ECONOMIC JUSTIFICATION OF COORDINATED CARE PROGRAM FOR THE UNIVERSITY OF MISSOURI HEALTH CARE SYSTEM

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by

LYNDSAY NICOLE HARWOOD

Dr. Cerry Klein, Thesis Supervisor

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The undersigned, appointed by the Dean of the Graduate Faculty, have examined the thesis entitled

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and hereby certify that in their opinion, it is worthy of acceptance.

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Dr. Cerry M. Klein

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Dr. James S. Noble

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Dr. Jerry C. Parker

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Chapter 1

1.1 Introduction

There is a pressing transition in the healthcare field to change the atmosphere of traditional healthcare services[41]. Currently healthcare is fragmented and viewed as "siloed" care[9,20,22], or individual care services that do not coordinate or communicate with other services, similar to the silo grain bins that dot the Midwest's landscape: solitary and disconnected. Hospitals and Emergency Departments are unnecessarily over-utilized, tests and examinations are often duplicated, and patients are disengaged from their own healthcare[9]. Additionally, there is a growing pandemic of chronic diseases in older adults that will continue to increase over the coming decades[8]. The Affordable Care Act looks to change the landscape of healthcare by focusing on improving the delivery of care through changes in Medicare reimbursements, expanding public health insurance, and coordinating care[42]. While there are many conflicting opinions about the Affordable Care Act and the healthcare field, supporters and opponents alike agree that healthcare needs to be reformed.

In 2008, 12% of high-risk Medicare patients accounted for one third of Medicare spending, and this number was suspected to be growing for patients with chronic illnesses[7,10]. This assumption is supported by the findings of Brown et. al., which demonstrate that the percentage of high-risk patients increased to 17% and the spending increased to 37% of Medicare expenses[12].

Medicare is not the only one suffering from the financial impact. The rising problem of Medicare 30-day readmissions is believed to generate $17.4 billion healthcare system expenditures[21]. In an effort to improve the quality of healthcare, the Center for Medicare and Medicaid Services began reducing the payments for hospitals paid under the Inpatient Prospective Payment System (IPPS) with excessive* readmissions for acute myocardial infarction (AMI), heart failure (HF), and pneumonia (PN) in October of 2012[32]. Since it is believed that readmissions signify low-quality care and can reduce patient satisfaction, CMS is using the hospital readmissions reduction program to financially incentivize hospitals to improve the quality and satisfaction of patients[21,32].

Due to the financial and political pressure of CMS, the healthcare field has placed a greater emphasis on decreasing the number of 30-day hospital readmissions and improving patient health care. Hospitals, independent researchers, and CMS have conducted a series of investigations into potential solutions ranging from health information technology (HIT), such as electronic health records (EHR) or health information exchanges, to disease management (DM) and then to coordinated care and transitional care programs[1,3,5,7,10,15,16,24,25,29,34,35,38]. The research provides varying results of effectiveness on the topic without a consensual best solution to reducing hospital readmissions while maintaining or reducing current financial expenses. The University of Missouri Health Care system is exploring one potential solution to the problem: the implementation of Nurse Care Managers (NCM) to coordinate care for individuals of medium or high risk in their patient population. The program was first implemented in February 2013 and will continue until June

2015. It is currently funded by a CMS grant, but is hoped to be continued in the future based on its sustainability by reducing cost in the system.

In this paper, I will address the problem of developing a model to economically justify the role of Nurse Care Manager based on the impact on admissions, 30-day readmissions, emergency department visits, outpatient observation stays, and urgent care visits and their associated costs.

1.2 Background on Healthcare Field

Traditionally, physicians focused on diagnosing disease and then treating it. This practice was supported by a traditional fee-for-volume or fee-for-service reimbursement system, where providers benefitted based on the volume of patients or services provided. This incentive model encourages providers to focus on the number of patients seen instead of the quality of care administered. It also supported redundant testing and procedures[41]. Undoubtedly, the quality of care is a physician's priority; however, the traditional incentive model does not reinforce its importance. A sweeping change from the healthcare reform is forcing a transition among providers from the traditional fee-for-service to a new standard of measure: fee-for-outcome. The focus of the new atmosphere is to prevent disease. Hospitals will now be judged and financially reimbursed based on the quality of care given, the prevention of hospitalizations, and the satisfaction of customers.

A few of the emerging research practices are care coordination, transitional care, and self-managed education interventions[11]. While each of these practices can overlap functionalities, they are each a distinct and separate program.

Self-managed education interventions engage patients in an evidence-based program designed to help teach patients how to manage their chronic conditions. These programs usually last for a month to two months in a community-based setting. The programs strive to enable patients to manage their symptoms and problems, to practice various activities for maintaining or improving current health status and reducing likelihood of health declines, to be involved with choices about diagnostic and treatment options, and to be proactive about collaborating with service providers.

Transitional care has been formally defined as a set of actions designed to ensure the coordination and continuity of health care as patients transfer between locations and levels of care[15]. It is focused on the coordination and success of a discharge plan for a patient from the hospital[11]. Patients are first engaged in the program when admitted to the hospital by a “transition coach”, an specialized nurse that assists with understanding post-discharge instructions, medication regimes, recognizing symptoms of complications, and maintaining follow-up appointments with necessary providers[29]. The goal is to eliminate the factors creating poor discharge outcomes: communication breakdowns between medical providers, inadequate patient or caregiver education, poor continuity of care, and limited access to additional services. These patients are usually engaged for 4 to 6 weeks after discharge[11].

Care coordination does not yet have a formal, recognized definition. Care coordination is frequently implemented by specialized nurses that focus on a range of activities[29]. Some programs focus on collaborating with physicians and providers to optimize a patient's health at discharge, design a discharge plan, and arrange needed home care services[29]. Others provide a broader description, making care coordinators responsible for guiding patients through the care delivery process[5]. For the purpose of this research, the definition provided by the National Coalition of Care Coordination (N3C) will be the accepted standard.

> " 'Care coordination' is a client centered, assessment-based interdisciplinary approach to integrating health care and social support services in which an individual's needs and preferences are assessed, a comprehensive health care plan is developed, and services are managed and monitored by an identified care coordinator following evidence-based standards of care"[11].

Care coordination is used to engage patients with chronic illnesses at a high risk of hospitalization over the year[11]. Care coordinators initially assess the patient and produce a care plan. The care coordinator then monitors the patient's symptoms and self-care habits and communicates with the patient, primary care physicians, and relevant service providers about pertinent information. The duration of this program is still undefined, but it is generally expected to follow patients for the entirety of their life after enrollment.

Due to similarities, care coordination and transitional care were often used interchangeably[42]. Both seek to meet the same objectives: reducing hospital admissions and readmissions and improving the quality of care and wellbeing of patients. Both implement similar activities by specialized nurses: planning discharge, educating patients on self-care and medicine regimes, recognizing symptoms of complications, and reminding patients of follow-up appointments. Despite all the similarities, each program has evolved into its own specified definition. Table 1 provides a matrix of differentiation.

	Care Coordination	**Transitional Care**
Reason for Enrollment	Chronic condition with high risk of hospitalization	Hospitalization
Timing of Enrollment	Prior to hospitalization	During hospitalization
Duration of Program	Life	4- 6 weeks
Favorable effects on	Satisfaction of care, quality of care, quality of life, survival	Short term hospital readmissions
Connection to Care	Long term patient and family connection to providers	Short term patient and family connection to providers

Table 1: Differentiation of Care Coordination and Transitional Care

The success of both care coordination and transitional care depend on the specialized nurses that serve as the transitional coach or the care coordinator. Nurses are believed to be the key to health care coordination success if utilized during transition and implementation[19]. These nurses are often known as case managers[21], care coordinators[5,43], or nurse care managers (NCM)[35,38]. Regardless of their title, they are the core and foundation of these programs, as they are the coordinators between medical providers and patients. At the University of Missouri Health Care system, the registered nurses providing coordinated care are known as nurse care managers and will henceforth be referenced as such.

In the past, nurse care managers were focused on patient safety and the time a patient spent in the hospital[21]. Now, care managers are focusing on reducing readmissions and improving quality of care by taking a proactive approach to preventing disease instead of the traditional reactive approach that focuses on diagnosing and treating. This change, through the development of coordinated care, expanded NCMs activities to include educating patients, collaborating and communicating with providers, managing medication regimens, reducing redundant lab examinations and other evidence-based activities to prevent hospital readmissions and improve patient satisfaction and quality of care[12,34,35].

Another current topic of healthcare systems is health information technology (HIT). Currently 95% of hospitals and 90% of eligible professionals are participating in a HIT incentive program to use HIT “meaningfully”[26]. A systematic review of HIT literature found that 75% of the 57 studies had financial benefits for the stakeholders and 46% reported cost savings[25]. Electronic health records, which store patients’ records electronically, are a widely implemented example of HIT that has been shown to increase productivity and delegation of work[1]. Additionally, health information exchanges, which allow physicians to request external electronic health records of patients, have been associated with a perceived improvement of efficiency and decreased lab and imaging tests[24].

Although such improvements are promising, it has been concluded that HIT is necessary for high value health care, but it is not sufficient[23]. HIT is an integral and necessary part of the developing healthcare atmosphere[43]; however, many entities have focused on care coordination as the best potential option to improve health care quality, patient satisfaction, and efficient resource utilization[5,15,16,29,35,38].

1.3 Literature Review

In order to support the new healthcare objectives, private and public researchers are implementing and analyzing various models of coordinated care. These models have covered an extensive range in order to find the most effective impact on population wellbeing while being economically efficient. Boult et. al. (2009) evaluated 123 articles and found 15 successful models to care for older adults with chronic illnesses[8]. Care management, equivalent to care coordination, is one of the 15 successful models. Care coordination practices have been implemented to determine its effect on avoidable hospitalizations and Medicare expenditures in a wide range of healthcare settings, including, but not limited to community hospitals, long-term care facilities, commercial disease management companies, academic medical centers, integrated delivery system, hospice centers, and retirement care facilities[34].

Several small studies have found Medicare hospitalization reductions of 7% to 28%[30,35,38]. These favorable effects led to larger experiments to hopefully prove more generalizable results. The largest randomized, controlled trial experiment was conducted by the CMS from 2002- 2006 in fifteen care coordination programs[34]. The goal of the experiment was to determine a statistically significant effect of 20% or more on hospitalizations and Medicare expenses with sample sizes large enough to yield a power of 65%-99%. However this trial did not find coordinated care to have a statistically significant effect ($p < .05$) on the reduction of hospitalizations. Only two of the fifteen programs reduced hospital admissions over the four year trial by 17% and 24%, and one program increased hospitalizations by 19%. The experiment allowed each program to define its own methods, treatment plans, target populations, and exclusion policies in hopes to determine characteristics of effective programs. It was determined by the researchers that “care coordination, as practiced by the programs participating in the demonstration from 2002-2006, holds little promise of reducing total Medicare expenditure for beneficiaries with chronic illnesses” (p.613). Four years later, authors of the original contribution, Brown and Peikes (2012), reviewed the data from the original experiment in direct relation to the high-risk patients for the 11 programs that were extended for 2 additional years[12]. Evaluating 4 subgroups of high risk patients, 4 of the 11 programs reduced hospitalizations in one or more of the subgroups. All 4 programs reduced hospitalizations in the 4th subgroup of high-risk patients. In order to qualify for this subgroup, a patient must 1) have one of three diseases: coronary artery disease, congestive heart failure, and chronic obstructive pulmonary disease, 2) have been hospitalized two or more times in the previous two years before enrollment in the program, and 3) have one of nine comorbidities: diabetes, cancer (except skin cancer), stroke, depression, dementia, arterial fibrillation, osteoporosis, rheumatoid arthritis or osteoarthritis, or chronic kidney disease. This was the most severe subgroup evaluated in this study and cost $1,797 per patient per month, which is three times greater than the average of nationwide beneficiaries. Three of the programs reduced the total number of hospitalizations by 8%-15% where 70% of the population were members of the 4th subgroup. The 4th program reduced hospitalizations by 33%; however, only 17% of this program's population are included in subgroup 4. Both of these findings are statistically significant at the p = .1 level. Total, this evaluation generated a statistically significant (p = .001) 10.7% reduction of hospitalizations at an average Medicare cost of $123 (5.7% reduction of cost). Including the program expenses, the programs did not generate net savings, but also did not generate a significant estimated cost. Therefore, the programs were deemed cost neutral.

Of the 11 programs that continued the CMS demonstration after 2006, Geisinger Health System and Washington University School of Medicine continued the analysis of their coordinated care programs and found favorable results[35,38]. Geisinger implemented their program in their advanced medical home model and found that acute admissions per 1000 decreased by 28% and number of emergency department (ED) visits per 1000 decreased by 8.1% for Medicare beneficiaries[38]. Patients with commercial insurance showed an even greater improvement of 37.9% reduction in acute admissions and 34.4% reduction in ED visits. This model also demonstrated that the optimal case load for a nurse care manager is 120-150 patients. Since this model also implemented standardized acute care protocol, post discharge templates, and long-term care facility discharge plans at the same time, not all reductions can be attributed to the NCM's.

Washington University School of Medicine encountered complications during the coordinated care study and were required to redesign their model[35]. Healthways, which acquired the company providing managed care for 80% of Washington University's participants remotely from a call center in San Diego, decided to discontinue its study participation when CMS offered to extend programs. Due to this withdrawal, Washington University redesigned its program to focus on a stronger transitional care, more in person contact, comprehensive medication management, and a more efficient, standardized care. This new model reduced hospitalization by 12% overall and 17% in high risk patients. Previous to the redesign Washington University's model increased Medicare spending by 12%; however, the new model reduced Medicare spending by $217 per member per month. Based on the $151 monthly cost of the program, this model generated $66 savings per member per month.

While these cases present strong mathematical backing for coordinated care programs, additional qualitative research has been evaluated as well. In primary care physician offices, coordinated care was found to reduce fragmentation of care, hospital admissions, length of hospital stay, mortality, ED visits, admission to long-term care facilities, and cost of care[33]. Another primary care model generated a lower mortality rate for all intervention patients at 1 and 2 year evaluations, but increased the number of ED visits of intervention patients[18].

This model was hypothesized to generate savings of $17,384 per NCM for all patients and $70,349 per year for patients with complex diabetes mellitus.

A similar model of care coordination provided “guided care” to geriatric patients[9]. The model implemented a comprehensive assessment, evidence-based planning, case management, transition care, and self-management and caregiver support. Overall, the program only reduced the number of home health care episodes by 29.7%. However, the subgroup insured by Kaiser-Permanente showed a statistically significant reduction in skilled nursing facility admissions and length of skilled nursing facility stay, as well as clinically significant reductions in hospital admissions, hospital readmissions, and ED visits. This subgroup’s success demonstrated the importance of integrating care coordination into the framework of the culture to ensure an effective program. Another geriatric model, Geriatric Resources for Assessment and Care of Elders (GRACE), found that the intervention improved the quality of care and patient health[16]. It also found that preventative and chronic care costs were offset by reductions in acute care for elderly patients. A similar study applied coordinated care to geriatric musculoskeletal patients to find that larger circles of care are challenging to implement, but were beneficial to the patients[27]. Although the multiple morbidities did not follow the traditional care trajectories, the patients were positively impacted by care coordinators particularly when the continuity of information was improved. Tummers et. al. continued to expand the evaluation of coordinated care to stroke patients to determine the same positive results on continuity of care[44].

The research supports the success of coordinated care models. Models have thrived in a range of healthcare settings and economic classes[12]. Programs are seeing improvements in patient care and wellbeing, reductions in hospitalizations, and savings in Medicare spending. MetroHealth Cancer Care Center anecdotally states that the yearly salary of a care coordinator was paid for in 3 months[5]. While many of these programs could use some refinement, there is promise for their future.

In order for these programs to continue, their economic sustainability must be verified. Currently, coordinated care studies have not proven to reduce Medicare spending costs, but have shown promise of cost neutrality. A mathematical model can be developed to determine the cost of a coordinated care program and the required savings to sustain the program. That is the intent of the work presented.

Chapter 2

2.1 Mathematical Model

To model the economic sustainability of the Nurse Care Manager program being implemented at the University of Missouri Health Care System, a linear program is a an effective model to evaluate the objective function and provide the optimal answer within the known constraints. The costs and constraints of this system are linear, making this modeling technique feasible. Also, the linear programming method inherently provides a sensitivity analysis to determine which factors have the greatest effect on the objective function. When addressing savings, one usually constructs the model to maximize savings. However, to determine the minimum level of sustainability, this system will be modeled as a minimization problem. The generalized model is seen below:

$$Min \sum_{i=1}^{n} cixi$$

$$s.t. \sum_{i=1}^{n} cixi \geq S$$

$$xi \leq Ri \; \forall \; i = 1 \ldots n$$

$$ci, S \geq 0$$

$$0 \leq xi, Ri \leq 1$$

Where

c_i – system cost of factor i

x_i – reduction percentage of factor i

S – point of sustainability

R_i – maximum plausible reduction percentage of factor i

n – maximum number of factors

Each factor i represents a cost bucket in the healthcare system. These factors can include, but are not limited to: 30-day readmissions, admissions, ED visits, outpatient observation stays, urgent care visits, imaging, lab work, primary care visits, specialty visits, home health, hospice care, pharmaceuticals, and many more. Each factor is denoted by a positive integer 1 to n, the maximum number of factors. Since the reductions of these factors are calculated at the population level, the cost c_i is the total cost of factor i for the entire population serviced. This can be generated for various time buckets, but it is most frequently calculated as an annual cost of all services billed for the given factor. The variable in this model is x_i, which is the percentage of the total cost for the population to be adjusted to generate savings. This variable will be adjusted until enough savings are generated to reach a level of sustainability S. This is the cost required for the system to function. Ideally, it should include the salary and benefits of each NCM employed, the cost of the space utilized by NCMs, and cost of resources utilized by NCMs. Since a system is only capable of reducing a factor to a certain point, variable R_i is the maximum possible reduction that a system can reduce a given factor i.

The objective function seeks to minimize the reduction of the cost of factors 1 through n in the system. The objective function sums the cost of all factors for the population c_i times the reduction variable x_i for factor i. The value generated is the total savings of the program based on the reduction of each factor i by x_i percent. The objective function is constrained by four constraints. The first constraint ensures that the reduction of cost for the population is greater than the cost of the program S. This constraint ensures the program is sustainable by reducing existing costs of each factor enough to cover the cost of the NCMs. The break-even point is when the reductions in cost are equivalent to the cost of the NCMs. The second constraint ensures that the model does not reduce a factor more than what is attainable by the system. If factor i can only be reduced by 20%, then R_i will equal .2 and confine variable x_i from exceeding .2. The third constraint ensures that none of the variables are negative. Total cost of factor i for the population c_i cannot be negative or it would be a profit. The cost of the program, or level of sustainability S, cannot be negative because it would imply that the program is already self-sustaining and generating a profit. The final constraint states that the reduction variable x_i and maximum reduction value R_i must be greater than 0 and cannot be reduced more than 100%. The variable x_i cannot be negative because it would cause the cost of factor i to become negative in the objective function. While this would minimize the objective function, it does not properly reflect the system. A negative reduction variable x_i, when multiplied by the total cost of factor i for the population c_i, would create a negative cost in the objective function. A negative cost implies negative savings, or a cost on the system, when the model is attempting to increase savings. A negative maximum reduction R_i would imply that the system cannot reduce factor i, but that it will increase. If the program is not capable of reducing factor i, it should not be included in the model because this model is to be used to evaluate factors than can be impacted by coordinated care. This constraint is redundant once maximum reduction values R_i have been determined because value R_i will ensure that the variable x_i is less than the determined maximum reduction, which should be less than 1.

2.2 Assumptions

This model is applied specifically to the University of Missouri Health Care system to determine the level of sustainability to maintain the Nurse Care Manager program. Unfortunately, this field has not been extensively researched before and requires that several assumptions must be made to provide a starting point.

The first assumption is that the system is based on a shared savings model. In the current fee-for-service model, reducing admissions would reduce income to a hospital; however, healthcare may be transitioning to a fee-for-outcome reimbursement system that would penalize readmissions, unnecessary tests, and extended stays. Also, for systems like the University of Missouri's Health Care system, which include hospitals, primary care physicians, specialty care physicians, behavior health services, urgent care, pharmaceuticals, and imaging and testing services, it is more beneficial to utilize the hospital for isolated incidences in healthy patients and manage patients with chronic illnesses in physicians' visits and treatment programs[37].

The next assumption is that the cost of chosen factors is known. For this study, cost will be based on charges submitted to Medicare and Medicaid for payment. While it would be more beneficial to know the true cost of each service, that information is not readily available in the healthcare industry. Additionally, it should be stated that the actual reimbursement may be less than the amount charged.

The third assumption is that reductions found in research are achievable for the system being studied, and that they serve as an upper bound for plausible reductions. This can be a dangerous assumption to make because each system is unique and confounding factors may be present. Since studies have not been conducted at the University of Missouri Health Care system to determine the range of plausible reductions in admissions, readmissions, and ED visits, assumptions from existing research are the best option.

The fourth assumption is that an upper bound constraint for outpatient observation stays and urgent care visits can be based on other factors. Currently, there does not exist any studies that evaluate reductions in outpatient observation stays or urgent care visits based on a coordinated care program. Instead, industry specialists were consulted to determine levels of plausible reduction for the two factors. It was determined that outpatient observation stays would respond to the coordinated care program similar to hospital admissions. Since admissions and outpatient observation stays are both initiated by ED visits, the two factors are expected to behave similarly. It was also determined that urgent care visits could be expected to respond to the coordinated care program similar to ED visits. Both factors are emergency situations where patients are attended by providers other than their established providers. Since visits are triggered by similar events, it is assumed that they will react similarly to the coordinated care program.

The final assumption is that the majority of the total cost is represented in the model. It is assumed that the biggest factors of cost for the shared savings model are 30-day readmissions, admissions, ED visits, outpatient observation stays, and urgent care visits. These factors were determined by the governing board for the grant and supported by industry experts. It must be noted that these are not the only potential factors. One can also evaluate home health, hospice care, imaging, lab work, pharmaceuticals, behavioral health services, durable medical equipment, and many others. The board chose to exclude primary care visits and specialty visits because a decrease in the specified factors should cause a rise in these two factors.

2.3 Method

To properly evaluate the University of Missouri Health Care system, data on the cost of the factors was obtained from the health information analysts (HIA) currently serving the system. The data collected spans February 2013 to January 2014 for the patients enrolled in the program before June 30, 2013 and still enrolled on March 27, 2014 when the data was collected. The total cost includes the hospital/clinic charges and physician charges, but does not reflect the actual reimbursement from Medicare or Medicaid. Additionally, it should be stated that the data collected on 30-day readmissions should be further evaluated for accuracy because of the HIA responsible for the data had recently become unavailable to provide assistance. The data collected can be seen below in Table 2.

Factor	Yearly Cost	Percentage of Total Cost
Admissions	$70,557,527	61.52%
30 Day Readmissions	$14,547,435	12.68%
ED Visits	$7,170,092	6.25%
Outpatient Observation Stays	$22,123,825	19.29%
Urgent Care Visits	$294,548	0.26%
Total:	**$114,693,427**	**100.00%**

Table 2: Yearly Cost of Factors for MU Health Care System

Then research was evaluated to determine the plausible upper bounds for reduction percentages. Research has found reductions in 30 day readmissions between 3.6%[24] and 50%[21], admissions between 4%[10] and 38%[5], and ED visits between 8%[38] and 34%[5]. Outpatient observation stays and urgent care visits have not previously been studied in current research about coordinated care. These numbers range across a variety of programs, size of programs, type of healthcare systems, and geographical locations. Ideally, the upper bounds would be calculated based on another large academic-based healthcare system. The two closest systems in research are Washington University School of Medicine and Georgetown University School of Medicine. Both colleges participated in the 15 site randomized trial of coordinated care in Medicare FFS funded by the CMS, which only collected data on admissions and Medicare cost. Georgetown reduced admissions by 24%, but never recruited enough study participants to yield a 65% power of statistical significance and dropped their participation before completing the study[10]. Washington University restructured their program after the first 4 years and reduced hospital admissions by 12% over the remaining 2 years of study. To be conservative, 12% will be used as the highest plausible reduction for admissions.

Since a large academically-based healthcare system has not evaluated the impacts on ED visits, 30-day readmissions, outpatient observation stays, and urgent care visits, these numbers will have to be inferred from existing research and industry experts. A study done at Geisinger Health, a physician-lead health care system, provides an upper bound of 8.1% reduction in ED visits[38]. It is a well-respected study and provides results similar to others found in research and supported by industry experts.

In the report commissioned by the National Coalition of Care Coordination, Brown recorded reductions of 25% - 34% of 30-day readmissions in randomized trials[11]. While he does not allude to the programs generating these reductions, they are accepted by the industry to be plausible. Therefore, 25% will be used as the upper bound for 30-day readmissions.

Outpatient observation stays and urgent care visits are not addressed in current research, but are believed by industry experts to be equitable to admissions and ED visits respectively. Due to the lack of research, it is necessary to depend on the knowledge of industry experts. Therefore, 12% and 8.1% will be used as the upper bounds for outpatient observation stays and urgent care visits.

The cost of the program, as previously calculated by the project team, is $1,000,000. This fee includes the salaries of 18 full-time equivalent (FTE) nurse care managers and the resources required to support their work. While this number was provided by the MU Health Care system, it does not appear to properly reflect the total cost of the program. The average salary for a registered nurse without benefits was $65,000 per year in 2012[13]. The given cost only generates an average cost of $55,555 per NCM per year. The given value appears to only cover salary costs of the NCMs. The total cost of sustainability S should also include the cost of benefits, the space utilized, and the resources used by the NCMs. The 18 FTE NCMs are responsible for the 10,000 patients currently enrolled in the coordinated care demonstration between February 17, 2013 and March 27, 2014, when data was collected for this evaluation.

The final model applied to the University of Missouri Health Care system can be seen below:

$$Min \sum_{i=1}^{5} 70{,}557{,}527\text{x1} + 14{,}547{,}435\text{x2} + 7{,}170{,}092\text{x3} + 22{,}123825\text{x4} + 294{,}548\text{x5}$$

$$s.t. \sum_{i=1}^{5} 70{,}557{,}527\text{x1} + 14{,}547{,}435\text{x2} + 7{,}170{,}092\text{x3} + 22{,}123825\text{x4} + 294{,}548\text{x5} \geq 1{,}000{,}000$$

$$x1 \leq .12$$
$$x2 \leq .25$$
$$x3 \leq .081$$
$$x4 \leq .12$$
$$x5 \leq .081$$
$$0 \leq xi \leq 1$$

Microsoft Excel 2013 was used to solve this problem in the Solver Add In as a Simplex Linear Program. It was computed on a 64-bit operating system with an Intel® Core™ 2 Duo CPU processor. For setup, see Figure 1 below.

Data									
Factor	Factor Index	ci	Ri		xi		Objective Function		
Admissions	1	70557527	0.12		0.01417283		∑cixi =	1000000	
30 Day Readmissions	2	14547435	0.25		0				
ED Visits	3	7170092	0.081		0		Constraints		
Outpatient Observation Stays	4	22123825	0.12		0		x1	≤	0.12
Urgent Care Visits	5	294548	0.081		0		x2	≤	0.25
							x3	≤	0.081
Cost of Program =	1000000						x4	≤	0.12
							x5	≤	0.081
							∑cixi =	≥	1000000

Figure 1: Excel Solver Configuration

2.4 Results

The solver generated a simple result of reducing admissions by 1.42% and holding the rest of the factors steady, which generates a savings of $1,000,000. This solution is easily validated by inspection. The problem is simple to solve because of the small number of factors the University of Missouri Health Care system wished to evaluate, the large difference of cost amongst the given factors, and limitations of supplied data and information. A greater number of factors and a less distinct high cost would make this problem much more interesting and complex.

Chapter 3

3.1 Improvements

While this model is useful for simple configurations of economic sustainability, there is a great number of improvements that can be made to it. It would be beneficial to the system to determine how many care coordinators are needed to ensure the coordinated care system can effectively handle the population. Research shows that the optimum case load is 120-150 patients for high risk patients that require extensive time and effort by the care coordinator[5,38]. To operate effectively, the nurse care managers need to be able to be proactive instead of simply reacting to events. If nurse care managers are confined to reacting to health episodes, then they will not be able to impact admissions, emergency department visits, and urgent care visits. Currently in the University of Missouri Health Care system, NCM's have an average of 516 patients to attend. Although these patients have a range of risk levels, it is still a greater workload than the optimal. Current NCMs reinforced the belief that they are limited on the amount of time they can give to each patient and are forced to be more reactive than proactive with patients[2,6,17,31,39]. To address this problem, an addition to the model is proposed that will calculate the number of care coordinators as well as reductions necessary to sustain the care managers. One constraint was added to determine the number of care coordinators needed for each level of risk, and that cost is then used to determine the level of sustainability for the given system. See the following model for the additions:

$$Min \sum_{i=1}^{n} cixi$$

$$s.t. \sum_{i=1}^{n} cixi \geq cNCM(\sum_{j=1}^{t} Nj$$

$$xi \leq Ri \; \forall \, i = 1 \ldots n$$

$$Nj \geq \frac{pj}{mj} \; \forall \, j = 1 \ldots t$$

$$ci, cNCM, Nj, pj, mj \geq 0$$

$$0 \leq xi, Ri \leq 1$$

Where
c_i – system cost of factor i
x_i – reduction percentage of factor i
R_i – maximum plausible reduction percentage of factor i
c_{NCM} – average cost of care coordinator
N_j – number of care coordinators for risk level j
p_j – number of patients in risk level j
m_j – maximum case load for risk level j
n – maximum number of factors
t – maximum number of risk levels

The variables from the previous model will maintain their existing definitions. However, additional inputs have been added to the model. The average cost of each NCM is denoted by c_{NCM}. This value should include the salary, benefits, space, and resources of each NCM. The risk classification for each patient is denoted by j. This can range from low risk patients that are mainly healthy to high risk patients that suffer many comorbidities. The number of levels of risk and the classification process of those risk levels are determined by each individual system. A new variable to calculate the optimal number of NCMs needed for a given level of risk is identified by N_j. This variable will calculate the number of nurse care managers required to effectively service the given population. The given population is denoted by p_j, which is the number of patients that are classified to have risk j. The final new input is m_j, which is the maximum number of patients to be assigned to a NCM. This is the maximum case load that will allow a NCM to proactively and effectively care for the wellbeing of his/her patients. It will vary depending on the level of risk of a patient and the level of involvement required to service the level of risk.

The objective function of the model is not altered from the original function, but still minimizes the reduction of costs for all factors i = 1 to n. The first constraint is modified to include the new cost of the program. The cost of the program is calculated by multiplying the average cost per NCM c_{NCM} by the total number of NCMs required to effectively service the population, or the sum of all NCMs required for each level of risk $\sum N_j$ for j = 1 to t. In the last model, this value would have been represented by S, the level of sustainability or cost of the program. Since the new model determines the number of NCMs needed for the population, the cost of the program is not previously known and must be calculated within the model. The next constraint was added to determine the number of NCMs N_j needed per risk level j. Each level of risk requires a varying degree of attention. Higher risk patients require more time and attention. Therefore, the number of NCMs attending higher risk patients must have a smaller maximum case load m_j, than NCMs attending lower risk patients. The number of NCMs will vary based on the number of patients in a risk level j and the maximum case load maintainable for the level of risk. The number of NCMs for risk level j N_j is calculated as the number of patients in risk level j per the maximum case load for level j. The remaining constraints are not changed, except to ensure that the cost per NCM, number of NCMs per risk level j, the number of patients per risk level j, and the maximum case load for risk level j are not negative.

3.2 Methods of Improved Model

The same assumptions and data for the University of Missouri Health Care system hold true for this model as the previous one. However, additional assumptions need to be made regarding the maximum patient load per nurse care manager. The highest risk patients should have a maximum case load of 150 patients, as determined in previous studies[5,38]. This will apply to Tier 3 and Tier 4 patients, as classified by the MU Health Care system. The optimal value for lower risk patients has not currently been explored in research, but industry specialists believes that 250-300 lower risk patients would be an acceptable case load[2,6,17,31,37,39]. Therefore, 250 low risk patients will be the maximum case load for Tier 1 and Tier 2 patients, as defined by the MU Health Care System. The number of patients in each tier classification was provided by the HIA's currently assisting the project. The patient population breakdown can be seen below in Table 3. Tier 1 includes patients of lowest risk and the tiers progress to Tier 4, which include patients with the highest risk. To accurately determine the optimal case load number and distribution for the given system, an evaluation by the MU Health Care system should be conducted. Since time and resources to do not currently allow such a study, the values will be based on existing research and studies.

Tier	Number of Patients	% of Population
1	2,555	27.52%
2	4,690	50.52%
3	1,359	14.64%
4	679	7.31%
Total	**9,283**	**100.00%**

Table 3: Patient Population by Risk Classification

Additionally, the cost for each NCM is calculated by the total cost of NCM’s divided by the 18 FTE NCM’s currently employed. This averages to roughly $55,555 yearly per NCM in the MU Health Care system and will be used as the average cost per NCM.

The new model applied to the University of Missouri Health Care system can be seen below based on the data and assumptions stated above.

$$Min \sum_{i=1}^{5} 70{,}557{,}527x1 + 14{,}547{,}435x2 + 7{,}170{,}092x3 + 22{,}123825x4 + 294{,}548x5$$

$$s.t. \sum_{i=1}^{5} 70{,}557{,}527x1 + 14{,}547{,}435x2 + 7{,}170{,}092x3 + 22{,}123825x4 + 294{,}548x5 \geq 55{,}555(\sum_{j=1}^{4} Ni)$$

$$x1 \leq .12$$
$$x2 \leq .25$$
$$x3 \leq .081$$
$$x4 \leq .12$$
$$x5 \leq .081$$
$$N1 \geq \frac{2{,}555}{250} = 10.22$$
$$N2 \geq \frac{4{,}690}{250} = 18.76$$
$$N3 \geq \frac{1{,}359}{150} = 9.06$$
$$N4 \geq \frac{679}{150} = 4.53$$
$$0 \leq xi \leq 1$$

The same computer and Excel program were used to compute the new model. The set up can be seen below in Figure 2.

Data									
Factor	Factor Index	ci	Ri		xi		Objective Function		
Admissions	1	70557527	0.12		0.03351612		∑cixi =	2364815	
30 Day Readmissions	2	14547435	0.25		0				
ED Visits	3	7170092	0.081		0		Constraints		
Outpatient Observation Stays	4	22123825	0.12		0		x1	≤	0.12
Urgent Care Visits	5	294548	0.081		0		x2	≤	0.25
							x3	≤	0.081
Tier	pj	mj	cncm		Ni		x4	≤	0.12
Tier 1	2555	250	55555.56		10.22		x5	≤	0.081
Tier 2	4690	250	55555.56		18.76		∑cixi =	≥	2364815
Tier 3	1359	150	55555.56		9.06		N1	≥	10.22
Tier 4	679	150	55555.56		4.52666667		N2	≥	18.76
							N3	≥	9.06
Cost of Program	1000000	$					N4	≥	4.526667
Number of NCM's	18	FTE					xi, Ni	≥	0
Avg NCM cost	55555.56	$							
Total Cost of Factor i	ci								
Max Plausible Reduction of Fac	Ri								
Patient Load of Tier j	pj								
Max Case Load for Tier j	mj								
Avg Cost of NCM	cncm								
Reduction of Factor i	xi								
Number of NCM per Tier j	Nj								

Figure 2: Sustainability Model with Variable NCM's

3.3 Results of Improved Model

For the University of Missouri Health Care system, the optimized cost of the system will be $2,364,815 to account for 42.56 FTE nurse care managers. Since this number is based on full-time equivalence, it is acceptable to assume half of a person due to part-time employment status. The NCM's should be assigned to tiers in accordance with Table 4. The cost of the program would optimally be compensated for by a reduction of 3.34% of admissions and holding the other factors steady. Again, the model determined that solely reducing admissions provides the greatest return for the investment.

Tier	Number of NCM's
1	10.22
2	18.76
3	9.06
4	4.53

Table 4: Assignment of Nurse Care Managers to Tiers

If part-time employees are not utilized, the number of FTE NCM's can be rounded to 43 NCM's at a cost of $2,388,888.87. The model again generated a sole reduction in admissions of 3.39% and holding the other factors steady.

3.4 Discussion

The University of Missouri Health Care system can support their current system of 18 FTE NCMs by reducing admissions by 1.42% and holding the rest of the factors steady. The $1,000,000 cost of the coordinated care program is covered by a simple reduction in admissions because of its high cost on the system. While this large discrepancy will not be present in all systems, it ensures an easy verification of the model generated.

While the reduction is simple, it is also important to ensure the program is operating optimally to achieve these results. Without the appropriate resources, it will be difficult for the current system to fulfill its objectives to improve the health of the population, improve patient satisfaction and participation, and provide continuity of care. Therefore, the number of nurse care managers needed to properly service the given population was evaluated in the improved model. This model determined that the optimal number of NCM's for the MU Health Care system is 42.56 FTE at a cost of $2,364,815. The cost can be optimally accounted for by decreasing the number of admissions by 3.34% and holding the rest of the factors steady. The system could choose to focus on reducing the other factors, but it would require greater efforts and reduction to produce the same results. Table 5 provides a better understanding of the needed percent reduction if the cost of the program was to be fully compensated by the single factor. The factors are evaluated for the current system of 18 FTE NCMs and for the optimal system of 42.56 FTE NCMs. The percent represents the sole reduction of each factor to fully support the program.

Factor	Current System	Optimal System
Admissions	1.42%	3.34%
30 Day Readmissions	6.87%	16.26%
ED Visits	13.95%	32.98%
Outpatient Obser. Stays	4.52%	10.69%
Urgent Care Visits	339.5%**	802.86%**

Table 5: Factor Reduction for Sustainability

The results generated by the improved system are intended to be used for guidance and information for the MU Health Care system to utilize. This is a real system in the actual world, which means the true optimality cannot be computed. The linear programming model is intended to be a decision making tool to support the decision making process as applied to actual systems. The results generated by this model are purely theoretical and should be used as supporting data to determine policies and practices for the University of Missouri Health Care system.

If the hospital wishes to maintain the level of admissions until the current fee-for-service reimbursement program is changed, then the coordinated care program should focus on reducing outpatient observation stays and then 30 day readmissions. These two factors have the next highest impact on the system due to their individual costs. It would be simple to reevaluate the model by excluding the admissions factor to determine the optimal reductions of the remaining factors if the system wished.

Another issue to consider is the allocation of NCMs to the varying tiers. The goal of the coordinated care program is to provide continuous care across the spectrum and lifespan of medical care. As patients progress through the system and medical events, they have the potential to change risk classification. Patients can move into a higher risk bracket (from tier 2 to 3) or to a lower risk bracket (from tier 4 to 3). While changes are not frequent, the program should be designed to manage the transitions. There are three options to assign NCMs to tiers:

1. Assign a NCM to a specific tier only
2. Assign a NCM to a normalized representation of the population (patients from all tiers)
3. Group tiers by similarity and frequency of transition, then assign NCMs to the grouped tiers

The first option does not provide continuity of care for patients that transition between tiers, but does allow NCMs to specialize in the specific challenges and diagnoses of their given tier. The second option provides continuity of care for all patients, but does not allow NCMs to specialize and may force an NCM to neglect Tier 1 and 2 patients in order to assist Tier 3 and 4, which are higher risk and often higher cost. The third option provides a median. It allows NCMs to specialize, but also accounts for minor tier transitions.

One goal of the program should be to prevent Tier 1 and 2 patients from progressing to be Tier 3 and 4 patients. By averting the risk transition, NCMs would be able to provide greater savings for the system by avoiding additional high risk, high cost patients. Therefore, I suggest that the University of Missouri Health Care system assign NCMs to groups of patients: Group 1 would include Tier 1 and Tier 2 patients and Group 2 would include Tier 3 and 4 patients. It is logical that patients will usually move one tier at a time and that Tier 1 and 2 have more similarities and transitions than either has with Tier 3 or 4. Tier 3 and 4 should be grouped together based on the same reasoning. Then, the system can apply the optimal number of NCMs to the given tiers to ensure the most effective operation of their program. The final result would be to assign 29 FTE NCMs to Group 1 of Tier 1 and Tier 2 patients. There would be a total of 7,245 patients that would be distributed amongst the NCMs. Each NCM would have a case load less than 250 patients and would have approximately 88 Tier 1 patients and 162 Tier 2 patients, based on averages. Additionally, 13.5 FTE

NCM’s will be assigned to Group 2 of Tier 3 and Tier 4 patients. Each NCM will have less than 150 patients that would approximately be comprised of 100 Tier 3 patients and 50 Tier 4 patients, for a total of 2,038 patients in Group 2. This ensures that NCMs have enough time to properly assist all of their patients proactively and specialize in the issues associated with each group. While it does not account for patients transitioning between Tier 2 and 3 classification, it does ensure that continuous care is provided for all other transitions.

The results generated for the MU Health Care system are easily verified and supported by inspection. The power of this model, however, will be more beneficial to systems that wish to evaluate more factors or have smaller differences in factor costs. The improved model provides an adaptive option to determine the number of necessary care coordinators, the cost of those care coordinators, and the necessary factor reductions to effectively and efficiently support the system. This model can be adapted and applied to any system.

Chapter 4

4.1 Best Practices

In order to ensure that these reductions are achieved or the factors are held steady, it is encouraged to implement the best practices, or industry-proven tactics that have been associated with the best results in previous research. Most of the studies evaluating the effect of care coordination on readmissions, admissions, and ED visits also attempted to identify which practices were common among successful programs. It was earlier mentioned that each program in the CMS demonstration of 15 programs was allowed to determine their own target population, practices, treatment plans, methods of implementation, and exclusion policies[12]. Since the programs were allowed to develop their own program set up and process, the initial researchers could evaluate the common characteristics of each successful program to determine the qualities of effective care coordination. Determining that the six most effective characteristics of care coordination programs are:

1. In-person contact in addition to telephone contact (averaging 1 in-person contact per month)
2. Assigning all of a physician's patients to 1 care coordinator to foster physician and care coordinator relationships and communication
3. Assign care coordinators to be the center of communication between varying providers and providers and patients
4. Evidence-based and proven patient education programs
5. Comprehensive and accurate patient medication management
6. Coordinated transition care that is effectively communicated with patient and providers in a timely manner

These characteristics are further emphasized and supported by additional research in the field[4,11,14,28,30,34,35,38]. Some of these studies also indicate that the following practices should be included as best practices, but were not as widely recognized as the previous six:

1. Patient-centered approach[28]
2. Targeting the highest risk population[28]
3. Interdisciplinary team with differing levels of licensed and non-licensed individuals[36,44]

The compliance of these practices at the University of Missouri's healthcare system was evaluated through structured group and individual interviews with the practicing NCMs. It was indicated that NCMs were making in-person and telephone contact, assigned to physicians to foster relationships, using evidence based patient education programs, and coordinating transition care[2,6,17,31,39]. It was found that NCMs are not the center of communication, but are mostly included in communication when necessary. They also address issues of medication regimes during critical transitions or when patients are scheduled for a clinic visit, but do not have enough time to properly evaluate and manage each patient's medication plans.

These NCMs also indicated that the practices that they believed had the most impact on patients included:

1. Follow up phone calls after critical transitions or changes in medical status or treatment plans[39]
2. Motivational coaching and motivational interviewing - not to be limited to medical issues, but to incorporate relevant behavioral and social issues[2,6,31]
3. Identifying what the patient is willing to and wants to change to determine the appropriate care plan[6,17]

It was also indicated that a few practices could be improved upon. It was expressed that the providers, staff, and patients should receive formal education on the role of NCMs and how they can be utilized[39]. It was also expressed that more time and space is necessary to effectively fulfill the responsibilities of the NCM role[2,6]. Another possible solution is to provide more extensive training in behavioral health and psychiatric services for NCMs or including non-licensed professionals on the care team, such as social workers and behaviorists[2,6,17,31]. Increasing the number of non-licensed professionals would also provide NCMs with more time to focus on practices that require a licensed practitioner. This practice is also supported by Janet Stallmeyer, a specialist of implementing care coordination programs across the country[37] and other industry specialists[36,44]. Experience has shown that healthcare systems should be working to utilize providers at the highest level of their license, be willing to work with non-licensed individuals, and focus on integrating behavioral health services. A coordinated care program is not sustainable without community involvement and support. This team based structure provides the support necessary to assist patients to manage their own health[44]. Additionally, it is frequently repeated that the high risk patients need to be able to contact a care coordinator seven days a week. These best practices are encouraged to increase positive results, but are not necessary or sufficient to ensure program success. Each program should tailor their methods to meet the individualized needs of their patient population and system constraints.

4.2 Future Research

Since this is the first model to determine economic sustainability of a coordinated care program, there are many potential opportunities for improvement in the future. First, determining and verifying the upper bounds of plausible reductions for each factor should be completed. The lack of research in this particular area could create significant problems for the model by allowing reductions that are infeasible or constraining the problem too tightly. Secondly, further research could be done on the best factors to include in the model. The factors chosen were based on the desires of the MU Health Care system. Additional factors, as mentioned previously, should be evaluated to determine their cost on the system and the potential impact of care coordinators to reduce those factors. Once research is conducted, one could include the impact factors in the model to encourage the model to reduce the factors most easily controlled by the care coordinators. It could also be interesting to apply this model to specific diagnoses or risk classifications to provide a better understanding of the costs and necessary reductions on a more specialized level. This could allow care coordinators to focus their attention appropriately and even allow implementation in specialty clinics. This model is a new addition to the current research and is intended to provide a basis to build upon. Another suggestion to improve the model is to adapt the model to evaluate a team-based model of care coordination. Currently, the model only evaluates the number of registered nurses required to care for the population. However, it was previously mentioned that the utilization of non-licensed individuals would provide a more balanced support system to service the patient populations. Research should be conducted to determine which professionals would impact and round out the coordinated care programs the most. These individuals and the distribution of team members should be included in the model to determine the number of care coordinators for a system and their respective cost. Lastly, a stochastic dynamic model could be developed that would allow for changes in the tiers and also take into account the impact of nurse care managers on reducing readmissions which would change the factor analysis over time. The current model is static and would have to be updated each time it is applied. There are a great many other options for future research and are not limited to these suggestions.

4.3 Conclusion

Healthcare needs to be reformed. There are many ideas and options that the industry is studying to improve the care and wellbeing of patients. Coordinated care is amongst the forerunners of effective changes currently occurring in the healthcare field. The University of Missouri Health Care system's implementation of nurse care managers to provide coordinated care to 10,000 Medicare patients has the potential to drastically improve the care and wellbeing of patients serviced by their program. Continuous care and a centralized case manager to communicate across isolated services can provide much needed improvements to the healthcare industry when implemented correctly. However, if the coordinated care program is unsustainable, the program will not exist long enough to fulfill its potential. The current program at the University of Missouri Health Care system will be sustainable if the program can reduce the number of admissions by 1.42% and maintain 30 day readmissions, ED visits, outpatient observation stays, and urgent care visits costs. I would encourage the University of Missouri Health Care system to consider the optimal solution of implementing 42.56 FTE NCMs that are educated on the best practices of the industry to effectively handle the case load. The new system could easily be sustainable by reducing admissions by 3.34% and maintaining the costs of the other factors.

The first model generated provides a base work of examining economic sustainability of a coordinated care program. It can be adapted and applied to any system, and could even determine the sustainability of other healthcare programs. The second model is more specific to the coordinated care program by determining the number of care coordinators needed, the cost of the program, and the necessary factor reductions to cover the costs of the program. This model has the potential to be improved in the future through further studies.

However, it has proven to provide insightful results to economically justify the coordinated care program at the University of Missouri Health Care system.

Endnotes

*Excess readmissions is calculated using a ratio of a hospitals “predicted” 30-day readmissions for AMI, HF, and PN by the number expected based on an average hospital with similar patients; a ratio greater than 1 is deemed to be excess readmissions[32].

**The reduction of urgent care visits required to solely support the program is unattainable

References

1.Adler-Milstein, J., Huckman, R. S. (2013). The impact of electronic health record use on physician productivity. The American Journal of Managed Care, 19, SP345-SP352.

2.Alioto, A., Keneipp, C., Faber, J. . (2014). Interview with Armine Alioto, Cindy Keneipp, Jackie Faber. In L. Harwood (Ed.).

3.Begum, R., Ryan, M. S., Winther, C. H., Wang, J. J., Bardach, N. S., Parson, A. H., Shih, S. C., Dudley, R. A. (2013). Small practices' experience with EHR, quality measurement, and incentives. The American Journal of Managed Care, 19, eSP12-eSP18.

4.Bendix, J. (2013). Making sense of the new transitional care codes. Medical Economics, 90(9), 40-47.

5.Bolch, M. (2013). Can care coordinators answer access problems predicted for primary care? Medical Economics, 90(11), 46-48.

6.Bomer, M. (2014). Interview with Marilee Bomer. In L. Harwood (Ed.).

7.Bott, D. M., Kapp, M. C., Johnson, L. B., Magno, L. M. (2009). Disease management for chronically ill beneficiaries in traditional Medicare. Health Affairs, 28(1), 86-98.

8.Boult, C., Green, A. F., Boult, L. B., Pacala, J. T., Snyder, C., Leff, B. (2009). Successful models of comprehensive care for older adults with chronic conditions: Evidence for the Institute of Medicine's "Retooling for an aging America" report. Journal of the American Geriatrics Society, 57(12), 2328-2337.

9.Boult, C., Reider, L., Leff, B., Frink, K. D., Boyd, C. M., Wolff, J. L., Frey, K., Karm, L., Wegener, S. T., Mroz, T., Scharfstein, D. O. (2011). The effect of guided care teams on the use of health services. Archives of Internal Medicine, 171(5), 460-466.

10.Brown, R., Peikes, D., Chen, A., Schore, J. (2008). 15-site randomized trial of coordinated care in Medicare FFS. Health Care Financing Review, 30(1), 5-25.

11.Brown, R. (2009). The promise of care coordination: models that decrease hospitalizations and improve outcomes for Medicare beneficiaries with chronic illnesses. Princton, NJ: Mathematica Policy Research.

12. Brown, R. S., Peikes, D., Peterson, G., Schore, J., Razafindrakoto, C. M. (2012). Six features of Medicare coordinated care demonstration programs that cut hosptial admissions of high-risk patients. Health Affairs, 31(6), 1156-1166. doi: 10.1377/hlthaff.2012.0393

13. Bureau of Labor Statistics (2014). Occupational outlook handbook: Registered nurses. http://www.bls.gov/ooh/healthcare/registered-nurses.htm: U.S. Department of Labor.

14. Carmona, R. H. (2009). Evaluating care coordination among Medicare beneficiaries. Journal of American Medical Association, 301(24), 2547-2548.

15. Coleman, E. A., Berenson, R. A. (2004). Lost in transition: Challenges and opportunities for improving the quality of transitional care. Annals of Internal Medicine, 141(7), 533-536.

16. Counsell, S. R., Callahan, C. M., Tu, W., Stump, T. E., Arling, G. W. (2009). Cost analysis of the geriatric resources for assessment and care of elders care management intervention. Journal of the American Geriatrics Society, 57(8), 1420-1426.

17. Davis, J. (2014). Interview with Janis Davis. In L. Harwood (Ed.).

18. Dorr, D. A., Wilcox, A. B., Brunker, C. P., Burdon, R. E., Donnelly, S. M. (2008). The effect of technology-supoorted, multidisease care management on the mortality and hospitalization of seniors. Journal of the American Geriatrics Society, 56(12), 2195-2202.

19. Fights, S. D. (2011). Nursing: The key to coordination of care. MedSurg Nursing, 20(5), 213, 246.

20. Ghosh, R. (2013). Opportunities, barriers, & champions. Analytics, 2013(September/October), 26-30.

21. Gilbert, P., Rutland, M. D., Brockopp, D. (2013). Redesigning the work of case management: Testing a predictive model for readmission. The American Journal of Managed Care, 19, eSP1-eSP6.

22. James, B., Samuelson, D. A. (2013). Change we can live with. OR/MS Today, 2013(October), 26-31.

23. Jha, A. K. (2013). Health information techonology: On the cusp of healthcare transformation. The American Journal of Managed Care, 19, SP335-SP336.

24. Kaelber, D. C., Waheed, R., Einstadter, D., Love, T. E., Cebul, R. D. (2013). Use and perceived vaue of health information exchange: One public

healthcare system's experience. The American Journal of Managed Care, 19, SP337-SP343.

25. Low, A. F. H., Phillips, A. B., Ancker, J. S., Patel, A. R., Kern, L. M., Kaushal, R. (2013). Financial effects of health information technology: A systematic review. The American Journal of Managed Care, 19, SPP369- SP376.

26. Mostashari, F. (2013). The data revolution comes to healthcare. The American Journal of Managed Care, 19, SP327.

27. McLeod, J., McMurray, J., Walker, J. D., Heckman, G. A., Stolee, P. (2011). Care transitions for older patients with musculoskeletal disorders: Continuity from the providers' perspective. International Journal of Integrated Care, 11, 1-11.

28. National Coalition on Care Coordination (N3C). (2011, March). Policy brief: Implementing care coordination in the Patient Protection and Affordable Care Act. Retrieved from **http://www.nyam.org/social-work-leadership-institute/docs/publications/N3C-Implementing-Care-Coordination.pdf**

29. Naylor, M. D., Brooten, D. A., Campbell, R. L., Maislin, G., McCauley, K. M., Schwart, J. S. (2004). Transitional care of older adults hospitalized with heart failure: A randomized, controlled trial. Journal of the American Geriatrics Society, 52(5), 675-684.

30. Nelson, L. (2012). Lessons from Medicare's demonstration projects on disease management, care coordination, and value-based payment. CBO's Health and Human Resources Division.

31. Nelson, R. (2014). Interview with Rose Nelson. In L. Harwood (Ed.).

32. Official Hospital Compare Data. (2013). Retrieved Jan. 20, 2014, from Centers for Medicare and Medicaid Services https://data.medicare.gov/data/hospital-compare

33. Parsons, M., Senior, H., Kerse, N., Chen, M., Jacobs, S., Vanderhoorn, S., Anderson, C. (2012). Should care managers for older adults be located in primary care? A randomized controlled trial. Journal of the American Geriatrics Society, 60(1), 86-92.

34. Peikes, D., Chen, A., Schore, J., Brown, R. (2009). Effects of care coordination on hospitalization, quality of care, and health care expenditures among Medicare beneficiaries. Journal of American Medical Association, 301(6), 603-618.

35. Peikes, D., Peterson, G., Brown, R. S., Graff, S., Lynch, J. P. (2012). How changes in Washington University's Medicare corrdinated care demonstration pilot ultimately achieved savings. Health Affairs, 31(6), 1216-1226.

36. Sinsky, C. A., Willard-Grace, R., Schutzbank, A. M., Sinsky, T. A., Margolius, D., Bodenheimer, T. (2013). In search of joy in practice: A report of 23 high-functioning primary care practices. Annals of Family Medicine, 11(3), 272-278.

37. Stallmeyer, J. (2014). Interview with Janet Stallmeyer. In L. Harwood (Ed.).

38. Steele, G. D., Haynes, J. A., Davis, D. E., Tomcavage, J., Stewart, W. F., Graf, T. R., Paulus, R. A., Weikel, K., Shikles, J. (2010). How Geisinger's advanced medical home model argues the case for rapid-cycle innovation. Health Affairs, 29(11).

39. Thullen, L. (2014). Interview with Lila Thullen. In L. Harwood (Ed.).

40. Tummers, J., Schrijvers, A., Visser-Meily, J. (2012). Economic evidence on integrated care for stroke patients; A systematic review. International Journal of Integrated Care, 12(1), 1-15.

41. Verdon, D. R. (2012). Managing patient populations to become new role for PCPs. Medical Economics, 89(19), 53-55.

42. Volland, P. J., Schraeder, C., Shelton, P., Hess, I. (2013). The transitional care and comprehensive care coordination debate. Journal of the American Society on Aging, 36(4), 13-19.

43. Weiss, G. G. (2013). PCMH: 6 ways to get started. Medical Economics, 90(6), 14-20.

44. Zimlich, R. (2013). How to coordinate care in a medical home. Medical Economics, 90(9), 44-57.