

The Critical Care Recovery Center: An Innovative Collaborative Care Model for ICU Survivors

A prototypical clinic tackles the recovery burdens faced by a vulnerable population.

OVERVIEW: Five million Americans require admission to ICUs annually owing to life-threatening illnesses. Recent medical advances have resulted in higher survival rates for critically ill patients, who often have significant cognitive, physical, and psychological sequelae, known as postintensive care syndrome (PICS). This growing population threatens to overwhelm the current U.S. health care system, which lacks established clinical models for managing their care. Novel innovative models are urgently needed. To this end, the pulmonary/critical care and geriatrics divisions at the Indiana University School of Medicine joined forces to develop and implement a collaborative care model, the Critical Care Recovery Center (CCRC). Its mission is to maximize the cognitive, physical, and psychological recovery of ICU survivors. Developed around the principles of implementation and complexity science, the CCRC opened in 2011 as a clinical center with a secondary research focus. Care is provided through a pre-CCRC patient and caregiver needs assessment, an initial diagnostic workup visit, and a follow-up visit that includes a family conference. With its sole focus on the prevention and treatment of PICS, the CCRC represents an innovative prototype aimed at modifying post-critical illness morbidities and improving the ICU survivor's quality of life.

Keywords: collaborative care, complexity science, critical care, ICU, postintensive care syndrome

More than 5 million Americans are admitted to ICUs annually with life-threatening illnesses; about 55,000 people receive critical care treatment on any given day.¹ These numbers are expected to increase in coming years as the U.S. population ages and life expectancy rises²—and, with recent advances in critical care medicine, more patients are now surviving an ICU stay.³ ICU stays are fraught with intrinsic stressors. Besides the stress of their illness, ICU patients commonly endure invasive, life-sustaining treatments such as central venous

and arterial catheterization, endotracheal tube placement, and mechanical ventilation. As a result, many ICU survivors suffer unique cognitive, physical, and psychological morbidities that adversely affect their quality of life.³ For example, there is evidence that nearly 50% of ICU survivors have neuromyopathy,⁴ 28% have clinically significant depressive symptoms,⁵ 24% have anxiety,³ 22% have clinically significant posttraumatic stress disorder (PTSD) symptoms,⁶ and 79% have cognitive impairment.⁷



Photo courtesy of the Muscular Dystrophy Association (MDA).

During a recent stakeholders' conference of the Society of Critical Care Medicine, the attendees recognized that such symptoms frequently occur together and thus grouped them under the unifying term of postintensive care syndrome (PICS).⁸ Naming this group of symptoms was an attempt to raise stakeholders' awareness, prompt screening, and encourage further investigation into the syndrome.⁸ ICU survivors need not exhibit all of the symptoms to be diagnosed with PICS. Singly or in various combinations, PICS symptoms can affect multiple aspects of an ICU survivor's life. For example, physical weakness stemming from neuromyopathy can make it difficult for the survivor to engage in functional or social activities that previously felt effortless. Such weakness coupled with cognitive impairment can result in delays in returning to work or in managing finances or medications. Survivors who experience depression, PTSD, or anxiety may have problems with insomnia or nightmares. Regardless of the combination of symptoms, the outcome is a diminished quality of life that can persist for up to five years after discharge,⁹ and possibly longer.

A number of different approaches to follow-up care have been implemented, including combinations of follow-up care, rehabilitative care, and various

forms of patient support.¹⁰ But we know of no established clinical models for managing long-term complications associated with critical illness. Moreover, it's well known that it takes many years for new scientific evidence to be incorporated into routine clinical practice—15 to 20 years, on average.^{11,12} If the health care community fails to develop timely and adequate means of treatment and support for ICU survivors, these patients may resort to seeking help in EDs, leading to hospital admissions that further strain the health care system. Novel interdisciplinary care models that can be rapidly translated into clinical practice are urgently needed. A comprehensive search of the literature revealed that no such collaborative care models exist in the United States that provide care specific to the physical, cognitive, and psychological needs of ICU survivors.

To address this gap, in 2010 the pulmonary/critical care and geriatrics divisions at the Indiana University School of Medicine began developing an innovative collaborative program at Wishard Memorial Hospital (WMH), a Wishard Health Services (WHS) facility in Indianapolis. (*Editor's note:* WMH has since been renamed the Sidney and Lois Eskenazi Hospital; WHS is now Eskenazi Health.) In 2011, we launched the result: a Critical Care Recovery

Characteristics of Complex Adaptive Systems and the Multimethod Assessment Process/Reflective Adaptive Process (MAP/RAP)

In a complex adaptive system,¹⁹

- individual agents behave according to their own mental models and interpretations of themselves and the environment.
- these mental models can and do change—learning is possible.
- the system's behavior emerges from its members' previous experiences and interactions, and novel emergent behaviors are expected.
- the system is nonlinear—small changes can result in major shifts in how the system works.
- the system is fundamentally unpredictable.
- the system has its own inherent order, and “broad-brush” predictions are often possible.

In the MAP/RAP,²³

- change is guided by vision, mission, and shared values.
- it's important to create the time and space necessary for learning and reflection.
- tension and discomfort are considered essential and normal during change.
- system agents—including patients—with varying views of the system and its environment should be included on improvement teams.
- supportive leaders who are actively involved in the change process are also required for change.

Center (CCRC) dedicated to providing collaborative care to ICU survivors. Here, we share our experiences of creating and implementing the CCRC.

ORIGINS

WMH is a 450-bed, university-affiliated urban public hospital that serves a population of approximately 750,000 in Greater Indianapolis and is staffed by Indiana University School of Medicine faculty and house staff. Its 22-bed ICU has an average of 335 admissions per month. Patients admitted to the ICU are cared for by medical or surgical critical care teams, with specialty services such as cardiology, nephrology, and geriatrics available for consultation. The ICUs are staffed with critical care RNs at a nurse-to-patient ratio of one to two or one to one, depending on patient acuity. Of the patients admitted to the ICU in 2009 and 2010, the average age was 53.7 years; 45% were African American; 47% were female; and 16% had Medicaid insurance. Fourteen percent died at or

before discharge, 28% were discharged to a skilled nursing facility, and 56% were discharged to home. (Because of rounding, the percentages don't sum to 100.) Seventeen percent died within 30 days of discharge.

In late 2010, two of us (BAK, MAB) conducted a natural history study of 1,149 patients who were admitted to WMH's medical-surgical ICU between May 2009 and May 2010 and who had survived their illness for at least 30 days. Results showed that 37% of the ICU survivors suffered from acute lung injury or delirium during their ICU stay and that 58% of the ICU survivors were discharged to home. Of those who had suffered acute lung injury or delirium, 4% and 13%, respectively, died within the subsequent 11 months, while 36% and 48%, respectively, were hospitalized for at least a second time during the same follow-up period.

In response to such high mortality and rehospitalization rates in the study population, as well as to high rates of functional disability and use of acute care services, hospital administrators and stakeholders supported the creation of the CCRC. An interdisciplinary team from the pulmonary/critical care and geriatrics divisions at the Indiana University School of Medicine who had used collaborative care models for patients with dementia, depression, and other geriatric syndromes developed a set of protocols and tools to meet the complex recovery needs of ICU survivors. The CCRC was conceived to enhance the delivery of this care.

THEORETICAL FOUNDATIONS

Initially, we used WHS's Healthy Aging Brain Center (HABC) as a model for the CCRC.¹³ The HABC care model was based on *implementation science*, which looks at “methods to promote the systematic uptake of new or underused scientific findings into the usual activities” of practice.¹⁴ Specifically, the HABC model was loosely based on the results of two randomized controlled trials demonstrating the effectiveness of a collaborative care model delivering biopsychosocial interventions for dementia patients and their caregivers.^{15,16} The HABC demonstrated “a positive impact on the quality of dementia care” locally within its first year.¹³ We felt that a similar model could improve the quality of care for and enhance the recovery of ICU survivors by providing care that focused on their specific needs. Such collaborative care models may also help to offset care fragmentation by integrating and connecting the various recovery resources available to this population.

We also based the CCRC on an approach taken from *complexity science*. A complex adaptive system has been described as “a dynamic network of semiautonomous, competing, and collaborating individuals who interact and coevolve in nonlinear ways with their surrounding environment.”¹⁷ In such a

system, the constant modification of relationships among its members results in varying emergent behaviors.^{18,19} Contrary to the usual view of health care systems as machine-like systems built around predictable behaviors that can be changed based on past performance,^{19,20} we believe—as do other experts^{17,19,22}—that health care systems should be thought of as complex adaptive systems characterized by often unpredictable behaviors. As Matthews and Thomas note, this model suggests that such “surprises” are not only inevitable but offer “promising opportunities for new approaches” in meeting goals.²⁰

To facilitate the development and effective implementation of the CCRC, we used an approach based on complexity science, the Multimethod Assessment Process/Reflective Adaptive Process (MAP/RAP).²³ For more information, see *Characteristics of Complex Adaptive Systems and the Multimethod Assessment Process/Reflective Adaptive Process (MAP/RAP)*.^{19,23}

DEVELOPMENT OF THE CCRC

Brainstorming sessions and deliberations regarding the CCRC's structure and functioning started well in advance of its opening. Quarterly meetings were held in 2010 and 2011 to discuss strategy, using the MAP/RAP approach. The meetings involved all stakeholders: leadership from Indiana University School of Medicine's pulmonary/critical care and geriatrics divisions; the Indiana University Center for Aging Research; and WMH's critical care nursing, care coordination, physical rehabilitation, and neuropsychology departments. Through these meetings, the mission of and vision for improving the cognitive, physical, and psychological outcomes of ICU survivors were recognized. The meetings also provided the time and space for the stakeholders to develop relationships, reflect on the challenges, and identify the minimal care specifications for the CCRC (for details, see *Standardized Minimum Care Components of the Critical Care Recovery Center*). Potential members were identified for the smaller operational teams that would meet weekly to solve problems, monitor progress, and once the program launched in July 2011, make timely modifications based on incoming data.

Eligibility. The following eligibility criteria, which are also among the risk factors for PICS, were established for referral to the CCRC: being 18 years of age or older, having been admitted to WMH's ICU, and either having spent 48 hours or longer on mechanical ventilation or having had delirium for 48 hours or longer. (For more information, see *Risk Factors for and Symptoms of Postintensive Care Syndrome*.³⁻⁸) Patients were also eligible if their critical care physicians determined that they might benefit from comprehensive physical, cognitive, and psychological assessment and protocol-guided therapy. Mechanical ventilation and delirium were selected as criteria

because of their negative effects on memory, physical function, and psychological outcomes³ and their potential to cause PICS symptoms. Patients enrolled in hospice or palliative care services were generally not eligible, because these patients receive care at home for conditions that prevent comfortable travel to the clinic. The eligibility criteria were eventually expanded to include referrals from ICUs outside WHS on a case-by-case basis.

Goals. The delivery team identified four primary goals for the CCRC with regard to patient care:

1. To maximize full cognitive, physical, and psychological recovery following hospitalization for a critical illness.
2. To enhance patient and caregiver satisfaction.
3. To improve the quality of transitional and rehabilitation care.
4. To reduce unnecessary rehospitalizations and ED visits.

IMPLEMENTATION OF THE CCRC

Physical characteristics. The CCRC, which is primarily a clinical program with a secondary research focus, is located in a building within WHS, a safety-net, tax-supported, urban health care system in Indianapolis, Indiana. The clinic, which is open one afternoon per week, has three patient examination rooms, one family

Standardized Minimum Care Components of the Critical Care Recovery Center

- Early assessment of the patient's cognitive, physical, and psychological functions.
- Patient and caregiver education and counseling to foster self-rehabilitation.
- Use of a reliable tool for periodic needs assessment and evaluation of ongoing therapy.
- Support for clinical decision making in order to accomplish targeted rehabilitation goals, including steps to address initial treatment failure.
- Provision of an effective medication prescribing process in order to discontinue inappropriate medications, reconcile medication regimens, and enhance regimen adherence.
- Longitudinal monitoring of patient outcomes and coordination of care.
- Effective case management and coordination with community resources.
- Provision of interventions that prevent and reduce the designated caregiver's psychological and physical burden.
- Timely access to specialty consultation and comanagement.

conference room for team meetings with patients and their designated caregivers, a workroom for interdisciplinary interaction between team members, a blood collection room, and a work space for documenting the clinical care plans. The collaborative care team consists of an RN, a critical care physician, a social worker, a medical assistant LPN, and a psychometrist, with support services from physical therapy, neuropsychology, and psychiatry. Both the RN and the social worker function as care coordinators. Clinic nurses manage the flow of the clinic, lead family conferences, oversee medication reconciliation, conduct scheduling and follow-up phone calls, and partner with the designated caregivers to provide stress reduction. A pharmacist is available for consultation about drug reconciliation, as needed.

Consistent with the mission of WHS, which provides funding for the clinic, the CCRC follows a patient-centered care philosophy; its clinical mission is to maximize the cognitive, physical, and psychological recovery of ICU survivors. Although at this writing the CCRC has no research funding, we use standardized manual and electronic assessment methods and collect management and performance data; such information is readily available for future research endeavors.

Operative characteristics. *Patient recruitment.* Most patients who come to the CCRC are recruited from WMH's ICU. We have used grand rounds,

focused meetings of providers, and physician and patient brochures to encourage patient recruitment and promote local awareness of CCRC services. In addition, the CCRC RN and social work care coordinators attend weekly transitional case managers' meetings to discuss possible CCRC referral for patients ready for transfer from the ICU to other hospital units. An ICU NP maintains a list of patients who meet CCRC eligibility criteria and refers them to the care coordinators. Using WHS's computerized data entry system, we also created a CCRC consult order, so that inputting such an order results in an automatically printed referral at the CCRC.

Patient assessment. The CCRC has two main patient assessment phases: an initial assessment and a follow-up. During the initial assessment phase, the CCRC team summarizes the relevant data, then formulates and implements an individualized care plan for the patient and the patient's designated caregiver. The follow-up phase is utilized to monitor and modify the patient's care plan based on feedback about the patient's progress.

The initial assessment phase involves three steps. The first step, a structured, pre-CCRC patient and caregiver needs assessment, is conducted either by telephone or in person at the CCRC. The second step is the CCRC workup visit, during which a complete diagnostic workup is performed. This includes a detailed history, structured physical and neurological examinations, a comprehensive neuropsychological assessment, a physical function battery, medication reconciliation, blood tests, and imaging as necessary. The third step, a family conference held at the CCRC, takes place two weeks after the initial visit and involves the patient, the designated caregiver, the RN, the social worker, and the physician. At this conference, the individualized patient care plan is discussed and modified as needed. The discussion entails review of diagnoses and prognosis; responding to patient and caregiver queries; dispensing self-management training manuals and pharmacologic and other therapeutic prescriptions; and providing referrals to community resources, neuropsychologists, and physical rehabilitative services.

The follow-up phase entails four follow-up visits to the CCRC for further patient monitoring and reassessment. The frequency of these visits varies depending on individual patient needs and response to therapy. During these visits, the collaborative care team reassesses the patient's symptoms, as well as the designated caregiver's stress and burden, using the Healthy Aging Brain Center Monitor (HABC-M) tool.²⁴ The HABC-M is a self- or caregiver-reported questionnaire encompassing the previous two weeks. It has 31 items in total; 27 items cover three patient symptom domains—cognitive, functional (physical activities of daily living), and behavioral-psychological—and four items address the caregiver quality-of-life domain. Each item

Risk Factors for and Symptoms of Postintensive Care Syndrome

Risk Factors⁸

ICU stay of ≥ 48 hours
 ≥ 1 instance of delirium
 Older age
 Sedation (anticholinergic or benzodiazepine medications)
 Mechanical ventilation

Common Symptoms (percentages are the reported prevalence in ICU survivors)

- *Critical illness neuromyopathy*: combined neural damage and muscle degeneration in patients requiring prolonged critical care (50%)⁴
- *Depression*: sadness, loss of interest, lack of energy, irritability, over- or undersleeping, appetite extremes, difficulty concentrating, trouble working (28%)⁵
- *Generalized anxiety*: uncontrolled, persistent, disproportionate worrying (24%)³
- *Posttraumatic stress disorder*: reexperiencing a traumatic event, hyperarousal, sleep disturbance, avoidance of related stimuli (22%)⁶
- *Cognitive impairment*: memory impairment; diminished attention and concentration; decreased executive, language, or visuospatial function, or a combination of these (79%)⁷

has four response choices: 0, not at all (0 or 1 day); 1, several days (2 to 6 days); 2, more than half the days (7 to 11 days); and 3, almost daily (12 to 14 days). The total patient score can range from 0 to 81, with higher scores representing more severe symptoms. The care plan is then modified based on the patient's symptoms and progress. The tool, which takes just a few minutes to administer, has shown good validity and reliability with dementia patients, the population for whom it was originally developed; it has not yet been tested in ICU survivors. (Slightly modified patient self-report and caregiver versions are available free at www.agingbraincare.org/tools/habc-monitor.)

Patients were also evaluated using several other instruments. These included a comprehensive Cognitive Status Profile, which is an expanded and slightly modified version of the neuropsychological assessment battery developed by the Consortium to Establish a Registry for Alzheimer's Disease (CERAD)²⁵ and later adapted by Unverzagt and colleagues.²⁶ The domains of cognition tested by the CERAD neuropsychological assessment battery include memory, constructional praxis, language, and executive function. The CERAD battery has demonstrated good validity and reliability with patients who have Alzheimer's disease, but has not yet been tested in other populations.

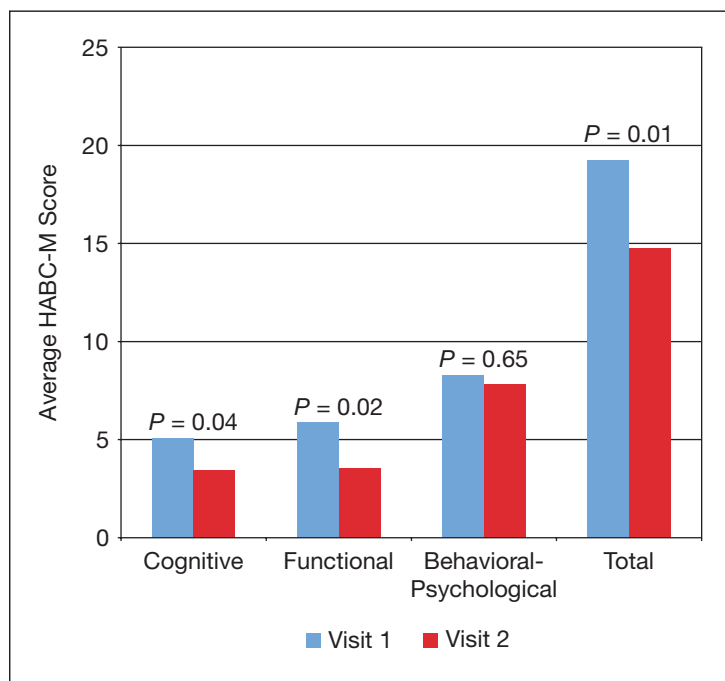
PATIENT CHARACTERISTICS AND EARLY RESULTS

From July 2011 through May 2012, the CCRC delivered care to 53 new patients. The first follow-up visit took place at approximately three months after hospital discharge. The average age of the patients was 56.6 years (SD, 16.3). Fifty-one percent were female; 49% were African American. The three most common initial CCRC workup diagnoses were ICU-acquired cognitive impairment, depression, and dyspnea. Indeed, on initial CCRC workup, of the 52 patients for whom Cognitive Status Profile results were available, a significant majority were found to have cognitive or psychological morbidities; only six (12%) had normal cognition. For more on the baseline characteristics of these patients, see Table 1 at <http://links.lww.com/AJN/A65>.

Twenty-four CCRC patients were evaluated using the HABC-M at least twice, allowing us to compare their cognitive, functional, and behavioral-psychological symptoms longitudinally. The first set of scores was obtained at the first follow-up visit; the second set, at the second follow-up visit. The average time between these visits was two and a half months. Score improvements were seen in all domains as well as in the total score, and were significant for all but the behavioral-psychological domain. Most striking was the reduction in the average total HABC-M score, which dropped from 19.21 points at visit 1 to 14.75 points at visit 2. For more details, see Figure 1.

Representative CCRC case vignette. A 37-year-old African American man without prior comorbidities

Figure 1. Longitudinal Monitoring of Critical Care Recovery Center Patients' Symptoms Using the Healthy Aging Brain Center Monitor (HABC-M) (n = 24)



was admitted to WMH's ICU for acute respiratory distress syndrome, secondary to *Escherichia coli* pneumonia and sepsis. After prolonged mechanical ventilation and an ICU stay of two weeks, the patient recovered and was discharged to home. He was first evaluated in the CCRC three months later, complaining of dyspnea, forgetfulness, and lack of energy, as well as recurrent episodes of anxiety and outbursts of anger. The patient's caregiver expressed feelings of depression and helplessness. The patient was assessed using neuropsychological and physical functioning test batteries, and was screened for depression and anxiety disorders. Based on the results, diagnoses of acquired multidomain amnesic cognitive impairment, major depression, and PTSD were made. He was offered cognitive training, problem-solving therapy, and a selective serotonin reuptake inhibitor. His caregiver was assessed and found to have a high level of caregiver stress. She was provided with a stress self-management training manual and was counseled on taking time off from caregiving. Both the patient and the caregiver were offered regular access to care coordinators.

DISCUSSION

Our preliminary data and experience with the CCRC suggest that a collaborative, interdisciplinary care model can enhance the cognitive, physical, and psychological recovery of ICU survivors. The CCRC

represents a prototype in the United States for providing post-ICU care to patients who present with PICS. Other models of care for ICU survivors have been tested elsewhere, including home-based²⁷ and nurse-led rehabilitation programs²⁸ in the United Kingdom. But to the best of our knowledge, the CCRC represents the first collaborative care clinic aimed at meeting the recovery needs of ICU survivors in the United States. The CCRC also expands care to include designated family caregivers. And it provides and coordinates care both inside and outside the clinic, thus going beyond the traditional primary care encounter.

Because ICU stays are often associated with significant long-term complications, it's essential that nurses become aware of the risk factors for PICS and educate family members and others who will provide postdischarge patient care. Ideally, critical care nurses should initiate PICS education for these caregivers when the patient is nearing transition from the ICU to acute care. Acute care nurses should continue to provide this education throughout the hospital stay, so that the caregivers can learn to recognize PICS symptoms, support the patient, and know when and how to access the health care system and ask for help.

is urgently needed.^{12, 32} The implementation of the CCRC at WHS represents one such endeavor; its clinical mission—to maximize the recovery of ICU survivors—has been realized in a standardized manner, thus serving to facilitate easy and timely access for research projects. Although our results so far are preliminary, we have continued to collect data and will report these data soon. The CCRC may prove to be an efficient way to modify or prevent PICS complications, and this in turn could decrease resource utilization. Care models such as the CCRC could also serve as ideal settings for researchers seeking to understand the mechanisms responsible for such complications.

Possible limitations. WHS is a county-supported health care system that provides care to underserved and minority populations. This may reduce the CCRC model's generalizability to different systems and populations. Moreover, through many interactions during ongoing research projects, our team has developed strong relationships with ancillary ICU staff, which has helped tremendously in patient recruitment for the CCRC. That may not be the case at other institutions. And the relationship between WHS and the CCRC might be unique. WHS has a locally developed,

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Although no single intervention has been shown to prevent PICS, certain nursing interventions have demonstrated efficacy in addressing new-onset PTSD, one of the symptoms of PICS. For example, interventions in which ICU survivors were helped to keep prospective diaries of their hospital experiences were found to aid their recovery²⁹ and lower the incidence of new-onset PTSD.³⁰ Another intervention, which included having survivors make follow-up visits to the ICU, helped them to “make sense of the critical-illness experience.”³¹ Such interventions could be initiated by critical care nurses and continued by acute care or primary care nurses even after the survivor has been discharged to home.

Given the current trends of an aging population, improved ICU survival rates, and the slow translation of evidence into clinical practice, it's likely that the U.S. health care system will prove increasingly inadequate to meet the needs of ICU survivors; this in turn will further burden families, communities, and society. To avert such a scenario, a “reengineering of the clinical research enterprise”³² such that research results are more quickly brought to bear on practice

comprehensive electronic medical record system that allows direct referrals to the CCRC. WHS also subsidizes CCRC services rendered, and using the local electronic medical record system, accesses data (such as rehospitalization rates) to evaluate the program's effectiveness. WHS further uses this information to assess the impact of the CCRC on the entire system and to make decisions about resource allocation and planning. Other institutions might not have these capabilities.

LOOKING AHEAD

We believe that in tackling the significant burden of physical, psychological, and cognitive morbidities commonly seen in ICU survivors, the CCRC represents a bold and innovative step forward in the care of critically ill patients. In striving to minimize PICS symptoms and improve survivors' quality of life, the CCRC may also reduce unnecessary ED visits, lower the rate of rehospitalization, and help to control health care costs. The CCRC prototype stands as an ahead-of-the-curve example for other U.S. health care systems that might be interested in instituting an

ICU aftercare clinic. We further recommend that the implementation process be tailored to a health care system's particular culture, using the principles of complex adaptive systems and the MAP/RAP approach. Further research to establish the effectiveness of programs like the CCRC will also be needed. ▼

For two additional continuing nursing education activities on topics related to care redesign, go to www.nursingcenter.com/ce.

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REFERENCES

1. National Quality Forum. *Endorsement summary: pulmonary and critical care measures*. Washington, DC; 2012 Aug. http://www.qualityforum.org/Projects/Pulmonary_Endorsement_Maintenance.aspx.
2. Needham DM, et al. Projected incidence of mechanical ventilation in Ontario to 2026: Preparing for the aging baby boomers. *Crit Care Med* 2005;33(3):574-9.
3. Desai SV, et al. Long-term complications of critical care. *Crit Care Med* 2011;39(2):371-9.
4. Stevens RD, et al. Neuromuscular dysfunction acquired in critical illness: a systematic review. *Intensive Care Med* 2007;33(11):1876-91.
5. Davydow DS, et al. Depression in general intensive care unit survivors: a systematic review. *Intensive Care Med* 2009;35(5):796-809.
6. Davydow DS, et al. Posttraumatic stress disorder in general intensive care unit survivors: a systematic review. *Gen Hosp Psychiatry* 2008;30(5):421-34.
7. Girard TD, et al. Delirium as a predictor of long-term cognitive impairment in survivors of critical illness. *Crit Care Med* 2010;38(7):1513-20.
8. Needham DM, et al. Improving long-term outcomes after discharge from intensive care unit: report from a stakeholders' conference. *Crit Care Med* 2012;40(2):502-9.
9. Cuthbertson BH, et al. Quality of life in the five years after intensive care: a cohort study. *Crit Care* 2010;14(1):R6.
10. Egerod I, et al. ICU-recovery in Scandinavia: a comparative study of intensive care follow-up in Denmark, Norway and Sweden. *Intensive Crit Care Nurs* 2013;29(2):103-11.
11. Balas EA, Boren SA. Managing clinical knowledge for health care improvement. In: Bommel JM, McCray AT, eds. *Yearbook of medical informatics 2000: patient-centered systems*. Stuttgart, Germany: Schattauer Verlagsgesellschaft mbH; 2000. p. 65-70.
12. Committee on Quality Health Care in America, Institute of Medicine. *Crossing the quality chasm: a new health system for the 21st century*. Washington, DC: National Academy Press; 2001. <http://www.nap.edu/books/0309072808/html>.
13. Boustani MA, et al. Implementing innovative models of dementia care: The Healthy Aging Brain Center. *Aging Ment Health* 2011;15(1):13-22.
14. Rubenstein LV, Pugh J. Strategies for promoting organizational and practice change by advancing implementation research. *J Gen Intern Med* 2006;21 Suppl 2:S58-S64.
15. Callahan CM, et al. Effectiveness of collaborative care for older adults with Alzheimer disease in primary care: a randomized controlled trial. *JAMA* 2006;295(18):2148-57.
16. Vickrey BG, et al. The effect of a disease management intervention on quality and outcomes of dementia care: a randomized, controlled trial. *Ann Intern Med* 2006;145(10):713-26.
17. Boustani MA, et al. Selecting a change and evaluating its impact on the performance of a complex adaptive health care delivery system. *Clin Interv Aging* 2010;5:141-8.
18. Holden LM. Complex adaptive systems: concept analysis. *J Adv Nurs* 2005;52(6):651-7.
19. Plsek PE. *Working paper: some emerging principles for managers of complex adaptive systems (CAS)*. Roswell, GA; 1997. <http://www.directedcreativity.com/pages/ComplexityWP.html>.
20. Matthews JL, Thomas PT. Managing clinical failure: a complex adaptive system perspective. *Int J Health Care Qual Assur* 2007;20(2-3):184-94.
21. Anderson RA, et al. Case study research: the view from complexity science. *Qual Health Res* 2005;15(5):669-85.
22. McDaniel RR, Jr., et al. Surprise, surprise, surprise! A complexity science view of the unexpected. *Health Care Manage Rev* 2003;28(3):266-78.
23. Stroebel CK, et al. How complexity science can inform a reflective process for improvement in primary care practices. *Jt Comm J Qual Patient Saf* 2005;31(8):438-46.
24. Monahan PO, et al. Practical clinical tool to monitor dementia symptoms: the HABC-Monitor. *Clin Interv Aging* 2012;7:143-57.
25. Morris JC, et al. Consortium to establish a registry for Alzheimer's disease (CERAD) clinical and neuropsychological assessment of Alzheimer's disease. *Psychopharmacol Bull* 1988;24(4):641-52.
26. Unverzagt FW, et al. Clinical utility of CERAD neuropsychological battery in elderly Jamaicans. *J Int Neuropsychol Soc* 1999;5(3):255-9.
27. McWilliams DJ, et al. Feasibility and impact of a structured, exercise-based rehabilitation programme for intensive care survivors. *Physiother Theory Pract* 2009;25(8):566-71.
28. Cuthbertson BH, et al. The PRaCTICaL study of nurse led, intensive care follow-up programmes for improving long term outcomes from critical illness: a pragmatic randomised controlled trial. *BMJ* 2009;339:b3723.
29. Combe D. The use of patient diaries in an intensive care unit. *Nurs Crit Care* 2005;10(1):31-4.
30. Jones C, et al. Intensive care diaries reduce new onset post traumatic stress disorder following critical illness: a randomised, controlled trial. *Crit Care* 2010;14(5):R168.
31. Engström A, et al. Re-visiting the ICU experiences of follow-up visits to an ICU after discharge: a qualitative study. *Intensive Crit Care Nurs* 2008;24(4):233-41.
32. National Institutes of Health. *NIH roadmap for clinical research: clinical research network and NECTAR*. 2007. <http://commonfund.nih.gov/clinicalresearch/overview-networks#>.