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Evaluating the association between unmet healthcare needs and subsequent clinical outcomes: protocol for the Addressing Post-Intensive Care Syndrome-01 (APICS-01) multicentre cohort study

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ABSTRACT

Introduction As short-term mortality declines for critically ill patients, a growing number of survivors face long-term physical, cognitive and/or mental health impairments. After hospital discharge, many critical illness survivors require an in-depth plan to address their healthcare needs. Early after hospital discharge, numerous survivors experience inadequate care or a mismatch between their healthcare needs and what is provided. Many patients are readmitted to the hospital, have substantial healthcare resource use and experience long-lasting morbidity. The objective of this study is to investigate the gap in healthcare needs occurring immediately after hospital discharge and its association with hospital readmissions or death for survivors of acute respiratory failure (ARF).

Methods and analysis In this multicentre prospective cohort study, we will enrol 200 survivors of ARF in the intensive care unit (ICU) who are discharged directly home from their acute care hospital stay. Unmet healthcare needs, the primary exposure of interest, will be evaluated as soon as possible within 1 to 4 weeks after hospital discharge, via a standardised telephone assessment. The primary outcome, death or hospital readmission, will be measured at 3 months after discharge. Secondary outcomes (eg, quality of life, cognitive impairment, depression, anxiety and post-traumatic stress disorder) will be measured as part of 3-month and 6-month telephone-based follow-up assessments. Descriptive statistics will be reported for the exposure and outcome variables along with a propensity score analysis, using inverse probability weighting for the primary exposure, to evaluate the relationship between the primary exposure and outcome.

Ethics and dissemination The study received ethics approval from Vanderbilt University Medical Center Institutional Review Board (IRB) and the University of Utah IRB (for the Veterans Affairs site). These results will inform both clinical practice and future interventional trials in the field. We plan to disseminate the results in peer-reviewed journals, and via national and international conferences.

Trial registration details ClinicalTrials.gov (NCT03738774). Registered before enrollment of the first patient.

Strengths and limitations of this study:

- To our knowledge, this is the first multicentre prospective study to empirically evaluate the association between early unmet healthcare needs and subsequent clinical outcomes among survivors of acute respiratory failure (ARF) in the US healthcare setting.
- Results of this study may guide future focussed interventions for more effective planning and delivery of healthcare services immediately after hospital discharge, with the objective of improving outcomes for survivors of ARF.
- We will not be able to definitively confirm causation between the exposure and outcomes in this study, given its observational design, and the possibility that measuring the outcomes may affect the exposure-outcome association.

INTRODUCTION

Recent medical advances have improved the survival of critically ill patients.[1–5] However, survivors often suffer from residual impairments in physical, cognitive and/or mental health, and face substantial financial burden due to delayed return to work and associated loss of earnings, for both patients and caregivers.[6–18] Survivors also experience fragmented healthcare after hospital discharge and mismatches between the healthcare

services needed and those received during the vulnerable weeks immediately after the hospital discharge.[19]

Many intensive care unit (ICU) survivors are readmitted to the hospital within months of discharge.[20–22] The 1-year readmission rate was 40% in a prospective study in Maryland, with an estimated median (IQR) hospital cost of US $18,756 ($7,852 to $46,174) for readmissions.[23] A retrospective analysis of 189 patients who were discharged alive after admission for sepsis at 10 hospitals suggested an association between fragmented care after discharge and 90-day hospital readmission, with lower readmission rates (OR 0.12 to 0.28) observed among patients who received more components of recommended sepsis aftercare.[19] In contrast, a comparative effectiveness analysis of Medicare data demonstrated that beneficiaries who received both early home health nursing and early physician follow-up after a hospitalisation for sepsis were less likely to be readmitted for any cause.[24]

Existing studies have provided preliminary data regarding associations between a few clinical predictors and individual post-discharge outcomes.[25] Although severity of illness is strongly associated with hospital mortality, factors driving post-discharge mortality and readmission are less well understood, and typical severity of illness scores are not associated with functional outcomes after hospital discharge.[26–36]

One important knowledge gap is understanding specific unmet healthcare needs of ICU survivors, especially in the early phases of their recovery after hospital discharge. The transition from an acute care hospital to home can be highly complex, with new healthcare orders, discontinued medications, follow-up appointments and the need for patients and/or family caregivers to shoulder new responsibilities. Multiple aspects of discharge plans might potentially be overlooked, leaving substantial unmet healthcare needs that may be linked to worse patient outcomes (figure 1).

In order to address these gaps in knowledge, we initiated the multicentre cohort study 'Addressing Post-Intensive Care Syndrome-01 (APICS-01)'. We have reviewed the underlying rationale for this study previously.[37] Herein, we report the study protocol used to assess the relationship between early unmet healthcare needs after hospital discharge to home and subsequent clinical outcomes among survivors of acute respiratory failure (ARF).

METHODS AND ANALYSIS

Study design

This is a prospective multicentre observational study of survivors of ARF in the ICU conducted at six hospitals affiliated with the following five medical centers in the USA: Intermountain Medical Center (clinical coordinating center), Vanderbilt University Medical Center (qualitative analysis center (QAC)), Johns Hopkins University (data coordinating center (DCC) and centralised study follow-up center), Beth Israel Deaconess Medical Center and George E Wahlen Salt Lake City Veterans Administration Hospital.

	Acute Illness	Hospital Recovery	Early Post-discharge Recovery	Late Post-discharge Recovery
Desired Outcome:	Survival	Discharge Home	Stay Home and Improving	Return to Baseline
Impediments to desired outcome:	• High-tidal volume ventilation • Late antibiotics for sepsis • Ventilator-associated pneumonia • Lack of clot prophylaxis	• Immobility • Undiagnosed delirium • Lack of physical therapy • Polypharmacy • Prolonged catheterization	• PICS • Caregiver misinformation • Fragmented care or inadequate follow-up • Vague or incomplete discharge instructions • Inadequate medication reconciliation • Missing DME • Inadequate PT/OT/ home services • Lack of subspecialist follow-up	• PICS • Inadequate vocational training • Disruptions to employment, finances, and insurance • Socioeconomic barriers to care (insurance, transport, cognition) • Patient and family financial burden • Undiagnosed cognitive impairment • Fragmented or inadequate family support • Polypharmacy
Location:	ICU	Hospital ward	Home	Home
Supervising clinician:	Intensivist	Hospitalist	PCP	PCP
Timeframe:	1-8 weeks	1-4 weeks	Through 3 months	3 months -5 years

DME—durable medical equipment; ICU—intensive care unit; OT—occupational therapy; PCP—primary care physician; PICS—post-intensive care unit; PT—physical therapy

Figure 1 Phases of acute lung injury and its aftermath.

Eligibility criteria

Eligibility criteria are presented in table 1. In brief, the study will recruit patients with ARF who will be discharged to home directly from their acute care hospital. We define ARF as ≥24 consecutive hours of any of the following[1]: mechanical ventilation via an endotracheal tube,[2] non-invasive ventilation (continuous positive airway pressure or bilevel positive airway pressure), or[3] high-flow nasal cannula with fractional inspired oxygen ≥0.5 and flow rate ≥30 L/min. We exclude patients for whom telephone-based follow-up is not feasible (eg, non-English speaking or inability to speak by telephone), patients with pre-existing dementia and patients who are very likely to die during follow-up for reasons unrelated to their ARF. To evaluate if patients have pre-existing dementia (excluded due to their very different healthcare needs and care-giving structures, and inability to complete telephone-based follow-up of self-reported functional outcomes), we used Informant Questionnaire on Cognitive Decline in the Elderly screening, as has been used in prior studies.[15 38 39]

Participant selection and recruitment

Trained research staff will prospectively screen ICUs of study hospitals to identify patients with ARF who meet eligibility criteria and follow them until the clinical team expects to discharge the patient home (rather than an inpatient healthcare facility). Site investigators provide final confirmation of patient eligibility. After confirming eligibility, members of the research team will approach the patient (or legally authorised representative, as appropriate) to explain the study and request consent for participation. After receipt of written informed consent, patients will be enrolled and data collection will begin. Patients who are enrolled and then, contrary to expectation, are not discharged home will be excluded from follow-up and do not count toward the sample size goal. This method of exclusion after informed consent allows timely enrolment of patients and avoids missed enrolment due to inadequate time for informed consent on the day of hospital discharge (figure 2).

Primary exposure

Unmet healthcare needs is the primary exposure of interest. We developed and pilot-tested an instrument to measure healthcare needs, as identified in hospital discharge documentation. This instrument was initially drafted based on recognised post-discharge needs from published literature and experience at two ICU aftercare and recovery clinics at study site hospitals.[40 41] Details of the development and testing of this instrument are reported in online supplementary appendix 1. These healthcare needs often include, but are not limited to, durable medical equipment, oxygen, home health services, dialysis, follow-up appointments, substance use counselling and medication management.[41–43]

Immediately after discharge, the healthcare needs case report form (CRF) is transferred from the study site hospital to the centralised outcome assessment group at the DCC. This CRF will be used to determine which healthcare needs are met or unmet at the time of the initial telephone assessment, conducted as early as possible within 1 to 4 weeks after hospital discharge to home. Items on this CRF (online supplementary appendix) are rated as (a) completed, (b) scheduled, (c) missed or (d) unknown. The discharge needs rated as missed or unknown are identified as 'unmet needs'. The patient or caregiver is the primary informant, as appropriate, with a preference for patient response. The primary exposure variable is the proportion of healthcare needs that are unmet (eg, if there were 10 healthcare needs identified with two needs unmet, then the primary exposure is scored as 0.2).

Primary outcome

The primary outcome is a composite binary outcome of death or hospital readmission within 3 months of discharge to home from the index hospitalisation.

Secondary outcomes

Secondary outcomes include the constituent elements of the composite primary outcome as well as additional outcomes measured during the 3-month and 6-month telephone-based follow-up assessments (box 1), including:[1] at 3 months: mortality, hospital readmission, cognitive impairment, depression, anxiety, post-traumatic stress disorder-related symptoms, and emergency department visits, and[2] at 6 months: mortality, healthcare utilization and health-related quality of life.

Data collection

The local research team at each study site will measure baseline demographics, premorbid function, baseline healthcare needs before hospital admission, and alcohol and tobacco use. The local research team also collects data to summarise relevant clinical exposures and processes occurring during the ICU stay (eg, acute physiology and chronic health evaluation (APACHE) II score, duration of mechanical ventilation, presence or absence of acute respiratory distress syndrome (ARDS), relevant medical interventions received in the ICU and ICU length of stay). As part of the hospital discharge assessment, the research team also will document the provision of substance abuse counselling and patients' clinical status (eg, hospital length of stay, activities of daily living (ADLs) and dialysis or oxygen dependence.)

Research staff will collect participant contact information following guidance for optimising participant retention in longitudinal studies provided via the National Institutes of Health/National Heart, Lung, and Blood Institute-funded www.ImproveLTO.com resource.[44] Trained research team members at the DCC will contact participants via telephone to measure the primary exposure and outcomes using evidence-based techniques to maximise cohort retention and minimise missing data.[44–49] Box 1 displays the data elements collected at each time point.

Table 1 Inclusion and exclusion criteria for study entry

Inclusion criteria	
► Acute respiratory failure, defined as ≥1 of the following: – Mechanical ventilation via an endotracheal tube for ≥24 hours – Non-invasive ventilation (CPAP or BiPAP) for ≥24 consecutive hours* provided for acute respiratory failure (not for obstructive sleep apnea or other stable use) – High-flow nasal cannula with FIO_2 ≥0.5 and flow rate ≥30 L/min for ≥24 consecutive hours*	
Exclusion criteria	**Rationale**
1. <18 years old	
2. Patient in ICU <24 hours	Concern about fidelity of measurement and comparability for respiratory failure outside the ICU
3. Prisoner	Vulnerable population
4. Homeless	Follow-up not feasible
5. Pregnancy	Distinct needs from other survivors of acute respiratory failure related to parenting a new child, ongoing pregnancy or recent fetal loss
6. Primary residence not in USA	Follow-up is impractical
7. Unable to communicate by telephone in English	Inability to complete telephone-based follow-up of self-reported functional outcomes
8. More than mild dementia (either known diagnosis of moderate or worse dementia or IQ-CODE >3.6; screening performed on patients >50 years old or with family reports of possible memory decline)	Different needs and caregiving structures, inability to complete telephone-based follow-up of self-reported functional outcomes
9. Patients with neurological injury either receiving treatment for intracranial hypertension or who are not expected to return to consciousness	Inability to complete telephone-based follow-up of self-reported functional outcomes
10. Residing in a medical institution at the time of hospital admission	Different needs and caregiving structures
11. Patient on hospice at or before time of enrollment	Survival likely <6 months
12. Mechanical ventilation at baseline	Does not meet criteria for acute respiratory failure; epidemiology, needs and outcomes differ between acute and chronic respiratory failure
13. Patients mechanically ventilated solely for airway protection or obstruction	Mechanical ventilation in that case is not a useful measure of respiratory failure
14.Not expected by the clinical team to be discharged home alive	The population of interest is those patients who are discharged directly to home with the anticipation of recovery
15. Patients who, based solely on pre-existing medical problems (such as poorly controlled neoplasm or other end-stage disease, including stage IV heart failure or severe burns), would not be expected to survive 6 months in the absence of the acute respiratory failure	Survival likely <6 months
16. Lack of informed consent	Ethical concerns

*Occasional rest periods of ≤1 hour each are not deducted from the calculation of consecutive hours.
BiPAP, Bilevel Positive Airway Pressure; CPAP, Continuous Positive Airway Pressure; FIO_2, Fractional Inspired Oxygen; ICU, Intensive Care Unit; IQ-CODE, Informant Questionnaire on Cognitive Decline in the Elderly .

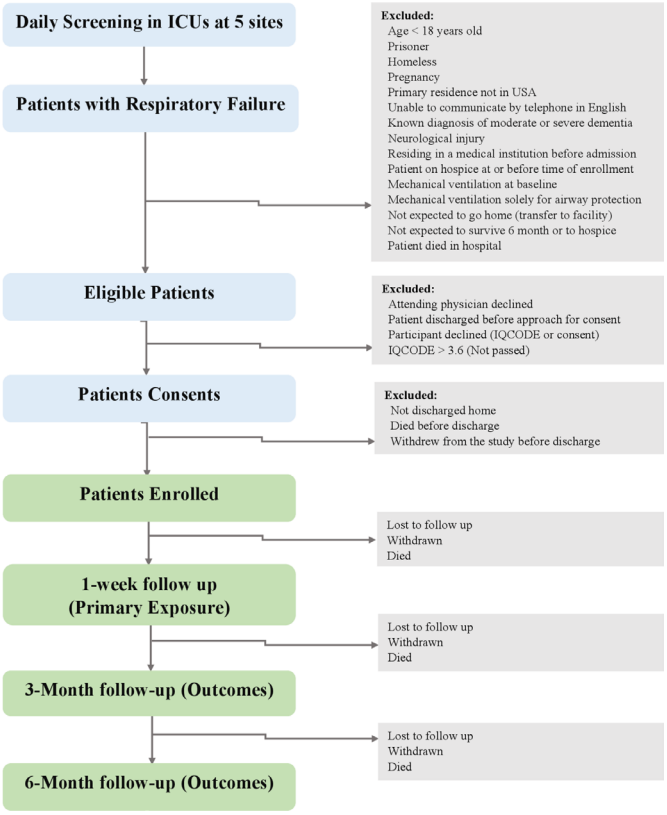

Figure 2 Flow chart depicting patient identification, enrolment and follow-up.

In addition, a telephone-based semi-structured interview will be performed by the QAC for participants who are discharged home alive but readmitted before the first phone follow-up. The interview will collect data regarding what factors the respondent (patient or family member, as appropriate) considered relevant to the early readmission.

Statistical analysis

Summary of analytical approach. The primary research question is whether unmet healthcare needs shortly after hospital discharge to home are associated with readmission or death within 3 months of hospital discharge in survivors of ARF. The ultimate inferential target is understanding whether approaches that address unmet healthcare needs in the early post-discharge period decrease readmission or death. The APICS-01 study is intended to move the research and clinical communities along the path to those ultimate inferences.

As described above, each healthcare need will be classified as either a medication or a non-medication need, and the two co-primary endpoints will be defined as the overall proportion of medication needs which are unmet (proportion of unmet medication needs) and the proportion of non-medication needs which are unmet (proportion of unmet non-medication needs). Preliminary analyses (blinded to study outcomes) indicate that the proportion of unmet non-medication needs follows a bimodal U-shaped distribution with a median of

Box 1 Data elements collected at each time point

Baseline assessment
- Admission APACHE II severity of illness score
- Demographics (age, sex and race/ethnicity)
- Body mass index
- Charlson Comorbidity Index
- Functional Comorbidity Index
- Maximum educational attainment
- Zip code and distance between home and treating hospital
- Type of insurance
- Strength of social support system (MSPSS instrument)
- Katz ADL instrument
- Lawton IADL instrument
- Clinical frailty scale
- Alcohol use (simplified AUDIT questionnaire)
- Tobacco smoking status
- Admission diagnosis category

ICU discharge assessment
- Presence of ARDS (based on Berlin criteria)[51]
- Duration of mechanical ventilation
- ICU length of stay
- Receipt of dialysis in ICU
- Intervention by physical therapist/occupational therapist in ICU
- RASS/CAM-ICU sedation/delirium assessments

Hospital discharge assessment
- Hospital length of stay
- Discharge disposition (eg, home or skilled nursing facility)
- Ventilator-dependent at discharge
- Dialysis-dependent at discharge
- Presence of tracheostomy
- Oxygen dependence/requirement
- Structured discharge plan data collection

Unmet needs assessment (1 week week after discharge)
- Healthcare use assessment
- Unmet needs assessment

Telephone follow-up instruments (3 months after discharge)
- All-cause mortality
- Healthcare use survey[23 64 65]
- EQ-5D-5L
- HADS
- IES-R
- MoCA-blind
- Katz ADL and Lawton IADL
- MSPSS
- Brief COPE
- Change in alcohol use

Telephone follow-up instruments (6 months after discharge)
- All-cause mortality
- EQ-5D-5L
- Katz ADL/Lawton IADL
- Return to work*[16 17]

*.improvelto.com/instruments
ADL, activity of daily living; APACHE II, acute physiology, age, chronic health evaluation II; ARDS, acute respiratory distress syndrome; AUDIT, alcohol use disorders identification test; CAM, confusion assessment method; COPE, coping orientation to problems experienced; EQ-5D-5L, EuroQoL 5-dimension 5-level; HADS: Hospital Anxiety and Depression Scale; IADL, instrumental activity of daily living; ICU, intensive care unit; IES-R, impact of event scale – revised; MoCA, Montreal Cognitive Assessment; MSPSS, multidimensional scale of perceived social support; RASS, Richmond Agitation Sedation Scale.

approximately 0.5, while the proportion of unmet medication needs is heavily positively skewed, with a mode at 0 and an upper tail extending upwards to approximately 0.6, with an occasional outlier above 0.6. In both cases, the distributions of these preliminary data are naturally split at the approximate median levels of the respective exposure variables.

As described in detail below, our co-primary analyses will use propensity score adjustment to estimate the average causal ('treatment') effects in the treated (ATT) which will respectively compare (i) the risk of the primary outcome among patients with unmet medication needs above versus below the median value (with unmet non-medication needs included, as a covariate, in propensity model); and (ii) the risk of the primary outcome among patients with non-medication needs above vs below the median value (with unmet medication needs included, as a covariate, in propensity model). Under the assumption of no uncontrolled confounding, the respective ATTs can be interpreted as the average amount by which the risk of the primary outcome might potentially be reduced among patients with above-the-median levels of the respective types of unmet needs if an intervention were implemented to reduce their proportion of unmet needs to below the median. Secondary analyses will address the proportions of unmet needs as continuous variables.

Descriptive analysis. This will be calculated and reported for exposure and outcome variables as well as relevant covariates. Central tendencies will be reported as mean and SD, relevant quantiles (eg, medians and IQR) or proportions as appropriate.

Detailed statistical approach. The primary statistical analysis is focussed on evaluating the association between[1] unmet needs evaluated as soon as possible within 1 to 4 weeks after hospital discharge (exposure), and[2] death or readmission by 3 months after hospital discharge (outcome).

Co-primary analyses. Key methodological considerations are the management of reverse causation (the disease process underlying readmission or death by 3 months is the reason why the healthcare needs are unmet) and confounding by indication (more complex discharge plans, with a higher risk for unmet needs, occur for patients at higher risk for death or readmission).

Here, we describe, in detail, the estimation of the ATT for the proportion of unmet non-medication needs on the primary outcome; our approach to estimation of the ATT for the proportion of unmet medication needs is completely analogous, with the roles of the two exposure variables reversed.

The first step in analysis will implement the covariate balancing propensity score (CBPS) methodology of Imai and Ratkovic[50] to develop estimates of the propensity score for the above-the-median unmet non-medication needs. The propensity model will be developed from a battery of variables available at the time of hospital discharge to control for indication bias and other sources of confounding based on considerations described above. The CBPS presumes a parametric model for the propensity score similar to logistic regression, but exploits the dual characteristics of the propensity score as a covariate balancing score and the conditional probability of 'treatment assignment' (in this case, unmet needs above/below the median). CBPS simultaneously optimises the estimation of the probability that the patient receives the 'treatment' while also optimising the balance of the covariates between the above the median and below the median proportion of unmet non-medication needs after applying the ATT weights determined by the propensity score. Simulation studies have shown that CBPS can dramatically improve performance of propensity score matching and weighting methods, particularly when the propensity model is not correctly specified.[51] As with many other modelling approaches for propensity scores, CBPS estimates the propensity score model without reference to outcome data. The balance of the covariates will be assessed by examining standardised differences, Kolmogorov-Smirnov test statistics and histograms to display differences in the covariate distributions after application of the ATT weights. If substantial imbalances are identified (eg, standardised mean differences >0.15), we will consider the application of generalised boosted models (GBMs) to estimate the propensity scores. GBMs use a collection of simple regression tree models which are added together to provide a general non-parametric estimate of the propensity scores which avoids imposing a specific parametric structure.[52]

After finalising the propensity score model, log-binomial regression (or modified Poisson regression with robust standard errors if the log-binomial model fails to converge) will be used to estimate the risk ratio comparing the risk of the primary outcome between the above the median and below the median proportion of unmet non-medication need groups. The primary outcome model will include medical centre, age and sex as covariates.

Some patients will be readmitted before measuring the primary exposure (ie, within 7 days of hospital discharge). These patients will be included in the primary analysis. Such patients are asked to report unmet needs before their early readmission. To assess for potential recall bias, these patients will be flagged as being readmitted before ascertainment of the primary outcome. This flag will be incorporated as a covariate in the final regression model.

The centralised telephone-based follow-up centre at the DCC has extensive experience minimising loss to follow-up in similar multicentre studies of ARF survivors.[44 53 54] In addition, the primary outcome can be ascertained, without telephone contact, via medical records review and review of public mortality data sets among patients who do not respond to telephone follow-up.

Secondary analyses. We will apply a parametric extension of the CBPS approach—referred to as a covariate balancing generalised propensity score—to continuous exposure variables in order to estimate average causal effects of the proportions of unmet non-medication and mediation needs considered as continuous covariates.[55]

Patient subgroups. The evaluation of the primary exposure-outcome associations will be performed with the propensity-weighted model. For purposes of illustration, but not inference, distribution of exposure and outcomes will be described in the following subgroups: presence or absence of ARDS, age ≥65 years, sex, haemodialysis at the time of hospital discharge, pre-existing comorbidities (eg, Charlson Index >2), frailty at baseline, and presence or absence of trauma as the cause of respiratory failure. Stratified models will not be performed for these subgroups given the risk of small cell sizes.

Multiple comparisons. Given modest sample size, we do not plan to implement formal adjustment for multiple comparisons in this study. Given the risks of false-positive and false-negative conclusions, we will emphasise presentation of study results as point estimates with 95% CI rather than as hypothesis tests.

Sample size and power. Given the complexity of contacting ICU survivors shortly after hospital discharge, we anticipate a possible post-discharge attrition rate of 24%. The follow-up rate is a conservative estimate based on extensive experience of follow-up in similar patient populations. Enrolment of 200 total patients would therefore provide the primary outcome (hospital readmission or death after hospital discharge) on 152 patients. Preliminary data suggest that 35% overall will die or be readmitted (primary outcome, based on both unpublished preliminary data from other cohorts and published literature).[40 56] Using statistical simulation, we estimated the minimum detectable effect size for the two co-primary analyses assuming (i) beta-distributed propensity scores with mean=0.50 and SD=0.10, (ii) a moderate association between the propensity score and the primary composite outcome (defined as a 5% increase in the odds of the composite outcome per 0.10 increase in the propensity score), and (iii) equal number of participants in the 'exposed' and 'non-exposed' groups, corresponding to categorising patients based on a cut-off that approximates the median proportion of unmet needs. Under these assumptions, the sample size provides 80% power with two-sided α=0.05 to detect an increase in the risk of the composite outcome from 30% for those in the lower unmet needs category to 53% for those in higher unmet needs category. This minimum detectable effect size applies to the co-primary analyses of both unmet medication needs and unmet non-medication needs.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Ethics and dissemination

This study is funded by the US Department of Defense (grant # W81XWH-18-1-0813). The study received approval, and is overseen, by Vanderbilt University Medical Center Institutional Review Board (IRB) with ultimate oversight by Human Research Protections Office (HRPO). The Veterans Affairs hospital site is overseen by and received approval from the University of Utah IRB. The study was fully approved before enrolment of the first patient. Written informed consent is obtained prospectively from all participants or their surrogates.

We are attentive to the balance between ethical mandates and scientific integrity in our performance of telephone follow-up. We therefore avoid clinical intervention unless a serious problem is identified. Serious unmet needs identified during the first call will be triaged in a standardised manner as described herein. Life-threatening problems identified during telephone calls will be immediately triaged to either local emergency services or the site primary investigator (a physician) to coordinate immediate management based on the clinical situation. All such episodes will be recorded in CRFs and tracked. Serious, but non-life-threatening, problems may result in an instruction to the patient and/or caregiver to contact their own, local clinician. In the event of a mental health concern during any study assessment, a clinical psychologist for the study (JCJ) will be notified to determine the optimal response. This strategy appropriately balances the ethical imperative for participant safety with the importance of obtaining unbiassed knowledge of the post-discharge period. We will not perform any intervention for non-serious issues identified during follow-up calls.

We plan to disseminate the results in peer-reviewed journals and at national and international conferences, including the Military Health System Research Symposium.

Limitations

Although this study explores the association between unmet healthcare needs and hospital readmission or death, the observational nature of this study precludes any determination of causality. Residual confounding may affect the cause-effect associations estimated in this study. However, this observational study is an appropriate starting point for future randomised controlled trials.

We also acknowledge the risk of the primary outcome (death or readmission within 3 months of hospital discharge) could decrease due to the initial assessment for the study's primary exposure (unmet healthcare needs). This initial telephone assessment might help a patient recognise an unmet need and seek appropriate intervention, potentially biassing the study results towards the null hypothesis of no association. However, given experience with similar patient populations in the setting of an aftercare and recovery clinic, we believe that the challenges in getting healthcare needs met are substantial enough that the initial telephone call is unlikely to have a major impact on the primary outcome assessed at 3 months after discharge.

We regret that key instruments for this study were not available in Spanish language; thus, limiting the study to participants who could speak English. We recognise the important goal of racial and ethnic diversity among study

populations and anticipate translating and validating relevant instruments for future studies to allow enrolment of participants who do not speak English. The enrolling centres were chosen, in part, for their ability to provide research participation opportunities to racial minorities, including African American, Latinx, Pacific Islander and American Native participants, as well as opportunities for patients with lower socioeconomic status.

We also acknowledge that there are currently no validated methods to distinguish between more versus less important unmet needs; hence, such analyses cannot be done on a priori basis. However, we anticipate that the findings of this study will help elucidate this issue to assist with future studies.

DISCUSSION

Survivors of critical illness experience physical, cognitive and mental health impairments, and often need a comprehensive discharge plan to address many new and ongoing healthcare needs after hospital discharge.[57] Barriers to optimal implementation of the intended discharge plan are many, leading to substantial unmet healthcare needs.[19 40 56] The frequency and nature of such unmet needs after hospital discharge and their impact on patients' clinical outcomes is not well understood.[58] The APICS-01 study will evaluate the frequency and character of unmet healthcare needs in the early post-discharge period, while exploring their association with mortality, readmission to an acute care hospital, healthcare resource use and other patient-centred outcomes, including quality of life, cognitive function and mental health impairments.

The findings of APICS-01 will inform ongoing work to understand optimal approaches to supporting survivors of ARF and other critical illness. Substantial prior work has focussed on ICU aftercare and recovery clinics, which attempt to provide and/or coordinate within one clinic, a range of rehabilitation and clinical services. Existing data on the effectiveness of these clinics has been mixed,[37 59–61] perhaps reflecting the generally late (eg, 3 months after discharge) initiation of such services. This model of support may miss an early window of vulnerability to address unmet healthcare needs and associated negative consequences.[56] Recently-developed ICU aftercare programmes, especially in the USA, have tried to provide follow-up within the days or weeks after hospital discharge, acknowledging that focussed interventions provided in this early time period may have potential to improve ICU survivors' outcomes, similar to results seen in other patient populations.[62 63] The first steps to evaluate this hypothesis are being explored in the APICS-01 study.

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