



AUGUST 2010

Issues in International Health Policy

Predictive Modeling in Action: How ‘Virtual Wards’ Help High-Risk Patients Receive Hospital Care at Home

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Commonwealth Fund pub. 1430
Vol. 94

ABSTRACT: A model of home-based coordinated care deployed recently in the United Kingdom offers promise in reducing hospital admissions in a relatively low-cost manner. The “virtual ward” program provides multidisciplinary case management services to people who have been identified, using a predictive model, as high risks for future emergency hospitalization. Virtual wards use the systems, staffing, and daily routine of a hospital ward to deliver preventive care to these patients in their own homes. Patients report that they value the improved coordination of their care, while staff report satisfaction in working on a virtual ward and the opportunity to share problems and find solutions with colleagues who are caring for the same patients. With its intuitive appeal, the virtual ward model has been deployed in a number of locations in the U.K. and internationally, including the United States.

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OVERVIEW

Emergency hospitalizations—and subsequent rehospitalizations—of people with chronic disease are a major source of costs within the U.S. health care system and health systems around the world. Indeed, in the United States, reducing avoidable hospital admissions and readmissions has become part of a national priority to improve patient outcomes and lower the costs of health care.

Reducing such hospitalizations in a cost-effective manner has, however, proved to be elusive. The Medicare program has undertaken several trials of chronic disease management programs in recent years, including the Medicare Health Support experiment and the Medicare Coordinated Care Demonstration,^{1,2} but these programs have produced largely disappointing results—underlining the great difficulty of realizing the potential savings from hospital avoidance. In view of these

findings, attention is turning once again to ways of improving the cost-effectiveness of chronic disease management programs.³

A model of home-based coordinated care deployed in the United Kingdom within the past six years offers promise in reducing hospital admissions in a relatively low-cost manner. “Virtual wards,” as the model is known, provide multidisciplinary case management services to people who have been identified, using a predictive model, as high risks for future emergency hospitalization. Virtual wards use the systems, staffing, and daily routine of a hospital ward to deliver preventive care to patients in their own homes—rather than waiting for patients to come to the hospital as costly emergencies. The first virtual wards opened in the London borough of Croydon in 2004, where there are currently 10 virtual wards open, with the capacity to care for 1,000 high-risk patients. Similar schemes are being adopted elsewhere in the U.K. and internationally.

What distinguishes virtual wards from other programs designed to prevent hospitalizations is that they couple predictive modeling with a virtual “hospital-at-home.” Predictive modeling aims to ensure that the intervention is targeted at those patients who are most at risk for emergency hospitalization in the next 12 months, while the hospital-at-home offers a way for staff to deliver highly coordinated, collaborative, multidisciplinary care to these carefully selected patients in an ideal setting—their own homes.

BACKGROUND: PRIMARY CARE IN ENGLAND

Under the U.K.’s National Health Service (NHS), all citizens are entitled and encouraged to register with a primary care physician, called a general practitioner (GP). Patients are free to change GPs but can only be registered with one GP at a time. This is to ensure that there is a single physician or group of physicians to take overall responsibility for a patient’s care—in other words, to provide the patient with a medical home. GPs typically work in small groups and are supported by administrative staff, nursing staff, and other health professionals. In general, GPs act as gatekeepers to hospital care and NHS patients

are not permitted to seek specialist care without a referral from their GP.

GPs are generally employed as part of a partnership that holds a contract to deliver primary care for a registered population. This is in contrast with most secondary care physicians, who are employed by NHS hospitals (although specialists are free to work privately as well if they wish). The primary care contract is held between the GP partnership and the local NHS commissioning organization, currently known in England as a Primary Care Trust, or PCT. The PCT has overall responsibility for the health of its local population and conducts a range of functions from contracting, strategy, and performance management to public health. GP practice income is calculated mainly on a capitated formula, but up to a third of a GP practice’s income is based on a pay-for-performance scheme called the Quality and Outcomes Framework (QOF).⁴

In England, patients can usually expect to see their GP for an urgent problem on the same day if they are prepared to wait in line, or they are entitled to an appointment within a maximum of 48 hours. Practices are required to be open from 8:00 a.m. until 6:30 p.m. and must also provide evening and weekend appointments. In addition, PCTs are responsible for arranging for after-hours coverage by separate primary care providers, typically from a cooperative of local GPs. Many patients choose to receive after-hours coverage at NHS walk-in centers (particularly in urban areas) or a local emergency room, known as Accident & Emergency, or A&E. Under nationally imposed targets, A&E patients are guaranteed to be seen, investigated, treated, and admitted or discharged within four hours of arrival. When a patient requires an ambulance, one is provided free of charge by the local NHS ambulance trust and, again, strict waiting time limits apply to ambulance services.

One criticism of the NHS in recent years is that care may be fragmented between GP practices and hospitals. For example, it is rare for a physician to work in both primary care and secondary care, and hospital physicians are generally unable to access the GP’s electronic medical record.

In contrast to health care, which is available to all citizens free of charge at the point of use, free social care in England is only available to those with low incomes and assets. Most nursing homes are privately run, although long-term care is increasingly being provided in clients’ own homes rather than in institutions. There are currently efforts under way to reduce unnecessary fragmentation in care between the NHS and social care as well as between GPs and hospitals.

PREDICTIVE RISK MODELING

Emergency hospitalization rates are highly skewed across populations, such that a small number of patients typically account for a very large proportion of admissions. For example, 5 percent of patients in England account for 49 percent of inpatient bed days.⁵ In theory, the health care system could make substantial net savings if it could reduce emergency hospitalizations by offering preventive care to these costly individuals.⁶

However, for hospital-avoidance programs to be successful, they must account for what is known as “regression to the mean”—that is, those patients who are currently experiencing repeated hospital admissions will, on average, have markedly fewer hospital admissions in

the future, even without intervention ([Appendix Exhibit 1a](#)).^{7,8} So a hospital-avoidance program that selects patients for preventive care based on their current risk will appear to be successful in reducing the number of admissions, when in fact most of this reduction would have occurred anyway; the true impact of such programs in these circumstances would be only marginal ([Appendix Exhibit 1b](#)).

If patients could instead be identified *before* they became high-risk, a much greater impact would theoretically be possible ([Appendix Exhibit 1c](#)). To explore this possibility, the Department of Health commissioned two predictive models for the NHS in England.⁹ The Patients At Risk of Re-hospitalization (PARR) tool and the Combined Predictive Model use a broad range of variables to predict future hospitalization.¹⁰ These relate to demographics (age, sex, and ethnicity), diagnoses, frequency of admission, and presence of chronic conditions; other variables have to do with community characteristics, such as levels of deprivation and the characteristics of local hospitals. Predictive models are designed to overcome the problem of regression-to-the-mean by identifying those patients who will be at risk of admission or readmission in the 12 months after prediction.¹¹

PARR and the Combined Predictive Model

PARR. The Patients At Risk of Re-hospitalization (PARR) tool was designed to be straightforward to use. The tool can be downloaded free of charge by NHS organizations and runs off hospital claims data, supply-side variables (e.g., the propensity of different hospitals to admit patients), and data from the census (e.g., a geographical indicator of deprivation). PARR generates a risk score between 0 and 100 for each patient who has had a reference admission. This score reflects the patient’s risk of readmission in the next 12 months. For high-risk patients (risk score of >50) the tool has a sensitivity of 54.3 percent and a positive predictive value of 65.4 percent. For very high-risk patients (risk score of >80) the sensitivity is lower, at 8.1 percent, but the positive predictive value rises to 84.3 percent.

Combined Predictive Model. The Combined Predictive Model is a more complex predictive tool that was designed to produce the most accurate predictions possible across the entire population. In addition to the datasets used in PARR, the Combined Model uses variables from the primary care electronic medical record (EMR). EMR data are collected and collated differently across England, so the Combined Model has to be adapted to suit local circumstances. Unlike PARR, the Combined Model generates a risk score for every member of the population, not just those who have been recently hospitalized. The 0.5 percent of the population with the highest predicted risk are 18.6 times more likely than the average patient to have an emergency admission in the year following prediction.

VIRTUAL WARDS AT WORK: THE INTERVENTION

Virtual wards were developed by the author and two nurse consultants at Croydon Primary Care Trust (PCT) in South London. Croydon is the largest of London's 32 boroughs, with a population of some 342,000. It is a major commercial and financial center, with a population that is highly diverse in age, ethnicity, and income.

Virtual wards use the output of a predictive model to select which patients should be offered multispecialty case management. There are currently 10 virtual wards open in Croydon, with the capacity to care for 1,000 high-risk patients. Croydon's virtual wards have won a

number of prestigious awards, and the concept is now being adopted and adapted elsewhere in the U.K. and internationally.¹²

Objectives

The primary objective of predictive modeling and virtual wards was to reduce the rate of emergency hospitalizations. For Croydon PCT, this strategy supported the targets established by the government for the NHS Public Service Agreement to reduce unscheduled acute hospital bed days by 5 percent between 2005 and 2009.

An important secondary consideration was the impact on health care disparities. One of the key

A Virtual Ward Patient from Wandsworth

Anna H. is a 50-year-old woman who had a cerebellar stroke two years prior to admission to a virtual ward, and was left with poor balance and reduced mobility. Anna has multiple chronic conditions, including insulin-dependent diabetes, poor renal function, and hypertension. She is legally blind and lives alone.

When Anna was discharged from the hospital post-stroke, she was referred to the community stroke team but never followed up. As a result, Anna had inadequate support at home and was finding it difficult to cope. She would frequently present at the hospital with complaints, from abdominal pain to hyperglycemia, that prompted admissions or investigation.

The PARR predictive model identified Anna as being at high risk for rehospitalization, and she was admitted to a virtual ward, with members of the virtual ward team assigned to provide ongoing support for her at home. The team arranged with the local visiting nurse service to have community nurses visit Anna twice a day, in order to help her administer insulin and measure her blood sugar. In time, Anna has learned to do these safely herself and the nurses visit less frequently now.

The local home security and fire safety team was contacted to replace Anna's fire alarm and door locks, which were all substandard. She was put in touch with Shopmobility, a local project of the Age Concern charity, which takes her out each week to do her shopping. The virtual ward social worker arranged for home care assistants to visit her twice a day to help with washing, dressing, and cleaning the house.

Since her admission to the virtual ward, the case manager and virtual ward physician have visited Anna regularly at home to manage and monitor her various medical problems. Anna has responded well to the sense of security that comes from knowing she has the virtual ward clerk's number and can call if she is in difficulty.

Despite having optimal stroke-prevention therapy, Anna unfortunately suffered a second stroke and has since had a further reduction in her mobility, plus a mild expressive dysphasia. The community stroke-rehabilitation team is now working closely with the virtual ward team, and Anna will stay under the care of the virtual ward for the foreseeable future.

As so many professionals are now involved in Anna's care, she is discussed frequently on ward rounds, which have proved to be a useful forum for sharing information, ensuring coordination, and avoiding unnecessary duplication by the different professionals.

strengths of PARR and the Combined Predictive Model is that they can potentially improve equity of and access to health care by mapping predicted risk across a geographical area. The catchment population for each virtual ward can then be adjusted so that in areas where there is an excess of patients with high risk scores, the catchment population can be made relatively small, and vice versa. In this way, it may be possible to counter Julian Tudor Hart’s Inverse Care Law, which states that the health care provided in a local area is typically found to be inversely proportional to its level of need.¹³

Rationale

The rationale for the virtual ward project was the potential net savings that could be made from future high-cost unplanned hospitalizations. By investing in “upstream” care for high-risk patients, it was hoped that averted hospitalizations would release funds “downstream.” The growing use of predictive models in health care over recent years has been made possible by a combination of better access to individual-level electronic data and improvements in computing power. Croydon PCT had been extracting information from primary care electronic medical records for several years before 2004, and so Croydon was one of the local areas that provided the data on which the Combined Predictive Model was built. The development of virtual wards came about because it was necessary to have an intervention ready to offer those patients whom the Combined Predictive Model would start identifying as being at high risk.

The innovation addressed the goals of a number of national initiatives, including policies to:

- improve care for people with chronic conditions;
- integrate health and social services (“horizontal integration”) and foster closer links between primary and secondary care (“vertical integration”);
- improve value for money spent on health care by reducing emergency hospitalizations; and
- reduce health care disparities (by using a predictive algorithm in which deprivation is one of the independent variables).

Organization Background

Virtual wards have a bearing on almost all elements of the health care delivery system in a local area (Exhibit 1). Most members of the virtual ward team are employed by the Primary Care Trust, but the project would not have been possible without the support and active participation of the primary care physicians and other organizations. Members of the virtual ward team have honorary contracts at local hospitals, so that they can obtain laboratory and radiology results and can visit patients who are eventually admitted to the hospital.

Virtual Ward Infrastructure

Virtual wards operate using the systems, staffing, and daily routines of a hospital ward but without a physical ward building—it is a ward without walls. Patients will only be selected for admission to a virtual ward if their score on a predictive model places them at sufficiently high risk for future hospitalization. These high-risk patients are provided with intensive preventive care while still living in their own homes.

The virtual ward team shares a common set of electronic notes and charts, conducts daily “patient rounds,” and has its own ward clerk to take messages and coordinate the team. Each virtual ward has a capacity to care for 100 patients (in hospital terminology, each virtual ward has 100 beds). This represents roughly the 0.5 percent highest risk out of a catchment population of 35,000.

Virtual wards are based in primary care, with each virtual ward being permanently linked to a small group of GP practices (Exhibit 2). In this way, the virtual ward staff develops close working relationships with the primary care physicians and their staff. Patients are chosen only from participating practices and keep their own GP. The virtual ward staff keeps the GP abreast of developments, and three-way consultations are encouraged between the patient, the patient’s GP, and the virtual ward case manager.

Exhibit 1. Provider Organizations in the Croydon Virtual Wards Network

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- Croydon Primary Care Trust (PCT) provides the infrastructure for virtual wards and employs most virtual ward staff. A PCT is a local division of the NHS that currently delivers some community services, and commissions primary and secondary care services for the local population. Croydon PCT also holds a contract with every GP practice in Croydon and a memorandum-of-understanding with each GP practice participating in the virtual wards program.
 - Croydon Council, the local municipal council, provides a social worker for each virtual ward.
 - Mayday Hospital (the local NHS acute hospital) has given honorary contracts to all virtual ward staff so they can visit patients on the wards, obtain laboratory results, and perform other functions. The emergency room has set up a system so that the arrival of a virtual ward patient at the ER triggers an alert that prompts the ER receptionist to contact the patient's virtual ward clerk.
 - The London Ambulance Service has set up a similar alert system and will dispatch an Emergency Care Practitioner ambulance crew wherever possible to virtual ward patients.
 - Croydoc, the local after-hours primary care service, takes over the ward clerk telephone number at night and has access to the virtual ward electronic patient records.
 - Croydon Voluntary Action (the umbrella group for all voluntary organizations in the borough of Croydon) has assigned to each virtual ward a named representative who acts as a link to all of the voluntary services, such as befriending services, advice helplines, and cultural groups available in Croydon.¹⁴
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Virtual Ward Staff

The day-to-day clinical work of the ward is led by a case manager, known in England as a community matron—a senior nurse who has received additional training in prescribing and in clinical examination skills. Other staff members may include a social worker, a pharmacist, visiting nurses, an occupational therapist, and a physical therapist; the exact composition of the staff will vary according to local health needs. A key staff member on all virtual wards is the administrator, called the virtual ward clerk, who acts as the central coordinator. With a dedicated telephone number and e-mail address, the ward clerk is able to collect and disseminate information between patients, their caregivers, primary care practice staff, virtual ward staff, and hospital staff.

Daily conversations between the case manager and the on-duty physician at each constituent primary care practice ensure appropriate medical oversight. The case manager is also able to book appointments with the patient's usual GP. In the South London borough of Wandsworth, which has been operating a virtual ward

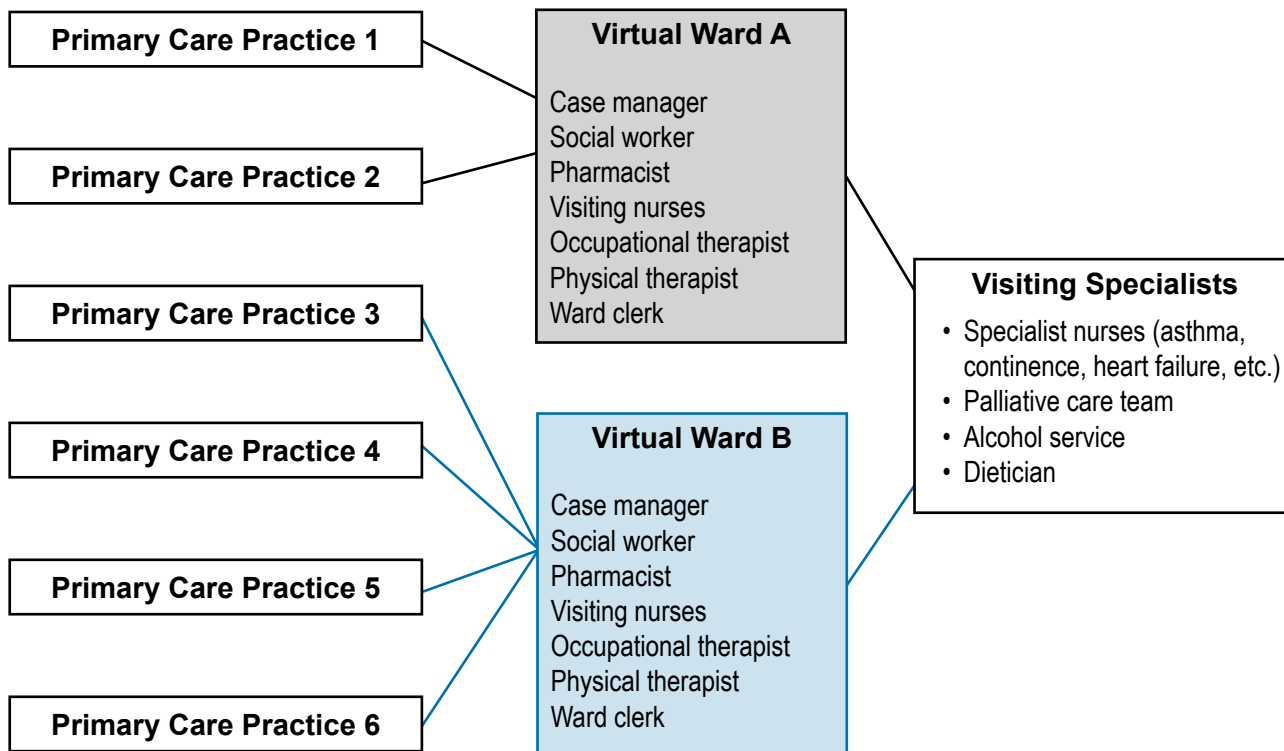
program since March 2009, each virtual ward has a dedicated primary care physician who works full-time as a core member of the team.

The virtual ward staff also maintains close working relationships with organizations such as hospices, drug and alcohol services, and voluntary sector agencies. Just as certain hospital nurses, such as asthma specialist nurses, will cover several hospital wards, the community's specialist teams likewise cover several virtual wards. These teams may include palliative care teams, drug and alcohol treatment teams, or specialist continence nurses. Participating specialists are invited to attend those ward rounds where their particular patients will be discussed, and they may attend either in person or by telephone.

Ward Rounds

When a patient is admitted to a virtual ward, the case manager visits the patient at home and conducts an initial detailed assessment. In Wandsworth, the case manager and the virtual ward physician conduct a joint visit. The patient is offered screening for certain conditions

Exhibit 2. Organizational Structure of Virtual Wards in Croydon



such as depression, cognitive impairment, or alcohol misuse. Working with the patient, the case manager drafts an initial action plan, which is entered into a set of electronic notes that is shared by all ward staff.

The virtual ward staff holds an office-based ward round each working day, with teleconference facilities available for staff who wish to join remotely. At ward rounds where newly admitted patients are discussed, team members can suggest changes to the patient’s care management plan and can agree which staff member will perform which tasks. Already admitted patients are reviewed more or less frequently depending on their circumstances and clinical stability. Of the 100 patients on each ward, typically about five patients would be reviewed daily, 35 patients would be reviewed weekly, and the remaining 60 would be reviewed monthly. So on any given ward round, 15 current patients are discussed in addition to any newly admitted or soon to be discharged patients.

Communications

The GP practice is informed of all significant changes to a patient’s condition or management. Every night a list of each virtual ward’s current patients is e-mailed securely to local hospitals and after-hours services, and these organizations upload the information to their clinical computer systems. The arrival of a virtual ward patient at a local emergency room or after-hours service will trigger an alert to staff that this patient belongs to a virtual ward. Secondary care staff can then contact the virtual ward clerk to obtain up-to-date details of the patient’s care and work in partnership with the virtual ward staff to try to avoid a hospital admission; when the patient must be hospitalized, hospital staff can arrange early discharge back to the care of the virtual ward team.

Discharge

When a patient has been assessed by all relevant virtual ward staff and has been cared for uneventfully for several months, ward staff may feel the patient is ready to be discharged back to the care of the primary care practice.

The virtual ward team also receives a prompt when the patient's name drops off the list of the 100 people with highest predicted risk in the catchment area, as determined by the Combined Predictive Model. The length of time that patients spend on a virtual ward is highly variable, ranging from a few weeks to a year or longer.

When a patient is discharged from a virtual ward back to the sole care of his or her GP practice, the virtual ward clerk sends the practice a discharge summary and sends a discharge letter—using lay terminology—to the patient. An informal evaluation of virtual ward patients in Croydon showed that their satisfaction with the service was very high. They particularly valued the sense of safety from being looked after by a multidisciplinary team and of having a single contact person—the virtual ward clerk—through whom they could contact the whole team.

Virtual Ward Patients

The virtual wards opened in Croydon Primary Care Trust in May 2006. Using routine historical data, Exhibit 3 characterizes the patients who were admitted to the first virtual wards.

IMPLEMENTATION

There were two major challenges in implementing virtual wards in Croydon. First, some GPs were reluctant to allow patients to be selected purely on the basis of a predictive risk model, and some requested the right to select which patients should be offered admission. In response, a series of presentations to GPs set out the evidence base for predictive modeling, in particular, findings from a literature review (conducted by The King's Fund for the Department of Health) that suggested that predictive models could be more accurate than clinical opinion in forecasting risk of future hospitalization.¹⁵

The second challenge was in communicating the virtual ward concept to community-based staff; staff initially felt the concept was somewhat abstract and difficult to grasp. However, after further explanation, most staff felt that virtual wards were an intuitive way to deliver care. Their experience of working in hospitals meant they did not find it hard to imagine how daily ward rounds would work, and they expressed enthusiasm for the *esprit de corps* they expected virtual wards to generate.

A detailed memorandum of understanding was developed between the PCT and the primary care practices. It proved challenging to obtain agreement, but the document has subsequently been very helpful in clarifying roles and expectations. Members of the virtual ward staff report clinically to the case manager (community matron) but otherwise maintain their previous professional lines of accountability.

Ward clerks were trained in telephone skills and in identifying potentially worrying symptoms such as breathlessness or chest pain. However, no new training programs were developed for other virtual ward staff, because an NHS case management guide had already been developed and was available for staff managing the care of patients with chronic conditions.¹⁶ Likewise, no specific new guidelines were developed for managing patients, since virtual ward patients generally have such complex problems that highly individualized plans are needed. For patients with multiple chronic conditions, and particularly conditions such as mental illness or substance abuse, the ward round is especially useful: it allows the multidisciplinary team to come together and develop care plans using the skills and experiences of all team members.

COSTS

Both the PARR tool and the Combined Predictive Model are owned by the NHS, and both models are free of charge to use within the health service. The PARR tool comes as ready-to-use software and uses data that are already captured centrally, so that its operating costs are very modest. In contrast, the Combined Predictive Model has to be adapted to local circumstances, lacks a software “front-end,” and, because the model uses codes taken from the EMR, a system has to be put in place to extract these variables from GP practices. All of these factors mean that the Combined Model is more challenging and costly to implement than PARR.

Most of the virtual ward staff was already employed by the PCT or municipal council, so it was only necessary to refocus which patients these professionals cared for. Many virtual ward patients were already known to community staff, and frequently several professionals were caring for the same patients; in such cases, lack

Exhibit 3. Virtual Ward Patient Characteristics

Age (years)	Number of Patients (n=131)
0–24	6
25–64	56
65–74	11
75+	58
Sex	Number of Patients (n=131)
Male	65
Female	66
Recorded Diagnosis	Number of Patients
Respiratory illnesses	37
Gastrointestinal illnesses	23
Heart disease or heart failure	17
Sickle cell disease	15
Cancer	13
Poisoning	10
Injuries/Falls	9
Renal failure	8
Primary care/social care needs	4
Diabetes	3
All other (including syncope and collapse; breathing abnormalities; and unclassified convulsions)	81
Total Virtual Ward Admissions¹	131

¹Some patients had more than one diagnosis recorded.
Source: David Osborne, Croydon PCT.

of communication used to result in frequent duplications, such as ordering the same tests multiple times for the same patient. The only new staff that had to be appointed were community matrons (case managers) and ward clerks. The Department of Health mandated that every PCT have a set number of community matrons in post, and ward clerks were relatively low-cost administrative staff.

TIMETABLE

Virtual wards were developed in anticipation of the Combined Predictive Model. Because of the complexity of the intervention and the unorthodox way in which patients were selected—using a computer algorithm rather than taking referrals—it took many months for the author to explain the concept to all of the relevant parties and to obtain their agreement to participate. Colleagues

in other locations have since been able to open virtual wards with shorter lead times, because they have been able to use the experiences and lessons from Croydon.

RESULTS

In the year after virtual wards were opened, Croydon Primary Care Trust spent £1 million (about \$1.5 million) less on acute admission services at the local hospital. However, since there were several other changes taking place in the local health economy at the time, this reduction cannot necessarily be attributed to virtual wards.

The original plan for evaluating the program was to conduct a cohort study comparing patients admitted to the original two virtual wards with matched controls from elsewhere in Croydon. However, a statistical calculation showed that 18 to 24 months of data would be required to detect a significant difference in hospital

admission rates. Primary care physicians in the eight intended control areas became impatient and lobbied for eight more virtual wards to be opened immediately, which meant that the control group was eliminated. The Nuffield Trust is currently evaluating the costs and benefits of virtual wards in Croydon, Devon, and Wandsworth, with funding from the U.K.'s National Institute for Health Research (NIHR). This research, which will report in November 2011, will compare the hospital use of people who received virtual ward care with a comparison group of patients identified from routine data, using a technique called "propensity score analysis," to see whether there are any differences.

CHALLENGES AND LESSONS LEARNED

This project involved a number of organizational and cultural changes, not least of which was the acceptance of referrals from a computer (in the form of the output of a predictive model) rather than from physicians. It was also necessary to adjust from a focus on reactive care to the delivery of preventive care to patients who might not appear to be particularly unwell.

Staff were initially resistant to holding daily ward rounds, particularly at the outset of the implementation, when the virtual wards began accepting their first patients and there were relatively few patients to discuss.

Finally, the needs of the patients themselves were often challenging. Many patients identified by the predictive model had two or more interacting chronic diseases, and most had a complex web of bio-psycho-social problems. The prevalence of alcohol and drug abuse in this patient group had not been anticipated, nor had the high prevalence of mental illness and sensory impairment. In combination, these have presented ongoing challenges to virtual ward staff.

Virtual wards have proved to be popular among patients and staff, and their intuitive appeal has resulted in adoption of the scheme in a number of locations in the U.K. and internationally, including in Canada and the United States. Patients report that they value the improved coordination of their care, and value the feeling of safety that comes from being cared for by a team that can be contacted easily through the ward clerk. For staff,

working on a virtual ward can be socially rewarding, and daily rounds also offer the opportunity to share problems and find solutions with colleagues who are caring for the same patients.

Croydon's financial constraints meant that participating primary care physicians could not be funded to attend ward rounds and the local GPs were not happy for the PCT to employ a dedicated virtual ward physician. However, in neighboring Wandsworth PCT, four dedicated virtual ward physicians have been appointed, and each is leading a virtual ward and working alongside the community matrons and other members of the multidisciplinary team.

One of the lessons learned is that some of the patients identified by the predictive risk model can be difficult to manage, and sometimes seem to have inimitable risks. In the United States, a number of modeling vendors are responding to this perception by developing what are called "impactability models."¹⁷ These use the output of the predictive model and then try to predict the subgroup of these at-risk people in whom case management is expected to be successful. By restricting admission to a virtual ward to patients for whom the intervention is likely to make a difference, it may be possible to demonstrate improved outcomes. However, if patients are ruled out on the basis of factors such as language skills, mental health, or substance misuse, any potential efficiencies may be at the expense of worsening health care disparities.

Implications for Policymakers

Virtual wards are a novel form of case management that promotes integration with social services and between primary and secondary care. They offer a number of theoretical advantages over typical case management, in which the community matron works alone. For example, virtual wards employ fully trained pharmacists and physical therapists, rather than relying solely on the case manager's prescribing skills and knowledge of physical therapy techniques. Furthermore, virtual wards are able to provide continuity of care when the case manager is sick or on annual leave.

Although virtual wards are intuitively appealing, their cost-effectiveness remains to be established.

HOSPITAL-AVOIDANCE PROGRAMS IN THE U.S. AND THE POTENTIAL OF VIRTUAL WARDS

Virtual wards are currently being planned or piloted at several international sites, including in the United States as a New York Medicaid chronic disease demonstration project known as “hospital to home.”¹⁸ In the U.S., virtual wards are by no means unique in providing disease management for high-risk, chronically ill patients. Rather, they should be seen as a new variation on a number of existing community-based hospital-avoidance programs. Other examples include:

- the Guided Care model, developed by Chad Boulton and colleagues at Johns Hopkins University;¹⁹
- the Program of All-Inclusive Care for the Elderly (PACE), now a permanent Medicare program;²⁰ and
- the Geriatric Resources for Assessment and Care of Elders (GRACE) intervention, developed by Steven R. Counsell and associates at Indiana University.²¹

Virtual wards, Guided Care, PACE, and GRACE are all primary care-oriented interventions that provide chronic disease management for elderly patients at high risk for hospitalization. Each intervention uses interdisciplinary teams to improve the quality and efficiency of health care, and the quality of life of enrollees. Nevertheless, these programs remain quite varied in terms of the stages of their development, the scope of services provided, the demographics of the target population, the size of the population, and the area served.

Guided Care

Of the three programs, Guided Care is in many ways the most similar to virtual wards. Guided Care uses electronic predictive modeling to identify and select high-risk patients for participation in the intervention, which aims

to enhance primary care according to successful innovations based on the Chronic Care Model. These include patient self-management of chronic disease, optimal coordination of care transitions, and the use of interdisciplinary teams. Central to the intervention is the Guided Care Nurse (GCN), a registered nurse who completes a specialized Guided Care educational course. The GCN is based in a primary care practice where he or she coordinates the care and manages the chronic illnesses of 50 to 60 high-risk patients. The GCN is supported by a specialized electronic health record (EHR) and guided by an individual care plan that the GCN develops in conjunction with each patient and the patient’s primary care physician and is founded on evidence-based practice guidelines generated from the patient’s EHR. Early results from a two-year randomized controlled trial of 904 patients in eight Mid-Atlantic primary care practices indicate that the intervention has the potential to improve the quality of life and the quality of care for this population (including better care coordination and decision support), as well as to improve physicians’ satisfaction with their care of multi-morbid older patients.

The main difference between virtual wards and Guided Care is that nurses in the latter program take individual responsibility for case-managing patients, whereas this responsibility in virtual wards is shared by the whole team. The theoretical advantage of an individual approach is that one person has sole responsibility and accountability for care, whereas the team-based approach is intended to increase continuity of care, facilitate specialist input, and improve morale and teamwork of the staff.

PACE

PACE was established as a permanent Medicare program by the Balanced Budget Act of 1997 and is the largest, oldest, most widespread, and broadest in scope of the hospital-avoidance programs. Approximately 17,000 people participate in 79 PACE programs (including five that are pre-PACE but receive Medicaid capitated and fee-for-service payments) across 31 states. Unlike virtual wards and Guided Care, PACE does not identify high-risk patients through predictive modeling. Rather, to be

eligible for PACE enrollees must be 55 or older, certified as dually eligible for Medicaid and Medicare, and certified as being eligible for nursing home care. These eligibility requirements capture a population of low-income, frail seniors with complex needs.

There are three PACE innovations worth noting: transportation, payment, and the Adult Day Health Center (ADHC). Provision of transportation increases participants' mobility, allowing them to continue living in the community for longer. PACE payments are entirely capitated and pooled, allowing PACE sites flexibility in care provision, but also requiring sites to assume full risk for costs. Finally, the program revolves around the ADHC, which serves as a social center for patients as well as a setting for close monitoring of participants' health status and for delivery of medical, therapy, and social services. Like the other interventions, PACE also uses interdisciplinary teams, which include physicians, nonphysician health professionals, and even drivers.

Several PACE evaluations in the 1990s demonstrated that enrollment in the program can result in more integrated care, better functional outcomes, better utilization outcomes (reduced hospital and nursing home admission and days of stay), higher levels of health status, and better quality of life for patients.

There are two principal differences between virtual wards and PACE: first, virtual wards use predictive risk modeling to select patients, whereas PACE uses a threshold model; and second, PACE is based in a physical center, while virtual wards are not tied down geographically. Certainly, having a physical building allows PACE to offer its patients a broader range of services. But a virtual approach may prove to be more cost-effective and may be particularly useful in rural areas where patients would not be able to travel great distances to attend the center.

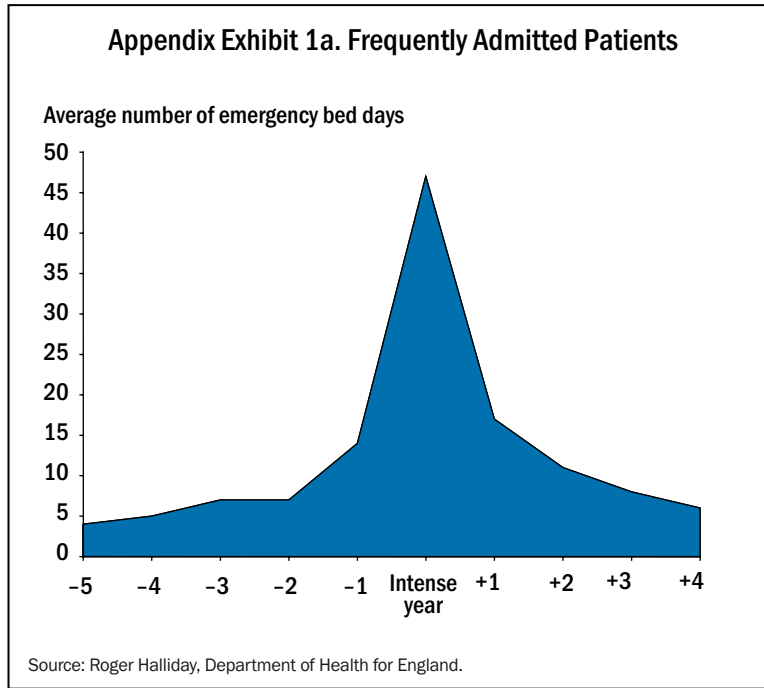
GRACE

As with PACE, the GRACE intervention does not identify specific multi-morbid or high-risk patients. Rather, it targets low-income seniors at large, who as a population are a high-cost group with more complex needs. Though GRACE does not use predictive modeling, the program's care management innovations are otherwise similar to those of virtual wards and Guided Care. GRACE uses a support team composed of a nurse practitioner and a social worker who use a specialized electronic medical record to monitor episodes and outcomes of care and to provide their patients with ongoing care management across providers and settings. The GRACE support team also consults with a larger interdisciplinary team composed of a physician and other health professionals to develop individualized care plans following specified GRACE protocols for each patient.

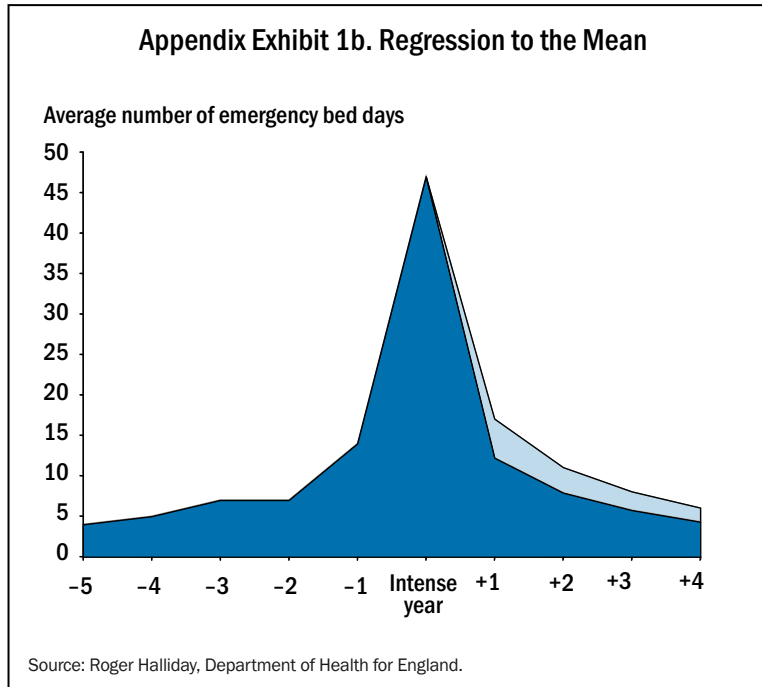
Following a two-year randomized controlled trial of 951 patients in six community-based health centers in Indianapolis, Indiana, the intervention demonstrated lower rates of emergency department visits and hospital admissions, better and more coordinated care, and improved quality of life for intervention patients. However, GRACE recruited potential patients by approaching seniors at their primary care physician visits, a strategy that proved ineffective. Results from the initial use of virtual wards in the U.K. suggest that such hospital-avoidance interventions could reach more people and potentially be even more effective if they were combined with electronic predictive modeling to specifically target those who might benefit most.

Guided Care, PACE, and GRACE have all demonstrated favorable outcomes in the quality and efficiency of care and in patient and provider satisfaction. The success of these programs suggests that virtual wards also have the potential to offer more integrated and efficient community-based care to elderly patients with complex needs.

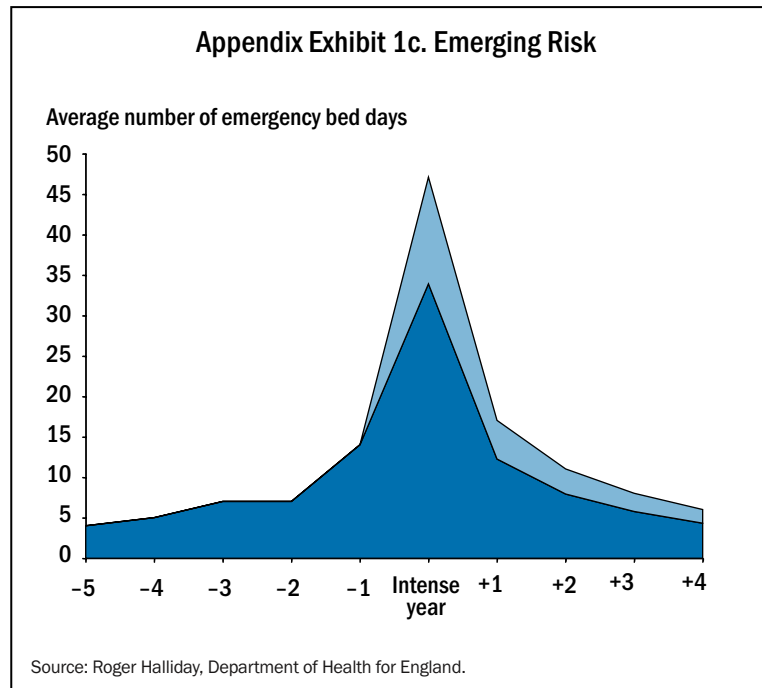
Appendix. Accounting for “Regression to the Mean”



Appendix Exhibit 1a spans a 10-year period of Hospital Episode Statistics for England. A cohort of frequent hospital users is identified in the intense year, and the hospital usage of this cohort is tracked for five years beforehand and five years afterwards. The rapid reduction in bed days, in year +1, which occurs without specific intervention, illustrates the phenomenon of regression to the mean.



Appendix Exhibit 1b shows the effect of a 20 percent reduction in emergency bed days starting in the intense year. The effect on hospital bed days of an intervention starting in the intense year would be only marginal.



Appendix Exhibit 1c shows the effect of a 20 percent reduction in emergency bed days starting one year before the intense year. A much larger impact on hospital bed days would be seen.

NOTES

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- ¹² The scheme won an unprecedented four prizes at the Health Service Journal Awards in November 2006 (the U.K.'s largest health care awards) for health care innovation, clinical service redesign, information-based decision making, and patient-centered care; the following year it was judged overall winner of the Guardian Newspaper's Public Service Awards 2007.
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ACKNOWLEDGMENTS

The author gratefully acknowledges the role of nurse consultants Mary Brice and Patricia Robinson who, along with the author, were the architects of the virtual ward scheme. He also thanks David Osborne from Croydon PCT, Heather Watson from Wandsworth PCT, and Robin Osborn and Leslie Kwan at The Commonwealth Fund for their advice and assistance with the preparation of this case study. The names and details of the patient have been altered in the vignette to ensure anonymity. The content of this case study does not necessarily reflect the views or policies of the Nuffield Trust, nor should the views be attributed to The Commonwealth Fund or its directors, officers, or staff.

Editorial support was provided by Nandi J. Brown.

