

accurately assessed and is actually underestimated. Inevitably, regular follow-up visits, emergency assessment of symptomatic patients, periodic 12-lead electrocardiographic recordings, and 24-h Holter recordings have a low yield of AF detection given that many episodes are brief and asymptomatic. The exact AF burden over long time periods can be reliably assessed only in patients with implanted modern pacemakers and implantable cardioverter defibrillators able to record atrial high-rate episodes. Another issue that needs further clarification in future studies is the relative significance of different types of AF. In the general population it is now well established that paroxysmal AF carries the same risk in terms of morbidity and mortality compared with persistent and permanent AF. Whether there is a similar risk in the setting of ESRD is uncertain. The differences in the underlying etiology and pathophysiology may imply different effects on morbidity and mortality. For instance, the acute changes in electrolyte levels and especially the relative hypokalemia have been associated with brief paroxysmal AF episodes.³

The pathophysiology of AF in ESRD is complex (Figure 1). It should be recognized that ESRD *per se* is associated with volume overload and neurohormonal alterations (mainly activation of the sympathetic system and the renin-angiotensin-aldosterone system) that promote ventricular hypertrophy and dilation as well as increased left atrial size and pressure.³ Inevitably, these abnormalities contribute to the structural and electrical remodeling of the atria. In addition, inflammation and oxidative stress have been implicated in the pathophysiology of ESRD and represent major mechanisms of cardiovascular dysfunction in this setting. Recently, AF has been associated with inflammation and oxidative stress, and much of the current interest regarding pharmacologic therapy has shifted to non-channel-blocking drugs with pleiotropic properties. Whether these interventions have a specific value in ESRD patients is unknown.

In conclusion, AF is prevalent among ESRD patients, representing an additional threat in this frail population. Undoubtedly, further larger studies with longer follow-up are needed in order to elucidate the impact of AF on various clinical parameters, as well as the role of different

prognostic factors and therapeutic modalities in this setting. Finally, the clarification of the complex underlying pathophysiology may favor the development of effective preventive and treatment strategies.

DISCLOSURE

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Preventing repeat hospitalizations in dialysis patients: a call for action

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Hospitalizations are frequent among dialysis patients, and reducing repeat hospitalizations could decrease costs and improve outcomes. Chan *et al* found that hemoglobin monitoring along with erythropoietin-stimulating agent dose modification and vitamin D administration reduced the risk of repeat hospitalization. These and other interventions, especially those related to close monitoring immediately after hospitalization and better communication between hospital and dialysis providers to assure continuity of care, should be further explored in observational or randomized studies.

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Hospitalizations are frequent for end-stage renal disease (ESRD) patients treated with dialysis. In 2006, dialysis patients

averaged nearly two hospital admissions per patient-year.¹ Furthermore, hospitalizations of ESRD patients cost the US health-care system \$31.5 billion between 2002 and 2006, which represented more than one-third of the total costs of treating ESRD over this time period.¹ Many of these hospitalizations were probably repeat hospitalizations, defined as hospitalizations that occur within a short period (for example, 30 days) following a previous hospitalization. Preventing such repeat admissions

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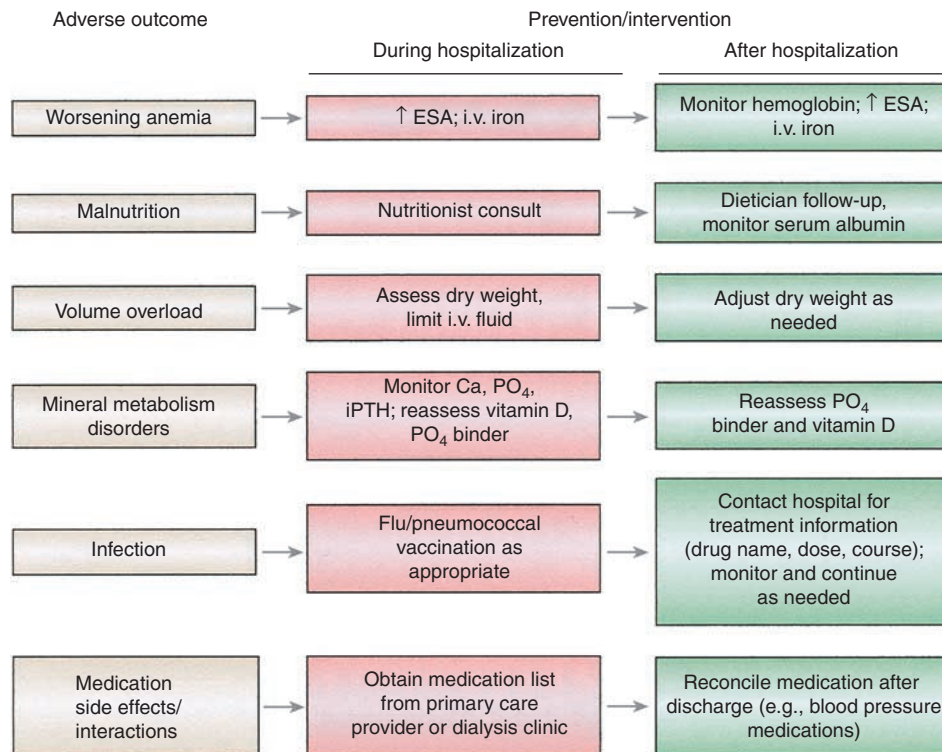


Figure 1 | Process of care for preventing repeat hospitalizations in dialysis patients. Ca, calcium; ESA, erythropoietin-stimulating agent; iPTH, intact parathyroid hormone; i.v., intravenous; PO₄, phosphate.

would reduce overall costs due to hospitalization and would also likely increase the overall health of the dialysis patient, as each hospitalization can have adverse consequences, including worsening anemia,² malnutrition, infection, and, possibly, in-hospital mortality. In addition, reducing repeat hospitalizations could potentially dramatically increase dialysis patients' quality of life, which may be as important as health outcomes from the perspective of patients and their families.

Chan *et al.*³ (this issue) describe the association of early post-hospitalization intervention with reduced risk of repeat hospitalization in a large observational cohort of prevalent hemodialysis patients receiving treatment at facilities managed by a national dialysis provider. The authors found that, after hospitalization, hemoglobin, albumin, phosphorus, calcium, parathyroid hormone, and dry weight were all significantly decreased relative to pre-hospitalization values. Although decreases in hemoglobin clearly represent worsening anemia, the picture is more complicated for decreases in the other examined markers during hospitalization.

For example, a decrease in phosphate during hospitalization would be problematic only in the setting of hypophosphatemia, which is less common than hyperphosphatemia among dialysis patients. In addition, the effect of decreased oral intake and possible lack of nutritional support during hospitalization on the observed decreases in albumin, phosphorus, calcium, and dry weight—relative to the effect of discontinuation of or change from usual pre-hospitalization therapy during hospitalization—is unknown.

Chan *et al.*³ also found that patients who had their hemoglobin monitored and their dosage of erythropoietin-stimulating agent modified were at 16% reduced risk of repeat hospitalization; vitamin D administration was associated with a 6% reduced risk. Target dry weight modification and monitoring of bone mineral metabolism markers were not associated with reduced risk of repeat hospitalization. The effects of these interventions were somewhat modest in reducing the risk of repeat admissions from any cause, probably because of the nonspecificity of the outcome to the intervention. Although

the most common causes of repeat admission are not listed by Chan *et al.*,³ they were likely similar to those reported for new hospitalizations, that is, infection and vascular access problems. The association of decreased hemoglobin with increased risk of repeat admission due to anemia, for example, may have been stronger. The beneficial effects of vitamin D administration on specific causes of repeat hospitalization are less clear.

There are several post-hospitalization interventions, in addition to those reported by Chan *et al.*,³ that could be explored to help reduce repeat admissions. In addition, some interventions or preventive measures could be undertaken earlier, during the initial hospitalization, to prevent repeat hospitalizations. A representation of a comprehensive process of care for prevention of repeat hospitalizations is shown in Figure 1. For worsening anemia, which could lead to repeat hospitalizations due to the anemia itself or associated morbidities, not only administration of an erythropoietin-stimulating agent but also intravenous iron, as appropriate, could be considered interventions.

Both require the monitoring of hemoglobin and iron profile immediately after hospitalization, which in itself could be considered an intervention but was not performed for more than one-quarter of the patients in the study by Chan *et al.*³ Malnutrition could be prevented or alleviated through nutritional interventions (hospital nutritional consults, dietary supplements, and post-hospitalization follow-ups by a dialysis clinic dietician) and by close monitoring of serum albumin. Volume overload could be prevented by limiting intravenous fluid during the hospital stay and by continual reassessment and adjustment of dry weight, both during and after hospitalization. Worsening of mineral metabolism disorders could be monitored through measurement of calcium, phosphate, and intact parathyroid hormone; assessment and adjustment of vitamin D levels during and soon after hospitalization; and reassessment of phosphate binder use during and after hospitalization. Monitoring of vascular access, as well, has been shown to be associated with better clinical outcomes⁴ and could be continued during and after hospitalization to prevent repeat admissions due to this very common cause of hospitalization in hemodialysis patients.¹ For all of these adverse outcomes, regular monitoring and reassessment of indicated markers during and immediately after hospitalization would provide better continuity of care from the inpatient to the outpatient setting, which has been associated with increased risk of medical errors that could lead to repeat hospitalization.⁵

Communication between the hospital and the dialysis provider is another very important category of intervention that could be addressed in chronically ill and often debilitated dialysis patients. For example, infections in the hospital would be treated as part of usual care, but, before discharge, the hospital could contact the dialysis clinic and provide timely and important information on the treatment course (for example, antibiotic name, dosage, and length of treatment) and continued monitoring. In this example, such

timely communication is an intervention that could certainly help prevent recurrent infection and might help prevent repeat admission due to inadequate treatment. In fact, availability of discharge summaries has been associated with decreased risk of hospital readmission in the general population.⁶ In addition, hospital providers could access dialysis patients' outpatient records and administer influenza and pneumococcal vaccinations as needed to prevent respiratory tract infections. Medication errors and adverse drug events after hospitalization have been shown to be associated with discontinuity of care and readmissions.^{5,7,8} For example, in dialysis patients, blood pressure medications that are similar to those taken by the patient as part of usual outpatient care may be prescribed by the hospital provider, which may lead the patient to unknowingly take two similar medications upon discharge and increase the risk of adverse side effects, with sometimes severe consequences. Such errors could be prevented by improvement of communication between the hospital and dialysis providers during hospitalization and reconciliation of medication records after discharge using the discharge summary.⁹ Regular and timely multidisciplinary conferences on dialysis patients after hospitalization could also help prevent repeat hospitalization by reassessing the patient plan of care, including medications. Previous studies have shown that this type of patient-care conference is associated with better patient outcomes, including an increased chance of meeting the albumin clinical performance target, decreased hospitalization, and decreased risk of mortality.¹⁰

Chan *et al.*³ have published a well-conducted study that is a first examination of the important issue of preventing repeat hospitalizations of dialysis patients through appropriate intervention. Future studies could focus on additional possible areas of intervention, including better monitoring and reassessment of other health indicators and better communication between the hospital and dialysis provider to provide continuity of care and

prevent medical errors. Examination of associations between interventions and cause-specific hospitalizations would also be of great interest. Additional observational studies would add to and strengthen existing evidence. However, such studies always have the limitations of possible residual confounding and selection bias. Thus, other study designs should be considered, such as pre-/post-intervention studies or even randomized clinical trials (examining the intervention versus usual care), which would provide more definitive evidence of the effect of interventions on repeat hospitalizations. Confirmation of the effect of interventions in such studies could lead to improved outcomes for dialysis patients and lower costs for the health-care system.

DISCLOSURE

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