IMPLEMENTING INTERACTIVE VOICE RECOGNITION TECHNOLOGY TO ACTIVATE VULNERABLE PATIENTS

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Abstract

To help better align the intersections of patient needs, quality of care, and cost, we implemented an automated monitoring program that aimed to reduce preventable hospital admissions for vulnerable patients. Interactive voice recognition (IVR) is a form of remote patient monitoring that enables the clinical team to intervene sooner when a patient's symptoms worsen. The goal was to improve patient activation by having them recognize symptom exacerbation and record their responses to a weekly IVR survey which was sent to the clinical team for potential action.

Methods: At a health care organization in Southern California, ninety chronic obstructive pulmonary disease (COPD) patients who were enrolled in a self-management program completed IVR surveys based on COPD symptom zones. Patients answered the weekly surveys for 6 months and the data were transmitted to the clinical team for review and potential action.

Results and Conclusion: When COPD program patients used IVR, hospital admissions decreased and a positive return on investment was projected. Patients stated that automated monitoring helped them become more involved and motivated in their care. Clinicians indicated that using IVR freed up their time to concentrate on patients who were more at-risk for disease exacerbation and expanded their clinical capacity. In an era of clinical and financial accountability, being able to better identify patients who are at risk for hospital admission and who may benefit from more intensive management are key elements to help improve quality of care and the patient experience.

Keywords: telehealth; telemedicine; health knowledge; self-care; COPD; mHealth; home monitoring.

Introduction

In an era of clinical and financial accountability, how can clinicians better identify vulnerable patients who are at increased risk of becoming seriously ill and may benefit from more intensive care management? Can symptom exacerbations be detected sooner, and interventions implemented earlier to reduce preventable hospital admissions and emergency department use?

To help align the intersections of patient/family needs, quality of care, and cost, we designed an automated monitoring program that aimed to reduce preventable hospital admissions by engaging vulnerable patients in disease symptom recognition. Vulnerable patients are defined as those who are chronically ill and at risk for hospital admission, readmission, and or emergency department use. Clinicians, researchers, and policy makers face challenges to activate these patients with positive behaviours that promote well-being, and yield sustainable, improved health outcomes while reducing costs.

Remote patient monitoring has been used to help detect disease symptoms earlier so that clinical staff can intervene sooner with the goal of reducing preventable hospital admissions, readmissions, and emergency department use. Although the literature presents congestive heart failure and diabetes monitoring evaluations, remote monitoring of chronic obstructive pulmonary disease (COPD) remains scant in refereed publications.[1-9] Real-time pulse oximetry to detect acute COPD exacerbations can be problematic as by the time the results are abnormal, it can be too late to avoid an acute COPD exacerbation which usually results in an emergency department visit or hospital admission.[5] We wanted to implement an easy to use, automated monitoring program that helped

activate patients with symptom recognition and self-management. The program would be scalable, sustainable, and able to be broadly disseminated. Principal factors in designing our system were: i) simplicity, ii) actionable input to and from patients, families and clinicians, ii) not a nuisance or hindrance to daily lives. We wished to expand clinical capacity by focusing on patients that needed more intensive care by appropriately referring patients to outpatient facilities thereby reducing preventable hospital admissions.

Background

Chronic obstructive pulmonary disease is an escalating public health problem for individuals, their families, and communities. COPD results in considerable morbidity and mortality, and contributes to substantial health service use and overall cost of care. Currently, it is the third leading cause of death in the United States.[10] COPD is a progressive, not fully reversible airflow limitation caused by decreased elasticity and an excessive inflammatory response within the lungs. COPD is mainly caused by tobacco smoking. Other factors include second-hand tobacco smoke, air pollution, and occupational exposure.

Although approximately 24 million individuals in the United States are estimated to have COPD, only 12 million are diagnosed and actively managed.[10] Early identification for diagnosis and treatment is critical to help reduce disease progression and acute exacerbation. The toll of COPD can also extend beyond the physical; feelings of isolation, depression, and loss of independence are common.[1] There are multiple components of patient and family management. These include assessment and monitoring, risk factor reduction, management of stable COPD, and exacerbation management.[1] Moreover, patient education is important to help manage COPD and should include disease awareness, medication administration, lifestyle changes, and exacerbation recognition. Early exacerbation recognition can reduce hospital admissions, bed days, and ED visits, thus improving the patient's quality of life and decreasing cost of care.

Our medical group is a large, integrated care organization located in Southern California, Florida, Nevada, and New Mexico that accepts global capitation. Our communities represent culturally diverse patient populations with wide arrays of socioeconomic classes, varying degrees of health status, and ages. In California, we serve approximately 600,000 patients. COPD is consistently one of the top 10 diseases that results in hospital admissions at our organization. The COPD population is approximately 25,500 individuals, with about16,000 over 65 years of age. The economic burden of COPD is considerable; inpatient hospitalization accounts for approximately half of the, per member, per month cost.

In 2008, we created a patient-driven, COPD self-management program with a focus on pro-active symptom recognition and management. This included symptom identification using action plans that were modelled after National Jewish Health asthma action plans which included symptom zone management for flare-ups.[11] Examples of COPD flare-ups and exacerbations may include, shortness of breath, trouble breathing, thicker or bloody sputum, fever, drowsiness, confusion and lower extremity swelling, among others. The action plans consisted of 3 zones based on symptom severity (green, yellow, and red), and 4 categories of COPD symptoms (breathing, sputum, thinking, and energy). Red zones indicated an emergent or urgent situation requiring clinician intervention and action plan initiation, whereas the yellow zone indicated symptoms of lesser severity that requires initiation of the action plan and clinician follow-up. The green zone was baseline for the patient and generally did not require intervention.

Rescue inhalers and oral steroids were provided to patients to help facilitate action plans for exacerbation periods along with pursed lip breathing techniques. A wallet-sized card was also provided to patients that contained COPD symptom zones, action plans, and clinician contact information to help reinforce self-management principles. The program was fully supported by nurses and physicians who met face-to-face with patients and conducted telephonic meetings to ensure patients understood and felt empowered to initiate their COPD action plan.

Recently, we launched a remote monitoring program using interactive voice recognition (IVR) technology to help expand clinical capacity and improve the application of user-friendly technology for the COPD

self-management program patients.[6-8] We created a nine question IVR survey corresponding to green, yellow, and red COPD zones (Appendix 1). Patients entered their current symptoms and then the data were sent to their care team for review. The goal was to identify yellow and red zones before a COPD flare-up or exacerbation occurred. The automated monitoring surveys did not substitute for face-to-face interactions with clinical staff. Rather, it was layered on top of a COPD self-management program to help activate patients.

Methodology

The sample in this program was drawn from patients in Southern California whose medical records indicated a COPD diagnosis. Our medical group has computer systems to document and facilitate selection of patients with COPD and report clinical service use. The average age of the patients was 75 years. This population presented approximately equal gender distribution, and represented a variety of ethnicities and socioeconomic classes. Patients were excluded if their doctor declined or opted-out, or were no longer an active patient at our organization. Additionally, patients were excluded if they were enrolled in hospice, institutionalized in custodial nursing facilities, unable to participate due to severe dementia or organic brain disorder, on haemodialysis due to end-stage renal disease, or undergoing chemotherapy for active malignancies.

Ninety patients were selected in an alternating 1-to-1 fashion from those enrolled in the COPD self-management program for at least six months. We enumerated hospitalizations and then used IVR on these same patients for six months and counted the number of hospitalizations in the preceding year. The same nine question survey was given weekly for 6 months. Outgoing calls ("push technology") were chosen as opposed to placing a call ("pull technology") to help facilitate patient activation. After participation affirmation, a larger font "welcome letter" was sent by post confirming the patient's enrolment in the telehealth program. This letter reiterated how the IVR system worked, when to expect the calls, and contained the survey questions to help familiarize patients and family with the programme.

An aim of the automated monitoring program was to avoid potentially burdensome set up, battery changes, monitor displays, auditory signals, voice prompts, touch controls, or internet connections that could be challenging to vulnerable patients and their families. Patients entered their symptoms using their telephone keypads instead of speaking into a phone. We were concerned with potential speech impairment due to wheezing as this is common with patients with COPD and could obscure symptom reporting during surveys.

Within 12-24 h following the IVR surveys, computer generated reports were transmitted to clinicians in an actionable format; reports included, total score (9-27 total points), a change greater than 2 from the previous survey, longitudinal trending, and no answer or incomplete survey results (figure 1). This gave clinical staff pertinent data to help focus on patients who are in need of outreach. Additional staffing was not needed because the IVR system was "layered" onto their existing COPD self-management program. The telehealth care coordinator acted as a patient-clinician liaison. This individual enrolled patients, and followed-up on missed IVR calls.

Each data point in the trend chart represents an IVR survey and a composite number (survey answer totals range from 9-27), that when "clicked" on, yields specific survey question answers. Red squares represent total scores >10, black squares, 9-10, and blue <9 (incomplete or missed survey).

The automated, outgoing survey calls were administered by an external vendor. Regional dialects and languages were available to help personalize and expand the program to diverse patient populations. Also, the phone number listed on the patients' caller-identification features was familiar (our medical group's phone number), therefore, reducing concerns that it was an unsolicited call. Patients completed the IVR nine-question survey either Monday and Thursday, or Thursday only. Weekly calling frequency was based on the patient's past clinical history and if more or less monitoring was necessary. Patients entered their disease symptoms based on categories of COPD symptoms. Patients answered the questions using their telephone keypad and their response was recorded by pressing 1, 2, or 3; these numbers responded to the green (1), yellow (2), and red (3) symptom zones. The average time to complete the

survey was between 2 to 3 minutes. The calls occurred at noon, and if there was no response or voice mail, a back-up" call between 18:30-19:00 occurred. Based on patient surveys, the timing for IVR calls was selected because patients were at clinical appointments prior to noon; they were free during lunch time and could answer the survey. However, during the afternoon, many were indisposed (e.g., sleeping, personal/family commitments). The "back-up" call time was also selected because this was before television programs or other personal obligations.

Results and Discussion

Vulnerable patients can have visual, auditory, and dexterity impairments which may potentially impede individuals from using automated monitoring devices. For our pilot program, patients simply entered their symptoms onto their personal telephone keypads ("push technology") instead of speaking into a phone to answer questions. Potential speech impairment due to wheezing is common with COPD patients. This could obscure symptom reporting and impede patient

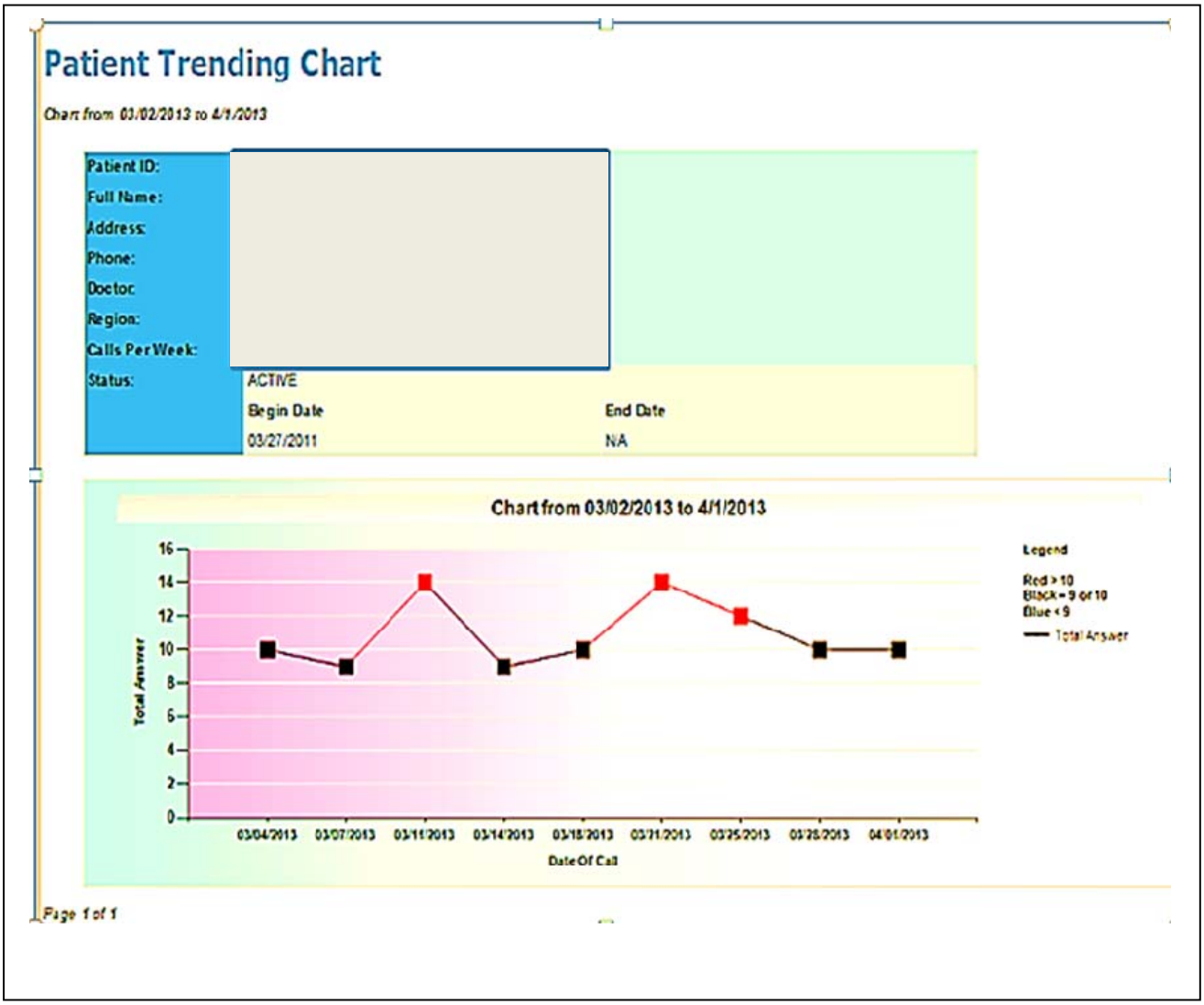

Figure 1. A screen shot of longitudinal trending data that is transmitted to clinicians.

activation. Moreover, psychosocial issues are important elements that can affect patient and family adoption of technologies, including, literacy limitations, financial challenges, logistical barriers, under/unemployment, adverse family dynamics, incarceration, and others that can limit activation with remote monitoring applications. It therefore was imperative that the technology was easy to use, avoided burdensome set-up, did not require battery changes, nor use monitor displays or require internet connections. We wanted the technology to be embraced by many and not appear as a potential nuisance, or another daily task.

The COPD IVR program as described in this preliminary report, helped align the intersections of patient and family activation, quality of care, and cost with a focus on preventing avoidable hospital admissions. When COPD patients used IVR, hospital admissions decreased and a positive return on investment (ROI) was projected. The program helped activate patients in care with self-management in concert with clinical support. Patients were provided with prescriptions (steroids, rescue inhalers) and empowered with proactive health behaviours (pursed lip breathing) whereby they recognized worsening COPD symptoms sooner, implemented their action plans, and sought clinician input earlier in the outpatient clinic instead of higher cost, more intensive care settings.

By preventing unnecessary hospital admissions, patients could remain at their chosen residence. This may ease family caregiver burden and decrease unnecessary health care use. Based on informal inquiry, the majority of missed IVR calls were due to psychosocial issues (family, economic, occupational), not because of medical reasons.

Ninety patients were enrolled initially. However, due to personal reasons or mortality, the sample size was 70 for our program. The telehealth care coordinator contacted the patients who requested to be dis-enroled in the program. Twenty patients did not complete the six month study. Of these nine refused to continue, six either received skilled nursing attendance or were admitted to a sub-acute facility, one died and four withdrew for other reasons, such as insurance ended, phone broken, onset of dementia.

A preliminary cost-analysis, ROI was also conducted to evaluate the cost-effectiveness of the intervention on chronically ill, older adults (tables 1 and 2). Our medical group has computer systems that record clinical service use. Such data were used to calculate costs and perform return on investment analysis.

Table 1: Technology, personnel, and total program costs for 90 patients.

Total Pilot Patient Enrolment	**$USD**
Technology and Other Operating Costs	
Technology Operating Costs	31,594
Per patient	351
Personnel Costs	
Registered nurses allocated time	98,000
Care Coordinator	37,000
Management resources'	4,900
Total Personnel costs per patient	1,559
Total Program Costs	
Total Operating costs	171,914
Total Operating costs per patient	1,910

Table 2. Hospital admissions, outpatient visit rates, and costs before and after IVR implementation.

Clinical and Financial Metrics ($USD)	**Pre IVR ($USD)**	**IVR ($USD)**
Hospital admissions	48	22
Hospital Costs	8,529	3,909
Outpatient Clinic Visits	446	581
Outpatient Clinic Costs	765	996
Return on investment	**$4,388**	

Six months after the IVR program, patients and clinicians were surveyed regarding their satisfaction

with the program. Based on satisfaction surveys, patients stated that the automated monitoring system helped them become more involved and motivated in their care. Clinicians indicated that using IVR freed up their time to concentrate on patients who were more at-risk for disease exacerbation and expanded their clinical capacity. Respondent answer choices were: definitely not, do not think so, maybe, think so, and definitely. Answers were combined into positive responses, definitely and think so and negative responses, definitely not and do not think so. Of the 70 patients who completed the 6 month study period 56 completed the questionnaire (80%) and 14 of the 17 clinicians surveyed, responded (82%), The results are presented in tables 3 and 4.

Table 3. Results of the patient telehealth satisfaction survey (n=56).

Patient Survey Questions	Responses	%
IVR calls were easy	think so/definitely	95
Technology took too much time	did not think so/definitely not	96
Technology was just as good as a nurse coming to my house.	think so/definitely	73
Program helped improve my health.	think so/definitely	55
More involved in my health care.	think so/definitely	82
More motivated to monitor health	think so/definitely	73

Patients were selected to participate from those already enrolled in a patient-driven, COPD management program. This may introduce a potential selection bias as the patients were already more motivated and activated than other COPD patients. Moreover, the IVR survey results were not "real-time" data; rather, the survey provided weekly updates to clinicians of patients' recorded symptoms.

Our IVR program does not replace continuous interactions with clinical staff. It is a value-added component to COPD self-management which includes clinicians working in concert with patients and their families. Before participating and during the program, all patients have "face-to-face" meetings with their nurse care manager for disease assessment and education. IVR surveys support administration of emergency prescriptions because patients are aware of their symptoms, can spot changes and exacerbations sooner, and are prepared to take action. When yellow or red zone symptoms are indicated during a survey, the clinical team may contact the patient or notify the physician and begin an action plan. Clinicians are able to focus on higher-risk vulnerable patients; this helps staff expand capacity by helping to identify patients who are at-risk for hospital admissions.

There were a greater number of outpatient clinic visits in the IVR group compared to the same patients without IVR. This can be explained by patients becoming more engaged in their care. Hence, they contacted clinical staff who arranged for follow-up in a lower cost setting (outpatient clinic, urgent care centre) compared to a hospital admission. Moreover, COPD patients may have a myriad of co-morbidities

Table 4. Clinician telehealth satisfaction survey (n=14).

Clinician Survey Questions	Responses	n (%)
Reports were easy to read and actionable.	think so/ definitely	13 (93)
Program took too much time to use.	did not think so/ definitely not	12 (86)
Feel more confident in ability to explain disease symptoms to patients/families.	think so/ definitely	10 (71)
Expanded clinical capacity.	think so/ definitely	13 (93)
Feel comfortable suggesting patients use system.	think so/ definitely	13 (93)

(e.g., diabetes, congestive heart failure, coronary artery disease, depression) in addition to COPD. Therefore, hospital admissions, clinic appointments, and urgent care and emergency visits may occur due to other chronic disease, thus having the potential to decrease the number of respondents stating that they felt as if they were improving their health in our COPD survey (table 4).

Patients and their families vary widely in their understanding and adoption of healthy behaviours. Their engagement and interaction with clinicians, and the health delivery system in general present areas of opportunity to help improve the patient experience while reducing health costs.[12] Many factors can complicate a patient's ability to undertake actions that promote their own well-being. Such factors include psychosocial issues including, cultural sensitivities, limited reading and or writing skills, family dynamics, behavioural health issues, and economics, among others.

IVR is a simple and potentially cost effective method of home monitoring of patients with COPD. There is opportunity to further develop the potential of the IVR model. Currently, identification of future high-risk, high-cost patients is complicated by a paucity of large scale databases covering long time periods, which can be used to develop and test methods for accurately identifying future vulnerable patients among chronically ill patient populations. Further work in this area is required.

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References

1. Arnaert A, Wainwright A. Developing a home telecare service for elderly patients with COPD: Steps and challenges. *Can J Nurs Inform* 2008;3(2):49-83.
2. Sund ZM, Powell T, Greenwood R, Jarad NA. Remote daily real-time monitoring in patients with COPD. A feasibility study using a novel device. *Respir Med* 2009;103(9):1320-1328.
3. Ritchie C, Richman J, Sobko H, Bodner E, Phillips B, Houston T. Telehealthcare management for patients with chronic obstructive pulmonary disease. *Expert Rev Respir Med* 2012;6(3):239-242.
4. Bourbeau J, Collet JP, Schwartzman K, Ducruet T, Nault D, Bradley C. Economic benefits of self-management education in COPD. *Chest* 2006;130(6):1704-1711.
5. Chuang C, Levine SH, Rich J. Enhancing cost-effective care with a patient-centric chronic obstructive pulmonary disease program. *Popul Health Manag* 2011; 14(3):133-136.
6. Levine SH, Adams J, Attaway K, Dorr DA, Leung M, Popescu P, Rich J. Predicting the financial risks of seriously Ill patients. California HealthCare Foundation, 2011.
7. Davis, S, Pigford M, Rich J**.** Improving informal caregiver engagement with a patient web portal. *Electronic J Health Inform* 2012;7:e10
8. Chuang C, Howe J, Larson L, Rich J. Best practices in managing patients with chronic obstructive pulmonary disease. American Medical Group Association, COPD Educational Collaborative Compendium, 2012.
9. Howe J, Larson L, Chuang C, Rich J. Empowering chronically ill patients and their caregivers using remote monitoring technology. *J Comm Inform* 2012;8(1).

10. National Heart, Lung, and Blood Institute. 2012. http://www.nhlbi.nih.gov/health/health-topics/topics/copd accessed 3 April 2013.
11. National Jewish Health. Using an action plan to manage asthma. 2006. Available at: http://www.njhealth.org/patient-materials accessed 3 April 2013.
12. Mosen D Schmittdiel J, Hibbard JH, Sobel D, Remmers C, Bellows J. Is patient activation associated with outcomes of care for adults with chronic conditions? *J Ambul Care Manage* 2007;30(1):21-29.

Appendix 1. Nine COPD questions asked in the IVR service.

Regarding breathing in general
Press 1 if you have no trouble breathing.
Press 2 if you have more coughing, shortness of breath, or wheezing than usual.
Press 3 if you are having a lot of trouble breathing when at rest.

Regarding breathing while eating
Press 1 if you can eat without being out of breath.
Press 2 if you are slightly out of breath when eating.
Press 3 if you are breathless when eating.

Regarding your feet and ankles
Press 1 if you have no foot or ankle swelling.
Press 2 if you have some swelling in your feet or ankles.
Press 3 if you have a lot of swelling in your feet or ankles.

Regarding your weight
Press 1 if you have not gained weight this week.
Press 2 if you have gained 2 to 4 pounds over the last week.
Press 3 if you have gained 5 or more pounds over the last week.

Regarding your sleep
Press 1 if you are sleeping through the night without problem.
Press 2 if you are waking up and unable to fall back to sleep 1 to 3 nights a week.
Press 3 if you are waking up and unable to fall back to sleep more than 3 nights a week, or woke up gasping for air.

Regarding your sputum/mucus
Press 1 if your mucus is clear.
Press 2 if your mucus is thick or stickier than usual, or your mucus is turning yellow or green.
Press 3 if you are having a lot of trouble coughing up mucus, or you have blood in your mucus.

Regarding your ability to focus
Press 1 if you can think clearly.
Press 2 if you are having trouble concentrating.
Press 3 if you are very confused or have slurred speech.

Regarding your appetite
Press 1 if you are eating your normal amount.
Press 2 if you are eating a little less than usual.
Press 3 if you are eating much less than usual.

Regarding your energy level
Press 1 if you are not tired doing your usual activities
Press 2 if you are tired or cannot finish your usual activities without getting tired.
Press 3 if you are very tired and cannot do any activities.