

Aims 1 and 2

Power Analysis. The sample size was calculated from 4 RCTs with behavioral interventions to improve pain intensity in hospice/palliative care patients identified in our review.¹⁴ A mean effect size of $\delta = 0.61$ was calculated. This implies that a final sample of 92 (46 per group), assuming $\alpha_{2\text{-tailed}} = .05$ and an effect size of 0.61, will produce a power estimate of .72.⁴³ This accommodates 25% for deaths and 5% for other attrition. This is conservative, as earlier hospice studies^{44,38} found 15% attrition due to all causes. A sample size of 92 triads (nurse, caregiver, and patient) plus 30% correction for attrition gives a total sample of 132 triads.

Data analysis. SPSS for Windows (v. 24) and R (v. 3.2)⁵⁴ will be used for data management and statistical analysis. A .05 significance level will be used for all statistical tests. All analyses will be performed on an intent-to-treat basis. Missing data are imputed using R package MI, a multiple imputation program based on Rubin's work.⁵⁵ The algorithm uses all possible information to impute missing scores. While we do not anticipate a high number of patients to die during the study, we will conduct multigroup analysis (died or survived) to identify between-group interactions (change over time by whether patient died or survived).

Participants' roles (patient, caregiver, nurse) will be dummy coded and included in multiple imputation modeling. Variables with significant baseline differences between conditions will be included in subsequent imputation analyses as covariates. Possible imputation covariates include the site, role (patient or caregiver), age, sex, ethnicity, and education of patient and caregiver; patient's diagnosis and *e-PainSupport* usage (how often caregiver or patient enters data). After missing data are imputed, multivariate analysis of variance will be conducted initially to adjust for multiple tests of hypotheses.⁵⁶ We will correct for having > 1 patient per nurse and multiple sites by analyzing patient data using a multilevel model that corrects for the shared variance within nurses and sites. Nurses will receive the *e-PainSupport* pain alert from only their patients randomly assigned to the intervention group making contamination unlikely.

Aim 1. Compare the effects of *e-PainSupport* to a standard care condition. A 2x2 contingency table of minimally important clinical improvement ($\geq 10\%$ improvement on the PROMIS Pain Intensity-Short Form) crossed with condition (primary outcome). Multilevel growth curve analysis for the two conditions across the two time points will test for significant time-by-condition interaction for improvement in pain intensity (secondary outcome). Analyses will include covariates to correct for possible suppressor effects (e.g., patient sex).

Aim 2. Examine mediating effects of patient and caregiver knowledge of pain management, self-efficacy, and adherence on change in patient-pain intensity over the two-week period, controlling for covariates the site, role [patient or caregiver], age, sex, ethnicity and education of the patient and the caregiver and the patient's diagnosis) and treatment condition. The mediating effects of changes in patient and caregiver knowledge, self-efficacy, and adherence on patient pain intensity will be examined (controlling for patient sex and treatment condition). Analysis will use regression models for estimate mediation effects as discussed in McKinnon.⁵⁷ We will use residualized change scores (i.e., difference between observed score of a variable and predicted score based on baseline measure of that variable) throughout analyses. These scores have the advantages of (1) evaluating change between measurement points without concerns about regression toward the mean associated with standard change scores and (2) reducing the number of variables in the model.

Aim 3. Identify hospice nurses' perceptions of their use of and actions based on *e-PainSupport*.

Data Analysis. We will use Hsieh and Shannon's systematic guidelines for directed approach to qualitative content analysis⁵⁹. Content analysis is appropriate for deductive approach with preconceived categories from prior research.⁶⁰ Rather than theory-building or finding relationships among concepts, content analysis focuses on selecting units of analysis for data reduction, creating categories, and generating themes for interpretation, as in our prior of palliative care study.⁶¹ Transcribed recordings are entered into Dedoose⁶² software. A staff member compares recordings and transcripts for accuracy. An initial set of *a priori* categories is developed, including facilitators, barriers, and benefits. Coding categories are added or eliminated⁶⁰ To ensure reliability, two investigators (Mayahara and Miller) will read transcripts independently to code blocks of text. Statements that do not fit predetermined codes will be assigned new codes. After 30% of transcripts are coded, investigators compare results and discuss differences until reaching 100% agreement. One investigator codes all subsequent transcripts. Categories are grouped into concepts based on similarities and differences. Concepts are classified into themes. Analysis decisions are recorded for transparency and dependability. Member checking of findings with two nurses is done for credibility.^{63,64} Findings will inform a future RCT.