
Intervention/Exposure	Directed extracurricular care coordination or navigational models, service-learning, health coaching
Comparator	Patients 'at-risk' receiving standard of care/no care and Pre-post studies
Outcome	Health: Self-assessed health status, Mortality, disease specific metrics DM, HTN, BMI, ED/Hospitalization Admission Rates Satisfaction: Self-Report or Validated Surveys
Timing	Published Articles in the last 20 years
Setting	Global
Study Designs	Retrospective/Prospective Cohort, Pre-Post Studies

Figure B-1: MEDLINE, EMBASE, Education Full Text, ERIC Search Strategy

Database: PubMed (MEDLINE) Search Date: 3/27/18

Set #		Results
1	"Education, Medical"[Mesh] OR “Students, Medical”[mesh] OR “medical student”[tiab] OR "medical students"[tiab] OR “medical education”[tiab]	183830
2	Student-led[tiab] OR student-run[tiab] OR student-initiated[tiab] OR student-driven[tiab] OR student-developed[tiab]	729
3	#1 AND #2	361

Database: Embase Search date: 3/27/18

Set #		Results
1	'medical education'/exp OR 'medical student'/exp OR “medical student”:ti,ab OR "medical students":ti,ab OR “medical education”:ti,ab	337406
2	Student-led:ti,ab OR student-run:ti,ab OR student-initiated:ti,ab OR student-driven:ti,ab OR student-developed:ti,ab	1002
3	#1 AND #2	541
4	#3 AND [embase]/lim NOT ([embase]/lim AND [medline]/lim)	232

Database: Education Full Text Search date: 3/27/18

Set #		Results
1	DE "Medical education" OR DE "Clinical medical education" OR DE "Medicine -- Study & teaching" OR DE "Premedical education" OR DE "Medical students" OR DE "Women medical students" OR TI (“medical student” OR "medical students" OR “medical education”) OR AB (“medical student” OR "medical students" OR “medical education”)	2177
2	TI (Student-led OR student-run OR student-initiated OR student-driven OR student-developed OR “Student led” OR “student run” OR “student initiated” OR “student driven” OR “student developed”) OR AB (Student-led OR student-run OR student-initiated OR student-driven OR student-developed OR “Student led” OR “student run” OR “student initiated” OR “student driven” OR “student developed”)	772
3	#1 AND #2	8

Database: ERIC Search date: 3/27/18

Set #		Results
1	DE "Medical Education" OR DE "Graduate Medical Education" OR DE "Medical students" OR TI (“medical student” OR "medical students" OR “medical education”) OR AB (“medical student” OR "medical students" OR “medical education”)	12222
2	TI (Student-led OR student-run OR student-initiated OR student-driven OR student-developed OR “Student led” OR “student run” OR “student initiated” OR “student driven” OR “student developed”) OR AB (Student-led OR student-run OR student-initiated OR student-driven OR student-developed OR “Student led” OR “student run” OR “student initiated” OR “student driven” OR “student developed”)	2193
3	#1 AND #2	30

Figure B-2: Systematic Review Flow Diagram

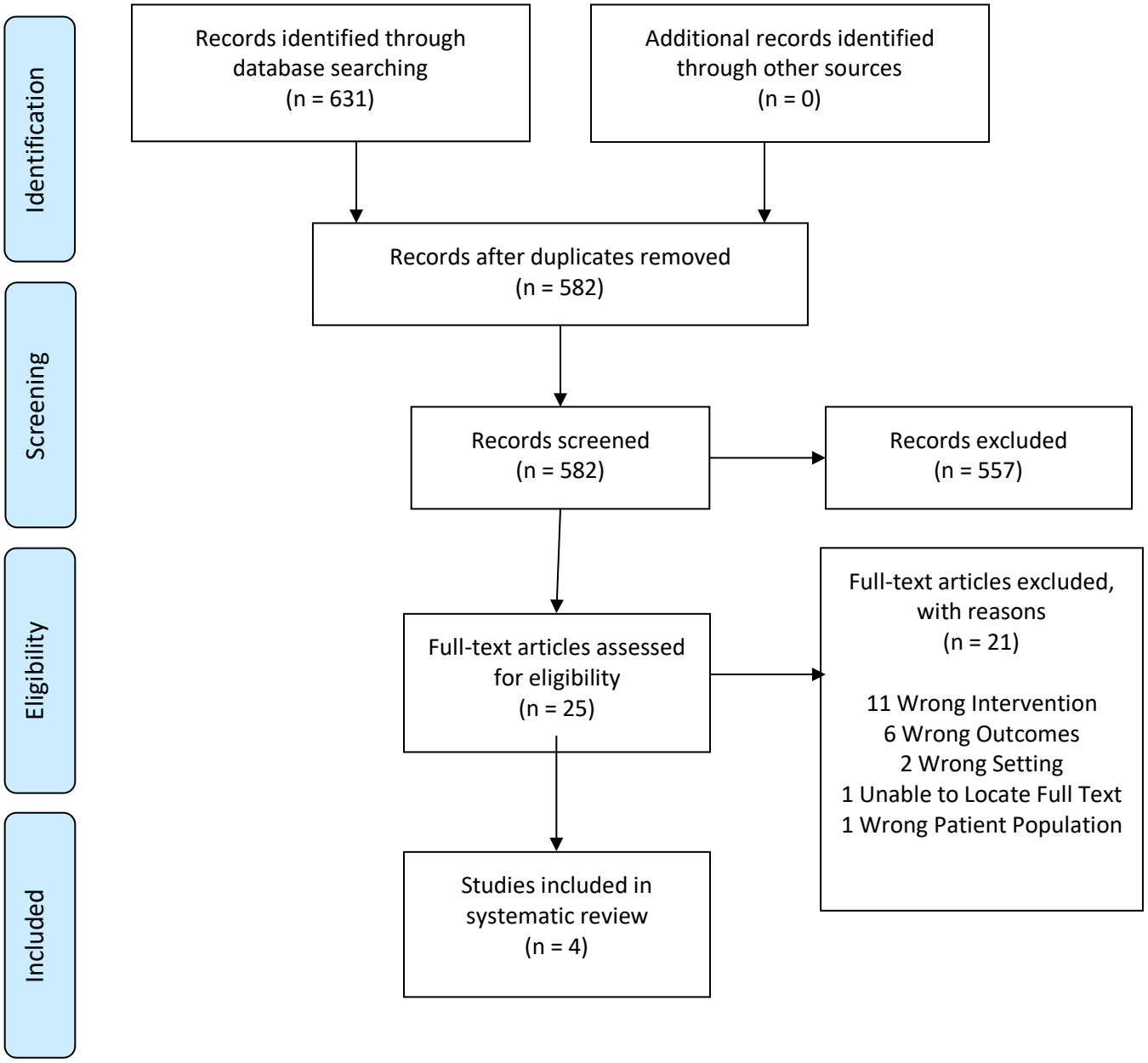

Table B-2: Study Characteristics & Results

Study	Country	Study Design	Student Population	Underserved Patient Population	Care Management Intervention	Curricular component?	Duration of Intervention
Wee et al. (2011)	Singapore	Prospective cohort study, pretest, posttest	240 medical students, 34 nursing students, all volunteers	Low-income, public housing residents	Home-based, service learning	Yes	6 months
Gorrindo et al. (2014)	USA	Prospective cohort study, single group pretest, posttest	286 first and second year medical students, all volunteers	Low-income, underserved community clinic patients	Directed disease management	Yes	1 year
Brown et al. (2015)	USA	Prospective cohort study	25 total nursing, medical, and graduate students, volunteers	Low-income, overweight and obese community residents	Directed disease management	Yes	10 weeks
Lough et al. (2011)	USA	Observational cohort	Not recorded, volunteers	Low income, uninsured community clinic patients	Directed disease management	Yes	12 weeks

Study Characteristics & Results *Continued*

Study	# of patients	Control	Setting	Health Outcomes Measured	Improvement?	Statistical Significance (SS)
Wee et al. (2011)	209 in phase I, 355 in phase II	None	Individual homes	Awareness, treatment, and control of HTN	Yes, Treatment (63% to 93%) and control (42% to 79%) improved	P <0.001
Gorrindo et al. (2014)	45	None	Community Clinic	HbA1c Control	Yes, mean HbA1c improved from 9.6 to 7.9	P <0.0001
Brown et al. (2015)	25	21 in physician led group	Group Teaching Sessions	Weight, BMI	Yes, 2.5% decrease in weight	P <0.001
Lough et al. (2011)	275	None	Smoking Cessation Clinic	Smoking Abstinence	Uncertain, 33% of patients abstained greater than 7 days	None

Study Characteristics & Results *continued*

Study	Utilization Outcomes Measured	Change in Outcomes	SS	Satisfaction Outcomes Measured	Improvement	SS
Wee et al. (2011)	Screening	Improvement in screening of DM, Dyslipidemia, and cancer	N/A	75% agreed that NHS improved health, 85% felt NHS provided enough time to address issues		
Gorrindo et al. (2014)	"Touch-points"	Increased touchpoints correlated with more improvement in A1c values	P=0.10	None	None	None
Brown et al. (2015)	Class attendance	Increased class attendance correlated with greater reductions in weight	P=0.03	None	None	None
Lough et al. (2011)	Clinic attendance	None	None	None	None	None

Table B-3: Risk of Bias

	Selection				Comparability
Study	Representativeness of the intervention cohort	Selection of the non-intervention cohort	Ascertainment of intervention	Demonstration that outcome of interest was not present at start of study	Comparability of cohorts on the basis of the design or analysis
Wee et al. (2011)	Somewhat Representative ★	Drawn from the same community ★	Self-Report/None	Yes ★	Non-Comparable/ Controls
Gorrindo et al. (2014)	Somewhat Representative ★	Drawn from the same community ★	Secure Record ★	Yes ★	Non-Comparable/ Controls
Brown et al. (2015)	Selected group of patients	Drawn from the same community ★	Secure Record ★	Yes ★	Controlled for attendance ★
Lough et al. (2011)	Somewhat Representative ★	Drawn from the same community ★	Structured Interview ★	Yes ★	Controlled for drop-outs ★

Risk of Bias *cont.*

	Outcome			Study Grade
Study	Assessment of outcome	Was follow up long enough for outcomes to occur?	Adequacy of follow up of cohorts	
Wee et al. (2011)	Record Linkage ★	Yes ★	Less than <20% loss ★	Poor due to lack of accounting for comparability/controls
Gorrindo et al. (2014)	Record Linkage ★	Yes ★	Less than <20% loss ★	Poor due to lack of accounting for comparability/controls
Brown et al. (2015)	Record Linkage ★	Yes ★	Less than <20% loss ★	Good
Lough et al. (2011)	Self-Report	Yes ★	Follow up rate less than 80% and no description	Poor due to lack of description and record of high drop-out