Joshua G Love. Leveraging Health Information Technology to Reduce Hospital Readmissions Rates for Medicare Beneficiaries. A Master's Paper for the M.S. in I.S degree. April, 2013. 41 pages. Advisor: Javed Mostafa

In keeping with the aims of the Affordable Care Act to improve the efficiency of healthcare delivery, the Center for Medicare and Medicaid Services has instituted the Hospital Readmissions Reduction Program, which penalizes hospitals that report readmissions rates that exceed predetermined expectations. This paper outlines the causes of the readmissions dilemma and then considers the parameters of the HRRP as well as the major objections to its methodology, before moving to a discussion of intervention strategies hospitals can implement in order to achieve compliance. Health information technology tools and solutions play a significant role in helping to prevent undue rehospitalizations, and this paper concludes with an overview of several of the most prevalent means of leveraging electronic resources to curb readmissions.

Headings:

Information storage & retrieval systems -- Medical care

Medical informatics

Medical records

Medical records -- Management

Medicine --- Information services

LEVERAGING HEALTH INFORMATION TECHNOLGOY TO REDUCE HOSPITAL
READMISSIONS RATES FOR MEDICARE BENEFICIARIES

by
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Table of Contents

Introduction

The Affordable Care Act is aimed in part at increasing efficiency in the delivery of health care, trimming waste, cutting unnecessary expenditures, and improving quality of services. The previous fee-for-service model failed to discourage some providers from introducing redundancy and waste into the equation. In a hospital setting, this failure to prioritize efficiency can manifest itself in the prompt readmission of patients who have only recently been discharged. Currently, Medicare pays for all rehospitalizations for its (largely elderly) beneficiaries, save in cases where patients are readmitted to the hospital within 24 hours following discharge for the same condition for which they were initially hospitalized (Jencks, Williams, & Coleman, 2009, p. 1419). However, in many cases rehospitalization represents a poor outcome for older patients, who might have been able to remain at home, or at least in the skilled nursing facility to which they were transitioned following index hospitalization, had the quality of their care been better during that initial hospital stay, or had their initial discharge been handled more smoothly, with more comprehensive information flows, and with greater follow-up attention. Improving readmissions rates represents a potentially enormous cost-saving measure for Medicare (as readmissions account for an estimated $15 billion annually in spending) as well as a policy lever for which data is already gathered, considering that Medicare, as the payer, is notified every time one of its beneficiaries is hospitalized (MedPAC, 2007, p. 103).

With that in mind, as part of the Affordable Care Act's efforts to lower costs and improve the patient experience, the Center for Medicare and Medicaid Services (CMS) has identified the reduction of hospital readmissions as a key point of policy emphasis. Beginning October 1, 2012, under the auspices of the Hospital Readmissions Reduction Program (HRRP), CMS will assess whether hospital readmission rates are higher than would be predicted by CMS models, which utilize a risk adjustment methodology endorsed by the National Quality Forum (NQF). Hospitals with higher-than-predicted rates of readmission will have their total Medicare reimbursement for fiscal year 2013 cut by up to 1%. This penalty increases to 2% in 2014 and 3% in 2015 (Readmissions Reduction Program, 2012). In order to avoid suffering such shortfalls in funding, many hospitals will be forced to implement targeted programs intent on identifying causes of readmissions and developing intervention strategies and procedures for curbing them.

Outline

The remainder of this paper will proceed as follows: first, we will enumerate the extent of the readmissions problem as it applies to Medicare recipients, both in terms of cost as well as number of patients affected. It naturally follows from a stark rendering of the scope of the issue to try and ascertain the cause of this readmissions crisis, but first we must distinguish which classes of readmissions can and should be addressed. With that in mind, we will examine the difficult question of differentiating preventable readmissions from unpreventable rehospitalizations. From there we will perform a more in-depth background analysis of the care deficiencies most generally accepted as causes

of preventable readmissions, particularly with regards to conditions that result in the greatest number of rehospitalizations of elderly patients.

Next, we will carefully define what is meant by readmissions in the context of the HRRP, examining the parameters CMS has pinpointed for the purposes of this quality initiative. We will address the factors for which CMS has chosen to adjust in measuring excess readmissions ratios, and then look at the criticisms of the HRRP made on behalf of hospitals regarding its failure to fully account for the characteristics of patient populations, medical conditions, and care systems that have been identified as the likeliest mitigating factors in achieving accurate measurements of a hospital's readmissions rate. In turn, we will present CMS' counterarguments downplaying the effect of these variables in hindering hospital compliance. We will touch on other common complaints regarding the HRRP's soundness as policy as well, considering contentions that measuring readmissions is a flawed, or even outright poor and misleading, approach to assessing hospital performance. Proposed alternative metrics will be considered.

We will then move to providing an overview of the most commonly utilized strategies to combating the readmissions problem, examining the extent to which effectiveness has been achieved, and looking at the various shortcomings and experimental gaps present in the major extant solutions. For most of these plans to demonstrate continued or greater success in the future depends heavily on the scaling up of health information technology and the utilization of electronic health records (EHRs). Embracing health IT does not, by and large, represent an easy fix to the problem of excess readmissions. However, the full spectrum of EHR offerings does provide hospitals

with a myriad of tools and operational frameworks that show great promise in helping to improve many of the facets of patient care that contribute to a facility's readmission rate, from the actual quality of care during the patient visit to facilitating handoffs and discharge to supporting post-discharge interventions aimed at monitoring home health and hence decreasing the likelihood of readmission. We will investigate at length several of the major HIT components and functions and examine their potential for facilitating the push to reduce readmissions. We will discuss specific capabilities EHRs possess to improve outcomes during the index visit, thereby potentially decreasing the likelihood of readmission, including: standardizing documentation, enabling communication between providers from disparate groups, networks, and locations, the power of computerized provider order entry (CPOE) tools to reduce the likelihood of medical errors, and the utilization of EHRs in the compiling of discharge summaries that are consistent, accurate, and timely. Post-discharge, we will look at patient-generated data resources that enable patients to track their own recovery as well as tools that allow providers to remotely monitor home health, interventions that show great potential for limiting preventable readmissions. We will also explore the promise of EHRs to assist providers in identifying particular populations or patient characteristics that might be indicative of a higher probability for readmission.

The Extent of the Readmissions Crisis

According to MedPAC (2007, p. 103), 18 percent of Medicare patients discharged from the hospital are readmitted within 30 days, one-third experienced rehospitalization within three months, and after one year, two-thirds were either deceased or had been

readmitted at least once. The report further states that readmissions, on average, result in a 0.6 longer length-of-stay than for patients in the same diagnosis-related group. According to varying estimates and calculations, these readmissions alone account for at least $15 billion annually in spending. Jencks et al. (2009, p. 1426) determined that Medicare payments for unplanned rehospitalizations in 2004 accounted for about $17.4 billion of the $102.6 billion in hospital payments from Medicare, making them a large target for cost reduction (their estimate derived by multiplying the 19.6% rehospitalization rate by 90 percent, which represents the percentage of unplanned rehospitalizations, and multiplying that product by 96 percent, as DRG-based payments for rehospitalizations are 4 percent lower than those for index hospitalizations). In light of estimates that the Medicare trust fund will have evaporated by 2017 (McBride, 2009), CMS has deemed it imperative to find areas where significant financial savings can be realized, and given the sheer volume of spending being channeled to cover readmissions for Medicare beneficiaries, it represents a clear target for policy-backed attention.

Drawing the Line between Preventable and Unpreventable Readmissions

Exploring the primary causes of readmission immediately forces an important but very difficult distinction to be drawn – between rehospitalizations that should be deemed preventable and those deemed unpreventable. A glance at various attempts to ascertain the proportion of readmissions that should be classed as avoidable reveals tremendous divergences in findings and criteria that underscores the problematic nature of making such delineations. MedPAC (2007, p. 107) estimated that as many as 84 percent of five-day readmissions, 78 percent of 15-day readmissions, and 76 percent of 30-day

readmissions are potentially preventable. Van Walraven, Bennett, Jennings, Austin, & Forster's (2011) more recent meta-analysis of several preventability studies discovered a 27.1 percent median proportion of 30-day readmissions deemed avoidable, with individual study conclusions ranging from 5 percent to 79 percent (p. E391). Van Walraven et al.'s canvassing notes the extremely subjective nature of criteria employed by the surveyed studies in tackling the question of preventability, as well as the wide range of data or information resources consulted, as most studies relied on the judgments of one reviewer or a small handful of reviewers, uniquely basing their assessments on a litany of guidelines that include diagnostic codes, adverse drug reactions, algorithmic methods, and self-created scales of avoidability (p. E393).

The Care Deficiencies that Cause Readmissions

So what causes the readmissions that we decide to label preventable? We can partition the major issues or breakdowns associated with triggering preventable readmissions into separate temporal categories – failings that take place during index hospitalization, insufficient efforts undertaken during the discharge transition, and shortcomings of post-discharge patient management. During the patient's initial stay, errors related to dispensation of medication and prevention of infection have been shown to lead to heightened readmission rates, with one study (Bernard & Espinosa, 2004) concluding a doubled rehospitalization rate (from 14 percent to 28 percent) in cases where the patient encountered a safety incident during index hospitalization.

Discharge is a point along the care timeline that is especially fraught with opportunities for gaps in care or miscommunication to occur that can increase the

likelihood of readmission. One area of concern that often goes hand-in-hand with the aforementioned problem of medication error is medication reconciliation at discharge, with patients experiencing such discrepancies found to be twice as likely to be rehospitalized as those who did not. Incomplete or incorrect delivery of post-discharge care instructions on the part of the hospital, or of comprehension of those instructions on the part of patients also contributes to negative outcomes, especially in terms of the provider adequately conveying and the patient subsequently following self-management guidelines and being aware of how to identify and properly respond to potential post-discharge warning signs (Minott, 2008, p. 5) In one study (Clark, 2006), 65 percent of patients claimed that no one talked to them about managing their care at home. Lastly, but perhaps most significantly, significant breakdowns have been observed with respect to post-discharge follow-up, maintenance of care, and transition either to the home or to the patient's subsequent care provider (such as a skilled nursing facility). Clark (2006) found that 81 percent of patients requiring assistance with basic functional needs failed to receive a home care referral. Jencks et al. (2009) purported that half of Medicare recipients who had been rehospitalized within 30 days had received no intervening physician visit, while 70 percent of surgical patients readmitted before the 30-day marker were rehospitalized for a medical, rather than surgical, diagnosis (p. 1418).

The HRRP: CMS' Punitive Policy Measure

The move towards codifying into law efforts to compel hospitals to reduce their mortality and readmissions rates began in earnest in June 2007, when CMS and the Hospital Quality Alliance (HQA) began publicly reporting 30-day mortality measures for

acute myocardial infarction (AMI) and heart failure (HF), followed one year later by reporting on pneumonia (PN); the publicly-reported measures (calculated annually based on claims and administrative data) were subsequently expanded in 2009 to include 30-day readmissions for these three conditions ("Outcome Measures," 2013).

When it came time to put the gathered data into practice and establish standards against which each hospital would be required to demonstrate compliance, CMS, according to its own website for secure communications and healthcare quality data exchanges ("Readmission Reduction Overview," 2012), developed risk-standardized readmission measures that are compliant with standards for publicly reported outcomes models set forth by the American Heart Association and the American College of Cardiology, in addition to being endorsed by the National Quality Forum and adopted for reporting by the Hospital Quality Alliance. CMS states that its readmissions measures adjust for each hospital's case mix (patient age and comorbidities) so that hospitals with a greater proportion of older, sicker patients are on a level playing field with other facilities ("Readmission Reduction Overview," 2012).

Mitigating Factors Affecting Probability of Readmission

CMS claims its measures sufficiently adjust for risk, yet from the perspective of the hospitals themselves there is widespread concern that the HRRP has not done an adequate job of accounting for the fact that rehospitalizations are not created equal. Drawn from the findings of a number of studies, several mitigating factors have been identified as capable of potentially bringing significant weight to bear in determining the likelihood that a patient will be readmitted.

A crucial element in confronting and combating rehospitalization rates lies in being able to target attention and resources towards patients that are most susceptible to being readmitted for a preventable reason (and later in this paper we will examine how electronic medical records can assist in this crucial task). Assessing the likelihood that a particular patient will be readmitted is a practice that can be improved by looking at a number of circumstances relating to the patient himself, his condition, and the care structure he can draw upon for treatment and support. From a strictly temporal standpoint, the probability that readmission will occur owing to a cause deemed preventable decreases as time elapses following discharge from the index hospitalization, suggesting that interventions will be most efficacious when implemented immediately after release (MedPAC, 2007, p. 107).

Patient characteristics can play significant mitigating roles in determining probability of readmission for elderly patients. Men are more likely to be readmitted than women. African-Americans have also been identified as carrying greater rates of readmission irrespective of other major factors, as Jencks et al. (2009) found that elderly black Medicare patients had higher odds of 30-day readmission than white patients for acute MI, CHF, and pneumonia (p. 1425). General socioeconomic and education-level factors are also potentially powerful predictors of rehospitalization for Medicare recipients, as patients who live below the poverty line, lack a stable living situation, and possess poor English and health literacy competencies have been shown to be especially at risk as well.

The particular condition or combination of conditions which necessitated index hospitalization can also tell us something about the chances for readmission. One

investigation (Benbassat & Taragin, 2000) found that 29 to 47 percent of elderly patients hospitalized for heart failure are readmitted within three to six months of discharge, while 30-day rates have been reported at between 20 and 24 percent (p. 1076). End-stage renal disease is another condition predictive of greater-than-expected rates of readmission, as is any patient with multiple conditions, which a study found to be the case with 65 percent of Medicare beneficiaries (MedPAC, 2007, p. 125; Wolff, Starfield, & Anderson, 2002, p. 2269). Other condition-based characteristics affecting readmission risk include presence of cancer, lung disease, alcohol or drug dependency, and depression, as well as index hospitalization for pneumonia or acute myocardial infarction (Jencks et al., 2009, p. 1422). Notice that these two ailments, along with the aforementioned heart failure, represent the three conditions the HRRP will initially be targeting, in the obvious hopes that the most immediately sizable gains and savings can be realized through a focus on these three highly-common, especially readmission-prone events.

While hospitals can capitalize on these types of data points to divert resources to productive channels, certain fundamental characteristics of the hospitals themselves can still trigger excessive readmissions rates capable of undermining almost any well-conceived intervention. For example, Jencks et al. (2009) demonstrated that, even more powerfully predictive than the race itself, were the readmissions rates at "minority-serving hospitals" (defined as slotting in the top decile of proportion of black patients), as patients discharged from such facilities had a 23 percent greater chance of being readmitted than patients indexed at all other hospitals, leading the authors to comment that "the hospital at which a patient receives care appears to be at least as important as his/her race" (p. 1424).

Intensity of care has also been posited as factor impacting the likelihood that a hospital will demonstrate higher-than-expected readmissions rates (Minott, 2008, p. 4). Intensity here refers to tendencies for more aggressive patterns of inpatient care, typically reflective both of the amount of time patients spend in the hospital and the intensity of physician intervention during hospitalization. Looking at a state-by-state view of the data for intensity of care and rate of readmission, there are strong parallels, as states' inpatient treatment intensities by quartiles indicate similar patterns by state with the readmission rate quartiles (Minott, 2008, p. 5).

CMS Response to Criticisms of the HRRP's Design

For its part, CMS does not concur that many of the distinguishing characteristics of patients, diseases, and care systems deemed mitigating factors in the above research are sufficient excuses for a hospital to report readmissions rates higher than expected based on the risk adjustment CMS already performs. The 2012 Medicare Hospital Quality Chartbook addresses and largely dismisses most of the extenuating circumstances outlined in the section above. Regarding hospitals that serve poorer populations, CMS defined a risk variable of whether or not an individual patient was enrolled in Medicaid ("dual eligible"). Categorizing hospitals into quintiles by the proportion of the hospital's patients who are dual eligible, CMS then compared hospitals' risk-standardized readmission rates (RSRRs) with and without including this socioeconomic standard (SES) risk variable in the risk model (Centers for Medicare & Medicaid Services, 2012, p. 35). They found the greatest difference in median RSRRs with and without SES adjustment was 0.2 absolute percentage points for hospitals with the highest proportion of

dual eligible patients with heart failure (p. 35) For all other comparisons, including all risk adjustments involving AMI and pneumonia), the rate was 0.1 percentage point or less (p. 35). From this data, CMS concluded that "Overall the range of performance is similar between the hospital groups, demonstrating that many hospitals caring for poor populations achieve low readmission rates" (p. 26). In CMS' view, "Risk adjustment for SES does not make a meaningful change in the assessment of hospitals' performance on the publicly reported AMI, heart failure, and pneumonia readmission measures" (p. 35).

Likewise, regarding the perceived impact on performance exerted by proportion of African-American patients, CMS allows that "hospitals with the greatest proportion of African-American patients perform slightly worse than hospitals with the fewest African-American patients" (p. 32), yet qualifies that finding with the further contention that the "wide range of performance among hospitals with high proportions of African-American patients illuminates the ability of such hospitals to achieve good RSRRs and the need to focus improvement efforts within those hospitals and their communities that are not achieving the same levels of success" (p. 32). Lastly, concerning claims that prevalence of certain conditions may unfairly affect a facility's relative readmissions rates, CMS finds that "Better performing hospitals have reduced readmissions across all diagnosis categories, suggesting systematic approaches to reducing readmissions may have a greater impact on readmission rates than condition-specific interventions" (p. 37).

The Validity of Readmissions as a Quality Measure

Joynt & Jha (2012) argue that using readmissions rates to assess hospital performance is flawed, and intensive, targeted efforts to hone in on readmissions as a

matter of healthcare reform are misguided. Some of their contentions regarding applying rehospitalization rates as a metric strike at the heart of the HRRP's parameters and provisions, as they judge that only a small percentage of 30-day readmissions are probably preventable; that many of the primary causes of even preventable readmissions are beyond the hospital's control (for instance, the success or failure of patients to follow post-discharge guidelines or the aforementioned presence or absence of resources in the community); that readmissions aren't always indicative of poor quality, as they may be reflective of low mortality rates or commendable access to care. Likewise, Stefan et al. (2012) determined in their large study of approximately 2,700 hospitals that there was "little association between hospital performance on the process of care quality measures and hospital risk-standardized, 30-day all-cause readmission rates across a spectrum of medical and surgical conditions," concluding that "it does not appear that efforts to reduce readmission rates are likely to benefit from further focus on collecting and publicly reporting data on these process measures" (p. 380). Weinberger, Oddone, & Henderson (1996) had previously drawn such discouraging conclusions, showing that bolstered post-discharge interventions actually triggered higher readmissions rates, but with concurrent increases in patient satisfaction. In a similar vein, Thomas (1996) found that readmission rates for patients receiving poor-quality care were similar to those of patients whose care was deemed acceptable. Meanwhile, Lazar, Fleischut, & Regan (2013) express concern that the recent inundation of quality measures may actually hinder hospitals from performing optimally, working from the fact that "healthcare organizations have a finite capacity for collecting and analyzing information" and subsequently worrying that "There is a risk that data-collection efforts will supersede

improvement efforts" (p.493). As to the concern of how best to channel attention, resources, and policy in improving healthcare, Joynt & Jha (2012) deem the focus on readmissions to be inordinate to its importance, arguing that efforts directed at improving patient safety are likelier to realize industry goals of delivering better care at lower costs.

Interventions Aimed at Reducing Readmissions: Past, Present, and Future

Regardless of criticisms of the soundness of the HRRP's design or of the fairness of tying reimbursements to readmissions rates in the first place, the fact remains that reducing rehospitalizations is a clear-cut policy target of CMS and will need to be addressed in earnest by any hospital concerned about potentially having to absorb the program's punitive cuts. Fortunately for them, a number of concerted intervention strategies for limiting readmissions have already been implemented and studied throughout the nation. The vast majority of specific intervention efforts have only been applied and measured for outcomes at a single hospital or a small handful of facilities, and as such their results cannot be confidently generalizable to all institutions. However, enough consistency exists between different approaches that hospitals eager to ensure compliance can draw from a number of successful methods.

A key initial principle driving many newer intervention approaches is the realization that planning for discharge should be set in motion as early as possible following index hospitalization. Minott's (2008) summarization of the AcademyHealth invitational meeting on readmissions reduction finds participants stressing that "a proper discharge plan is in place, refilling prescriptions and scheduling a primary care appointment prior to discharge" (p. 6). Multifaceted efforts at managing the needs of

patients as they move from the site of index hospitalization to either the home or to some other care facility are commonly known as transitional care models. According to Hernandez et al. (2010), "Important elements of transitional care include communication between sending and receiving clinicians, preparation of the patient and caregiver for what to expect at the next site of care, reconciliation of medications, follow-up plans for outstanding tests, and discussions about monitoring signs and symptoms of worsening conditions" (p. 1720). Successful implementations of this comprehensive strategy include:

Beginning from the premise that early outpatient follow-up after hospitalization could be an effective means of reducing readmission rates, Hernandez (2010) observed the post-discharge progression of elderly patients with heart failure enrolled in the Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients With Heart Failure and the Get With the Guidelines – Heart Failure quality improvement program from January 1, 2003 through December 31, 2006. Hernandez found that "Among patients who are hospitalized for heart failure, substantial variation exists in hospital-level rates of early outpatient follow-up after discharge. Patients who are discharged from hospitals that have higher early follow-up rates have a lower risk of 30-day readmission" (p. 1716).

A nurse discharge advocate working with patients during their hospital stay arranged follow-up appointments, confirmed medication reconciliation, and conducted patient education with an individualized instruction booklet that was sent to the primary care provider. A clinical pharmacist called patients two to four days after discharge to reinforce the discharge plan and review medications. Participants in the intervention

group had a lower rate of hospital utilization than those receiving usual care (Jack et al.,

2009).

A three-month APN-directed discharge planning and home follow-up protocol

was implemented for elderly patients hospitalized with heart failure, increasing the length

of time between hospital discharge and readmission or death, reducing total number of

rehospitalizations, and decreasing healthcare costs (Naylor et al., 2004).

A care transitions intervention designed to encourage patients and their caregivers

to assert a more active role during care transitionn found that intervention patients had

lower rehospitalization rates at 30 days and at 90 days than control subjects (Coleman,

Parry, Chalmers, & Min, 2006).

A similar transition strategy based on Coleman's work was implemented in 2007

in ten California locations serving 1,000 patients. The Care Transitions Intervention

(CTI) consisted of a four-week process focusing on medication self-management, use of

a patient-centered health record that helps guide patients through the care process,

primary care provider and specialist follow-up, and patient understanding of "red flag"

indicators of worsening conditions and appropriate next steps. These tools and skills were

reinforced by a "transition coach" (nurse, social worker, or trained volunteer). In a

randomized controlled trial, use of CTI resulted in lower rehospitalization rates

("Coleman Care Transitions Intervention," 2009).

Outside of the hospital-to-home handoff but still in the realm of readmissions,

Russell (1999), having studied the factors contributing to readmissions and identifying

inadequate continuity of care as one of three main factors, observed the appointment of

an ICU follow-up nurse to facilitate transitions from the ICU to the general ward, finding

that "the appointment of the follow-up nurse has not only reduced the rate of readmissions to the ICU but also decreased the acuity levels of those readmitted" (p. 365).

The Role of Health IT in Reducing Readmissions

Indeed, most remedies for preventable readmissions involve hospitals taking a more proactive, thorough approach to transitional care that stresses clearly and quickly communicating information as well as anticipating problems before they require rehospitalization. Improving the quality of care during index hospitalization, particularly in terms of ensuring accurate diagnosis and medication dispensation, is also critical to curbing readmission rates. Not too long ago, implementing such measures would have been entirely dependent upon substantial additions of manpower and increased expenditures of time, and in many scenarios these investments were unlikely to produce desired outcomes, as putting extra eyes and hours on a clinical case does not always contribute positively to accuracy, clarity, or efficiency (and are often actively detrimental to these ends). Recently, however, a wave of new systems and electronic tools has begun to revolutionize the possibilities for delivering optimal, timely care.

Many of these innovations have met with opposition from providers, some of whom balk at the notion of investing resources in scaling up health IT functions when researchers have yet to produce compelling evidence that utilizing certain of these tools triggers demonstrably improved patient outcomes. Of course, much of this aversion to more fully embracing health IT due to a dearth of corroborating evidence takes the form of a Catch-22. Proof of the efficacy of certain resources may be tenuous at present,

implying that further study is needed. Iterative investigations are also necessary to assess and consequently improve the quality of the tools themselves, gauging their sensitivity, comprehensiveness, and ease of use to determine how they can be tweaked to better serve patients. The most expedient means of testing new modifications to EHR-derived resources is for hospitals to actually put them into practice and gather data on their performance, either through statistical reporting of patient events and outcomes or through surveys. Yet, again, there is reluctance on the part of providers to invest in implementing tools that lack a proven track record.

This dilemma makes the HRRP mandate especially momentous. There are certainly a number of very valid arguments to be had concerning what proportion of readmissions are preventable as well as the extent to which even preventable readmissions are affected by circumstances and variables outside a hospital's control. Regardless, if a facility's readmissions rates are deemed currently too high, it has no choice now but to either accept penalization or adopt new strategies and approaches for curbing rehospitalizations. A considerable number of intervention programs will no doubt seek to leverage the possibilities of health IT even through the utilization of tools whose benefits have yet to be precisely measured (or perfected). So while the primary intended short-term effect of these new regulations is the reduction of readmissions, a subsequent and potentially even more transformative product of CMS' requirements should be the proliferation of new test cases for devices, systems, techniques, and studies that draw upon the electronic medical record and other automated care aids. Increased usage of these resources is vital to improving their capacity to help in generating better patient outcomes. As Blumenthal (2009) puts it, Congress "sees HIT — computers, software,

Internet connection, telemedicine — not as an end in itself but as a means of improving the quality of health care, the health of populations, and the efficiency of health care systems" (p. 1477).

At present, however, adoption of EHR-leveraged tools has been extremely sporadic, generating results that are largely inconclusive. Bradley et al.'s (2012) national study of hospital strategies for reducing 30-day readmissions may have found that "Nearly 90 percent of hospitals agreed or strongly agreed that they had a written objective of reducing preventable readmission for patients with heart failure or AMI," yet their findings became more dispiriting as they drilled down into specific measures, finding that "Less than one-half (49.3 percent) of hospitals had partnered with community physicians and only 23.5 percent had partnered with local hospitals to manage patients at high risk for readmissions" (p. 609). More pertinently, they reported that "Inpatient and outpatient prescription records were electronically linked usually or always in 28.9 percent of hospitals, and the discharge summary was always sent directly to the patient's primary medical doctor in only 25.5 percent of hospitals. On average, hospitals used 4.8 of 10 key practices; <3 percent of hospitals utilized all 10 practices" (Bradley et. al, 2012, p. 610). Likewise, while Jones, Friedberg, & Schneider's (2011) attempt to assess links between HIT implementation and reductions in readmission rates reached the mixed conclusion, after evaluating a 2007 national sample of US hospitals, that "hospital participation in HIE was not associated with lower hospital readmission rates; however, high levels of electronic documentation (an aspect of HIT use) were associated with modest reductions in readmission for heart failure," they also reported that "The majority of hospitals in our sample did not participate in HIE (58.7 percent),

did not order medications electronically (60.4 percent), nor did the majority report ordering labs electronically (50.9%), leading the authors to grant that "More detailed data on participation in HIE are necessary to conduct more robust assessment of the relationship between HIE and hospital readmission rates" (p. 644). Most recently, Lee, Kuo, & Godwin (2013) "found evidence for small but clinically significant changes in reduction of length of stay and 30- day mortality but an increase in 30-day rehospitalization with no change in inpatient mortality with the introduction of a basic EMR in US hospitals," yet also admitted that "Despite efforts to encourage the adoption of EMR, the impact of EMR on outcomes at US hospitals remains unknown."

The following sections will individually discuss specific health IT tools and EHR-derived interventions, outlining their typical characteristics and functions as well as examining their record to date in terms of improving care. Namely, these HIT components are: medication reconciliation interventions, electronic discharge summaries, tools and techniques that allow newly discharged patients to monitor (and be monitored) from home, and algorithms and other EMR-derived data mining efforts intended to identify types of patients most likely to be readmitted.

Medication Reconciliation

Managing medication is a complicated process, particularly for elderly Medicare beneficiaries, who are likely to have extensive histories containing prescriptions written by a variety of providers from disparate networks and geographical areas over the course of a long period of time. Gaps must often be filled in by patients themselves or by family members, and even in cases where high levels of health literacy are present, the

expectation of satisfactory recall of medication dispensation and dosage can be quite a

daunting feat to ask. Such complexity can lead to medication errors such as omission;

incorrect dose, route, or frequency; failure to discontinue; and duplication, which may

result in adverse drug events (Endo & Jacobsen, 2006). Medication errors are among the

most common type of patient-safety error and therefore are a priority for organizational

performance-improvement efforts (Kramer et al., 2007). An estimated 5% of hospitalized

patients experience medication errors, 60% of which occur during transitions of care (i.e.,

admission, transfer between levels of care, and discharge). (Rozich & Resar, 2001). Root

causes of errors are typically related to inadequate communication, transcription,

documentation, and teamwork (Paparella, 2006, p. 517).

A process found to greatly reduce adverse drug and medication events is

medication reconciliation, which consists of a comparison of at least two sources of

medication lists, identification of discrepancies between the lists, and indication of

reconciliation (resolution) of the discrepancies (Bassi, Lau, & Bardal, 2010, p. 886). This

critical and often disaster-preventing task can be significantly accelerated and bolstered

through the utilization of information technology, both in terms of leveraging the

electronic medical record for data as well as in the design of electronic tools that can

perform automated reconciliation support. In Bassi, Lau, & Bardal's (2010) scoping

review of information technology usage in medication reconciliation, the types of

information technology present in MedRec studies ranged from general tools like email

to applications designed specifically for conducting MedRec (p. 886). Four studies had

some kind of an electronic MedRec tool, which was classified as Decision Support

functionality. Fifteen studies mentioned the existence of an organizational electronic

medical record or electronic health record. Other types of IT included pharmacy systems, databases, computerized provider order entry, and medication administration record (MAR) systems. All remaining types of health information systems, such as clinical information systems and computerized record systems, were grouped into a general category of "Other HIS" (p. 888). The most common type of IT mentioned in the scoping review was an EMR followed by other HIS (p. 889). In the view of the authors, this finding was not surprising, considering EMRs typically contain a patient's medical history, including current medications. In many of the studies Bassi et al. reviewed, the focus was determining the accuracy of medication lists contained within information systems. Most often, IT was used to obtain medication information. In some studies, a medication list was extracted from an EMR or information system for comparison (p. 889).

Although there were only a few MedRec tools in the studies, they supported the central activities for MedRec: comparison of medications and clarification of discrepancies. The most comprehensive was the system described by Agrawal et al., which allowed the clinician to invoke the MedRec application to bring up a list of medications, document the "currently taking" status and " intended action," add additional medications, and automatically route to an electronic work queue for the pharmacy. The pharmacist could view the MedRec documentation and CPOE orders and record any discrepancies.

Two other MedRec tools also supported the comparison and clarification steps. In the study by Poole et al., the Physician Discharge Medication Worksheet (PDMW) was a paper form generated by the hospital information system with medication information

and posted on the paper chart for the physician to review and update prior to discharge. The use of this computer-generated tool led to a reduction in discrepancies in drug frequency and dose, as well as therapeutic duplication, at the time of discharge, with the authors concluding that "Through the use of the PDMW, medication reconciliation has been dramatically improved" (Poole et al., 2011, p. 12).

Meanwhile, in the system described by Turchin et al. (2008), the Preadmission Medication List (PAML) Builder, a medication reconciliation application, imported medication information from source systems and displayed it on a screen for providers to create a validated list of medications at admission. According to Schnipper et al.'s (2009) evaluation, PAML is a Web-based application that promotes the creation of a preadmission medication list from several electronic sources (including two ambulatory electronic medical record systems used at Partners HealthCare and discharge orders from the two study hospitals), documents a planned action on admission for each PAML medication (e.g., continue on admission, discontinue), facilitates review of a completed PAML and admission medications by a second clinician, and facilitates reconciliation of the PAML with current inpatient medications when discharge orders are written. Schnipper et al. found that "A computerized medication reconciliation tool and process redesign were associated with a decrease in unintentional medication discrepancies with potential for patient harm," as in their two-hospital cluster-randomized controlled trial (according to the authors the first randomized controlled trial of an IT-based medication reconciliation intervention), they "found that a medication reconciliation intervention consisting of novel IT and process redesign involving physicians, nurses, and pharmacists

was associated with a 28% relative risk reduction in unintentional medication discrepancies with potential for harm" (Schnipper et al., 2009, p. 771).

Electronic Discharge Summaries

One of the most critical and potentially precipitous points in the care continuum occurs when a patient is discharged from index hospitalization. When handled correctly, this event can yield very positive outcomes, with the patient transitioning smoothly into a care program at another type of facility or into home care. When discharge is handled poorly, however, the patient becomes a far likelier candidate for preventable readmission. Among the most powerful tools the provider has at his disposal to help prevent that adverse result is the discharge summary. It represents an opportunity for the caregiver to comprehensively and clearly assemble all of the pertinent information related to the cause of initial admission, diagnosis, treatments administered and patient response, as well as post-discharge recommendations. Having this summary, and knowing that it is accurate and sufficiently thorough, is vital to any physician or other care provider who might encounter the patient in those crucial first weeks and months following discharge.

Unfortunately, as Kripalani et al. (2007) observe, the availability of a discharge summary at the first post-discharge physician visit is as low as 12 percent to 34 percent, and even in instances where summaries are provided, they remain highly prone to deficiencies in content and accuracy (p. 831). Likewise, O'Leary et al. (2006) find that community based physicians have labeled more than one-third of adverse events occurring shortly after discharge as byproducts of poor transfers of information.

Historically, discharge summaries were dictated, but in recent years there has increasingly been a push to electronically generate these important documents. Maslove et al.'s (2009) randomized controlled trial evaluating primary care provider and housestaff preferences regarding electronic versus dictated discharge summaries notes that the literature on electronically created summaries indicates they possess a greater likelihood of being generated, are more accurate, are delivered faster than dictated summaries, and are preferred by community physicians. On the other hand, Callen, Alderton, & McIntosh (2008) conclude that electronic discharge documents often lack crucial information, while Weir & Nebeker (2007) found them to be rated poorly by end users. Maslove et al.'s own investigation involved housestaff completing fields by a combination of free-text entry, cutting and pasting from the HIS patient record, and selection from pick lists. After being finalized, the summaries were electronically signed and authenticated by the attending physician, uploaded to the HIS, and sent out to the PCPs. Forms generated included a structured discharge summary report, a computer-generated prescription, and patient letter (Maslove et al., 2009). The authors found no difference in PCP satisfaction, but did determine that "Housestaff found the EDS significantly easier to use than conventional dictation" (Maslove et al., 2009, p. 999).

More promising in its outcomes and design is O'Leary et al.'s (2009) quality improvement efforts utilizing an electronic discharge summary. Most intriguingly, the researchers leveraged the EMR in their study, creating logic that queried the "primary care physician" field within the EMR at the time the discharge summary was electronically signed, and then adding an automated process that sent the discharge summary via electronic fax to the physician listed in the "primary care physician" field.

The authors also accounted for the fact that many outpatient physicians use EMRs different from those employed by the index hospital, and thus created a process that sent discharge summaries from the hospital EMR into patient charts within this separate EMR" (O'Leary et al., 2009). Their findings were roundly positive, as "fewer outpatient physicians reported one or more of their patients having a preventable adverse event or near miss as a result of suboptimal transfer of information at discharge after the implementation of the electronic discharge summary" (O'Leary et al., 2009, p. 220), an encouraging sign that such IT-optimizing interventions can help curb preventable readmissions.

At present, however, there is cumulatively little research extant specifically regarding readmissions outcomes resulting from utilization of electronic discharge summaries as opposed to more traditional formats. Motamedi et al.'s (2011) systematic review of computer-enabled discharge communication interventions, which identified 12 unique studies, found that only four studies reported on readmissions, with rehospitalizations similar between groups at 14 days, 28 days and six months, yet with significantly lower readmissions for the intervention group at 12 months. The authors concluded that "primary outcomes of mortality and readmission were inconsistently reported" but were adamant in their conviction that further scientific enquiry into the effectiveness of these technologies was vital, urging "organisations that move now to implement such systems to also incorporate formal evaluation protocols to expand collective knowledge on their efficacy," and that "Given the rapid uptake and continuing evolution of electronic patient information systems in acute and primary care settings, it

is important to continue to scientifically study the extent to which such systems affect patient outcomes" (Motamedi et al., 2011, p. 414).

Telemonitoring

As soon as elderly patients transfer into home care, they immediately become to at least some degree at risk for developing complications that could have been better managed or even avoided entirely had they remained in the hospital. Of course, long-term hospitalization is a scenario that all parties involved wish to avoid, so it becomes vital that care is extended in every reasonable, efficient way possible following discharge to prevent subsequent readmission. Again, health IT innovations are often a very important factor in helping to bridge spatial and temporal care gaps that naturally result from a patient exiting the hospital. A particularly popular and oft-studied tech-leveraging intervention is telemonitoring, the remote monitoring of patients by the health care provider, typically accomplished through the presence of monitoring devices in the home that collect data related to the patient's health (heart rate, weight, glucose, etc.) and then transmit that information to the provider, or through telephone interactions between the patient and a caregiver, or through a combination of the two techniques.

A number of promising studies in recent years have reported positive findings regarding the capacity of telemonitoring to aid in preventing readmissions. Giordano et al.'s (2009) multicenter randomized trial for a home-based telemanagement program for CHF patients suggested reductions in hospital readmission at the one-year mark, as did Dar et al.'s (2009) intervention. In the same year, Dansky & Vasey published a remote monitoring study in which a "Health Buddy" appliance was utilized to transmit the

disease management program to the patient, collect clinical data and patients' responses to questions, and transmit data back to the healthcare provider. The authors sought to determine whether adverse events, such as rehospitalization, could be minimized or prevented, and concluded that "continued use of the Health Buddy for 180 days had a significant effect on the number of inpatient hospital admissions... Among the 64 patients in the telehealth group, none (0%) reported any inpatient admission, compared to 13 (28.3%) patients in the control group (p < .001)" (Dansky & Vasey, 2009, p. 986). More recently, Delaney et al.'s (2013) randomized controlled trial of a telemonitoring and self-care education intervention showed a significant decrease in all cause hospitalization at 90 days following home care discharge in the experimental group compared with the control group and a trend toward decreased rehospitalization at 30-days post–home care discharge.

Not all investigations into benefits of telemonitoring in limiting readmissions have yielded favorable conclusions. On the one hand, Clarke, Shah, & Sharma's (2010) meta-review concluded that telemonitoring can reduce CHF hospital admission over a 12-month period," with the authors stating that "Telemonitoring in conjunction with nurse home visiting and specialist unit support can be effective in the clinical management of patients with CHF and help to improve their quality of life" (p. 7). Likewise, Inglis et al.'s frequently-cited (2010) Cochrane review also determined that telemonitoring reduced CHF-related hospitalizations. However, Maric, Kaan, Ignaszewski, & Lear's (2009) systematic review found that "several studies reported significantly decreased hospitalizations and improved QOL while the others did not report significant differences on these measures" (p. 507). Along those same lines,

Chaudhry et al.'s (2010) multicenter, randomized, controlled trial involving patients recently hospitalized with heart failure found no reduction in the risk of readmission or death from any cause with telemonitoring as compared with usual care, and further claimed that while "These results contrast with the findings of a recent Cochrane review of telemonitoring for patients with heart failure, our study was of higher methodologic quality and was larger than most of the studies included in the review" (p. 2306).

Indeed, as with many attempts to make a comprehensive survey of a relatively nascent field of enquiry, the quality of the methods used in the studies was variable, and many of the studies were small (Delaney et al., 2013). Much of the discrepancy in the perceived efficacy of such interventions reported by various reviews and RCTs might be explained by the rather broad spectrum of specific tools and strategies that have been variously categorized under the "telemonitoring" umbrella. The Cochrane review does clearly delineate between structured telephone support interventions and remote telemonitoring efforts. As Maric, Kaan, Ignaszewski, & Lear (2009) observe, "with the rapid advancement in technology in recent years, data from a number of new studies utilizing different telemedicine modalities are now available" (p. 507). On the other hand, Chaudhry et al.'s RCT did not involve automated gathering of health data by means of a device, but rather took the form of patients being instructed to make a daily phone call to a telemonitoring system that conveyed a series of questions about symptoms and daily weight (Chaudhry et al., 2010). In that light, the authors' skepticism regarding the potential of telemonitoring to aid in reducing readmissions is mediated by the fact that their study did not take full advantage of the technological possibilities of this

intervention, specifically the ability to collect information about patients without requiring active participation on their part.

Identifying At-Risk Patients

Ideally, all hospitalized Medicare beneficiaries would be carefully monitored following discharge to help reduce the risk of readmission. Often, however, realistic interventions must be targeted, and in the interest of maximizing financial, technological, and manpower resources, it is critical for hospitals to direct efforts at particular patient populations that are most susceptible to rehospitalization. Analyzing data on rehospitalized patients relating to gender, race, income, education, lifestyle, and other factors yields a number of characteristics historically predictive of readmission. Now, thanks to the increasing presence of electronic medical records in U.S. hospitals, models are being developed to better stratify readmission risk and give information early enough during hospitalization to trigger transitional care interventions, many of which involve discharge planning and begin before hospital discharge (Kansagara et al., 2010, p. 1688).

Amarasingham et al.'s (2010) automated predictive model for 30-day readmission was derived from data extracted from the EMR and then compared with readmission models developed by CMS and a HF mortality model derived from the Acute Decompensated Heart Failure Registry (ADHERE) model. The model demonstrated good discrimination for 30 day readmission (C statistic 0.72), outperforming the two aforementioned models, and performed better after the incorporation of complex social variables such as number of address changes, census tract socioeconomic status, history of cocaine use, and marital status (Amarasingham et al., 2010).

One year later, Watson et al. (2011) tested 15 psychosocial predictors of readmission, 11 of which had been extracted from the EHR (six from structured data sources and five from unstructured clinical notes). These markers were analyzed to determine their level of association with 30 day rehospitalization, and ultimately a multivariable predictive model was established to represent high-risk individuals. The five characteristics most strongly linked to likelihood of readmission were dementia, depression, adherence, declining/refusal of services, and missed clinical appointments, the first four of which were captured from unstructured clinical notes, suggesting they are a very rich source of risk-identifying data.

Elsewhere, Khan et al. (2011) evaluated the ability of a 20-point, four-dimensional tool to predict 30-day readmissions for an elderly population and found it potentially better at identifying patients not at risk for readmission. In addition, Silow-Carroll et al.'s (2012) examination of EHR utilization by leading hospitals pointed to promising examples of facilities leveraging health IT to target their interventions. The authors identify both Geisinger and Sentara as having developed early warning systems that derive their predictive power from frequently-updated data found in the EHR, with Geisinger extending this program to the development of an algorithm to assess patients' risk of readmissions that seeks to mitigate identified risks (Silow-Carroll et al., 2012).

Conclusion

When elderly Medicare beneficiaries are discharged from the hospital, they immediately enter a very precipitous healthcare phase. Regardless of whether they are being transferred to another care facility or are being sent home, this transition must be

managed actively and delicately to reduce the risk of negative outcomes. One of the primary outcomes providers should seek to avoid whenever possible is the rapid readmission of patients to the hospital following that index hospitalization. Of course, often readmission is either planned or unavoidable given the patient's condition or course of treatment. However, when it can be avoided, providers should be doing everything in their power to prevent hospitalization from becoming a revolving-door proposition for patients who are likely to be in an extremely fragile state.

This thinking has motivated the implementation of the Hospital Readmissions Reduction Program by the Center for Medicare and Medicaid Services, a penalty-based initiative that will cut Medicare reimbursements to hospitals that readmit a higher rate of beneficiaries than CMS models deem acceptable for that facility. Advocates and representatives of hospitals' and the CMS' respective interests have subsequently grappled over a number of parameters, definitions, and predictive indicators related to an institution's capacity to meet these new requirements. These debates have centered around issues such as distinguishing between preventable and unpreventable readmissions, pinpointing the specific shortcomings in care that trigger rehospitalizations deemed avoidable, mitigating circumstances and characteristics that may mark certain patients and patient populations as unfairly more prone to readmission, and even whether readmissions is a suitable measure of healthcare quality in the first place.

Arguments aside, hospitals will be required to produce readmissions rates in line with expectations in order to avoid absorbing penalties. For many facilities, targeted intervention programs or protocols will need to be implemented in order to ensure compliance. Several such strategies have already been tested with demonstrated success

throughout the country, involving careful discharge planning and preparation that begins during index hospitalization, informed and thoroughly communicated handoffs, and outreach efforts conducted after the patient leaves the hospital to ensure treatments are being followed and conditions do not unnecessarily worsen.

To achieve optimal outcomes it is vital for hospitals to make use of the resources at their disposal, and recent advancements in health information technology have made it possible, with varying degrees of affordability, to curb readmissions rates in powerful new ways. As facilities increasingly work their way towards compliance with HITECH Act mandates relating to utilization of electronic health records and their associated tools, researchers are testing and tweaking new aids that leverage the EHR to provide timely interventions that can prevent rehospitalizations. Through medication reconciliation, electronic discharge summaries, telemonitoring tools, and EHR-derived risk-prediction models, hospitals possess the capability to anticipate which patients might be especially prone to readmission, reinforce index care decisions, ease transitions, and provide care and support after discharge.

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