


BMJ Open Videogame intervention to increase advance care planning conversations by hospitalists with older adults: study protocol for a stepped-wedge clinical trial

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ABSTRACT

Introduction Fewer than half of all people in the USA have a documented advance care plan (ACP). Hospitalisation offers an opportunity for physicians to initiate ACP conversations. Despite expert recommendations, hospital-based physicians (hospitalists) do not routinely engage in these conversations, reserving them for the critically ill. The objective of this study is to test the effect of a novel behavioural intervention on the incidence of ACP conversations by hospitalists practicing at a stratified random sample of hospitals drawn from 220 US acute care hospitals staffed by a large, nationwide acute care physician practice with an ongoing ACP quality improvement initiative.

Methods and analysis We developed *Hopewell Hospitalist*, a theory-based adventure video game, to modify physicians' attitudes towards ACP conversations and to increase their motivation for engaging in them. The planned study is a pragmatic stepped-wedge crossover phase III trial, testing the efficacy of *Hopewell Hospitalist* for increasing ACP conversations. We will randomise 40 hospitals to the month (step) in which they receive the intervention. We aim to recruit 30 hospitalists from up to eight hospitals each step to complete the intervention, playing *Hopewell Hospitalist* for at least 2 hours. The primary outcome is ACP billing for patients aged 65 and older managed by participating hospitalists. We hypothesise that the intervention will increase ACP billing in the quarter after dissemination, and have 80% power to detect a 1% absolute increase and 99% power to detect a 3.5% absolute increase.

Ethics and dissemination Dartmouth's Committee for the Protection of Human Subjects has approved the study protocol, which is registered on clinicaltrials.gov. We will disseminate the results through manuscripts and the trials website. *Hopewell Hospitalist* will be made available on the iOS Application Store for download, free of cost, at the conclusion of the trial.

Trial registration number NCT04557930.

Advance care planning (ACP) is an integral part of the National Academy of Medicine's objective of ensuring that patients receive

Strengths and limitations of this study

- A strength of this study is the theoretical basis of the intervention, which draws on insights from the psychological and behavioural science literature.
- A second strength of this study is our plan to distribute the intervention through a partnership with a national acute care physician staffing organisation, which will increase the generalisability of our observations.
- A limitation of this study is our use of billing as a surrogate measure of physician behaviour.

person-centred, family-oriented and evidence-based care.¹ ACP improves the quality of end-of-life care, while reducing unwanted resource utilisation.² Unfortunately, fewer than half of all people in the USA have documented ACPs, such as an advance directive.¹ Existing guidelines therefore advocate that physicians use hospitalisation as an opportunity to initiate these conversations.³

Multiple barriers exist to the initiation of ACP in the hospital.⁴⁻⁶ High-quality conversations require physicians to have the motivation, skill and time to engage in these emotionally complex interactions. As a result, physicians typically defer ACP for all except the most critically ill. In contrast, experts advocate that these conversations occur prior to discharge for all patients over the age of 65.⁷ Efforts to facilitate ACP through text-based education, reminders, incentives and outreach by opinion leaders have had variable success.^{8,9} How best to ensure that physicians meet this standard therefore remains unclear.¹⁰⁻¹²

We propose a novel intervention to modify physicians' knowledge of and attitudes towards ACP conversations and increase their

motivation for engaging in them. The central mechanism is *narrative engagement* (ie, using storytelling to change behaviour).¹³ Stories deliver memorable messages that resonate with recipients in personally relevant and meaningful ways.¹³ Programmes using stories to transmit best-practice decision principles have reduced drug use among middle school students, reduced sexually transmitted diseases among high school students and increased the rates of mammogram acquisition among low-income minority groups.^{13–15} We built a customised adventure video game that uses narrative engagement to educate physicians about the benefits of ACP for all patients age 65 and older.

The objective of the planned study is to test the effect of the video game intervention on ACP rates, measured by billing, among a convenience sample of 150 hospitalists recruited from up to 40 US hospitals staffed by a large, nationwide acute care physician practice with an ongoing ACP quality improvement initiative. We hypothesise that the intervention will increase ACP billing in the quarter after dissemination, and have 80% power to detect a 1% absolute increase and 99% power to detect a 3.5% absolute increase.

METHODS

Conceptual framework

Our population of hospitalists employed by a national physician practice already receive best-practice ACP interventions designed to increase: (1) knowledge of ACP guidelines (through web-based didactic education); (2) identification of patients to prioritise for ACP (through decision support and reminders in the electronic medical record); (3) the influence of social norms (through audit and feedback regarding ACP billing rates compared with hospital peers) and (4) extrinsic motivation (through a financial incentive of \$20 for each billed ACP conversation). These efforts have increased ACP substantially over the last 3 years, but rates remain below the standards set by a Delphi panel of experts, who recommend ACP conversations for all inpatients over the age of 65.^{7 16} Formative work, consistent with behavioural theory, suggested positive attitudes could facilitate ACP; therefore, we chose hospitalists' attitudes towards ACP conversations as the primary intervention target.¹⁷

To intervene on this target, we refined an existing intervention based on the theory of narrative engagement.¹⁸ The intervention—an adventure video game—had proven successful at improving physician decision making in trauma triage, without any identifiable adverse consequences.¹⁸ Strong conceptual reasons existed to believe it would have efficacy in this context.^{19–23} Finally, in assessing potential harms and benefits associated with this intervention, we relied on a meta-analysis of interventions to increase ACP, which found positive outcomes for patients.²

Study overview

We developed the video game (*Hopewell Hospitalist*) in collaboration with Schell Games (Pittsburgh,

Pennsylvania, USA) through an iterative process involving behavioural scientists, hospitalists, palliative care experts, intensivists and game developers, with the intention of increasing physicians' frequency of ACP conversations with hospitalised patients. We plan to compare the impact of *Hopewell Hospitalist* on ACP practices before-and-after intervention dissemination in a stepped-wedge cluster randomised trial (figure 1).

A stepped-wedge trial randomises physician participants (and the patients they collectively care for) at the group level (eg, hospital); each group 'crosses over' from control to intervention at a randomised timepoint and is followed through multiple 'time steps' of data collection.²⁴ This trial design is the best option to test the efficacy of the video game because: (1) physician-level randomisation risks misclassifying patients, contaminating control physicians and failing to address group-level attitudes to and practices of ACP; (2) a two-group parallel cluster randomised design risks imbalance among groups, especially if relatively few hospitals participate in the study, because of the high intraclass correlation (ICC) that exists for ACP billing at the hospital level and (3) there are logistical challenges to rolling out the intervention simultaneously at all hospitals.

We will use a stepped-wedge design with five steps (with each step lasting 1 month), and will compare the difference in ACP billing of physicians enrolled in the trial in the time period before and after intervention dissemination. A preperiod of 3 months duration will yield retrospectively measured observations that augment the analysis data. Drawing on more than 3 years of data, inclusive of the early stages of the COVID-19 pandemic (January 2017–June 2020), organisation-wide ACP billing rates for patients 65 and older increased from 5% to 22%, corresponding to a 1.5% absolute quarterly increase. We hypothesise that physicians will have a 5% absolute increase (a 3.5% net increase) in ACP billing in the quarter after dissemination of the intervention (primary outcome).

Participants

Study setting

We partnered with a national physician practice that employs acute care providers in hospital medicine, emergency medicine and critical care. This physician practice: (1) staffs over 200 hospitals with a wide variety of geographical and organisational characteristics, increasing the generalisability of our observations; (2) has already implemented best-practice quality improvement efforts to improve ACP practices at its hospitals, making our comparator enhanced usual care and (3) seeks to further increase ACP rates, increasing organisational buy-in.

Hospital sampling

We will sample hospitals staffed by the physician practice using the following inclusion criteria: at

TIMEPOINT**	STUDY PERIOD								
	Enrolment	Allocation	Post-allocation					Close-out	
	Month 0	Month 0	Months -2-0	Month 1	Month 2	Month 3	Month 4	Month 5	Months 6-8
ENROLMENT:									
Eligibility screen	X								
Informed consent*				X	X	X	X	X	
Allocation		X							
INTERVENTIONS:									
<i>Hopewell Hospitalist: Step 1</i>				X	X	X	X	X	
<i>Hopewell Hospitalist: Step 2</i>					X	X	X	X	
<i>Hopewell Hospitalist: Step 3</i>						X	X	X	
<i>Hopewell Hospitalist: Step 4</i>							X	X	
<i>Hopewell Hospitalist: Step 5</i>								X	
ASSESSMENTS:									
<i>Hospital:</i> Number of hospitalists, ACP billing, presence of practice-employed, nurse liaison.	X								
<i>Physicians:</i> demographics, educational background, practice environment, baseline attitudes to ACP, completion of organization's CME course				X	X	X	X	X	
<i>Physicians:</i> intervention dose (self-report, application)				X	X	X	X	X	
<i>Physicians:</i> questionnaire with items relating to intervention usability, fidelity of intervention receipt, mediators of fidelity of intervention receipt (self-report)				X	X	X	X	X	
<i>Patients:</i> claims based data from practice, CMS and SSA**			X	X	X	X	X	X	X

* Consent will be obtained immediately preceding roll-out of the intervention at hospitals in the step to limit erosion of participant adherence to the intervention.

**Data will be collected for all sites for the three months preceding and following the trial.

Figure 1 Schedule of enrolment, interventions and assessments. Description of data: description of enrolment, interventions and assessments based on spirit guidelines.

least two quarters of contracting with the practice, a risk-adjusted ACP billing rate >0% in Q2 of 2020, agreement of physician leaders within the hospital to participate and availability of an onsite, practice-employed, nurse liaison to collect secondary outcome measures.

Once a hospital is sampled, we will recruit hospitalists at the hospital by distributing email invitations. Eligible hospitalists are those employed by the practice for at least two quarters. We will obtain consent from interested physicians, collect baseline demographic and professional characteristics, as well as initial baseline measurements of attitudes towards ACP, then provide them with instructions on how to

complete study tasks. A full list of the study sites will be published with the study results.

Randomisation and blinding

We will randomise sampled hospitals to the order in which they receive the video game. We will generate randomisation schemas using R statistical software (R Core Team, Vienna, Austria), using random block sizes of 8, seeking to balance hospital risk-adjusted ACP rate, change in ACP rate between Quarter 2 2019 and Quarter 1 2020, practice size (number of practice-employed hospitalists) at the hospital and region. Although we cannot blind study personnel

**Box 1 Description of *Hopewell Hospitalist***

Duration: Three hours of gameplay possible.

Theory-based intervention goal: To increase advance care planning (ACP) conversations.

Theory-based intervention targets: Attitudes to ACP (positive, valuable for patient well-being and role-aligned).

Theory-based intervention delivery strategy: Provide personally relevant and emotionally compelling feedback through storytelling that increases retention of the message (theory of narrative engagement).

Didactic principles: All hospitalised patients who are 65 years or older should have an ACP conversation. Each of the five teaching cases (see below) embeds supporting didactic principles in the feedback.

- ▶ Older adults who require intensive care unit (ICU) care for mechanical ventilation have $\geq 70\%$ risk of death or disability at 1 year, and preadmission frailty is associated with even higher risk of death or disability after ICU-level care. Assessing goals for treatment can help hospitalists support goal-concordant treatment decision making when/if medical decompensation occurs.
- ▶ Patients with severe comorbidities (eg, cancer, end-stage renal disease) are at high risk of medical decompensation requiring decisions about ICU-level care, yet $\leq 10\%$ have had documented ACP conversations with their specialists or primary care providers prior to admission. Hospital admission is a fruitful time for ACP conversations and can be an opportunity to discuss hospice eligibility and introduce hospice services.
- ▶ Patients hospitalised with even a minor clinical problem have a 30% risk of dying within 3 years. Hospitalisation can therefore be an opportunity to think generally about values and goals and therefore attend 'life completion' tasks.
- ▶ Having an ACP conversation early reduces the emotional distress and decisional conflict experienced by surrogates and patients when/if medical decompensation occurs.
- ▶ Race should not influence physician decisions to engage in ACP conversations because individual goals and values, not race, affect patient preferences for end-of-life treatment.

Game concept: The player takes on the role of Andy Jordan, a young emergency medicine physician, who moves home after his grandfather's disappearance and accepts a job at a local community hospital covering night shifts.

Game content

Medical: Physicians interview patients who present to Hopewell Hospital, and have the option of investigating further, having an ACP conversation with the patient/surrogate, or completing the daily documentation. The patients include:

- ▶ Five 'teaching' cases of patients with serious illness, adapted from clinical practice. These patients are 65 years or older and require hospitalisation for assorted complaints (eg, heart failure, peptic ulcer disease). If players engage in ACP conversations, they later receive updates on the positive outcomes experienced by these patients. If players do not engage in ACP conversations, these patients return with complications of their initial complaint. Players also receive feedback from in-game characters (eg, their supervisor, consultants, family members) about the impact that timely advanced care plans can have on the trajectories of patients' care.
- ▶ Five 'non-teaching' cases of patients with diagnostically challenging problems, adapted from the clinical case records of the Massachusetts General Hospital as presented in the *New England Journal of Medicine*. These patients are designed to facilitate player engagement in the clinical task.

Continued

Box 1 Continued

- ▶ Two 'non-teaching' cases of patients with life-threatening illnesses, adapted from clinical practice. These patients serve as a management challenge to facilitate player engagement in the clinical task.

Non-medical: Robert Jordan, Andy's estranged grandfather, has disappeared. The prologue hints that his disappearance may or may not have occurred voluntarily. The player must solve the mystery by uncovering clues revealed through conversation within-game characters and by exploring the environment.

Game mechanics

1. Connect the dots: clues (medical and non-medical) appear on a notepad on the screen. The player can draw connections between clues to uncover information and to unlock additional dialogue options.
2. Tap to act: the player can tap on the screen to move through the world and interact with other characters. This mechanic also allows the player to perform key patient-care actions, including procedures like lumbar punctures and intubations.
3. Points: players receive points for uncovering non-medical clues, which unlock in-game lore. Specifically, they can access letters written by Andy and his grandfather, which should provide additional insight into their characters and motivations.

and participants, we will mask the hospital's assignment during the analysis phase.

Study protocol

We will preload new iPads with the video game and mail them to hospitalist participants. We will ask participants to spend a minimum of 2 hours completing the intervention task, and then complete a web-based questionnaire with items assessing (a) the intervention's usability, (b) fidelity of intervention delivery and receipt and (c) mediators of intervention receipt. Completing the questionnaire will take approximately 15 min. Participants should complete the two portions of the study protocol within 2 weeks of receipt of the iPad. They will keep the iPad as an honorarium (approximate value \$300). Reminders will include three email letters and a phone call, made by the study principal investigator (AEB). Participants will continue to receive all usual care ACP interventions, mandated by the practice, throughout the study period.

Intervention: *Hopewell Hospitalist*

Hopewell Hospitalist is an adventure video game designed to shift hospitalists' threshold for selecting patients with whom to have inpatient ACP conversations from patients at high risk for clinical deterioration to all hospitalised patients over the age of 65, drawing on Centers for Medicare and Medicaid Services (CMS) policy, the physician practice quality improvement (QI) targets and ACP expert consensus.^{7 25} We adapted the art and game mechanics from a previously tested game,¹⁸ after identifying key didactic principles based on a review of the literature and the input of a multidisciplinary team of palliative care physicians, hospitalists and intensivists.²⁶ We iteratively piloted the game with a series of play testers between June and August 2019. We summarise didactic

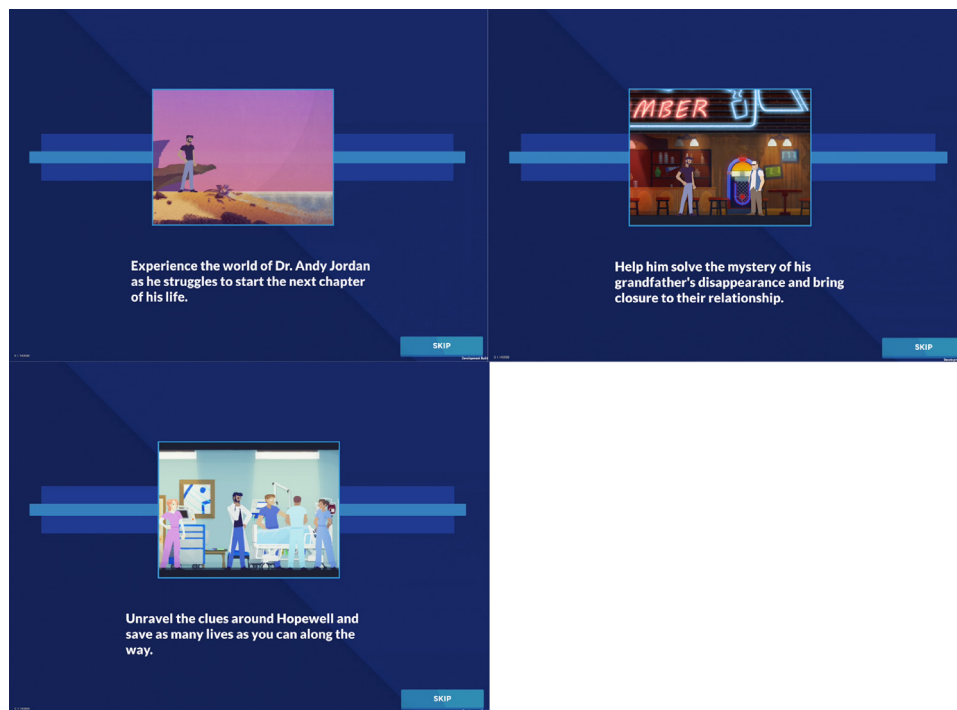


Figure 2 Screen shots of trailer to *Hopewell Hospitalist*. Description of data: we show the trailer to the game. We provided players with two explicit objectives in order to heighten narrative engagement, while simultaneously providing a vehicle for physician education.

principles, game content and game mechanics of *Hopewell Hospitalist* in [box 1](#) and in [figure 2](#).

Data sources and management

Physician characteristics

Each participating physician will complete a baseline questionnaire with items related to: age, gender, race/ethnicity, use of ACP billing codes, educational background, professional characteristics (years spent as hospitalist, nocturnist, years spent as a hospitalist) and an initial baseline measurement of attitudes towards ACP.²⁷ The practice will provide information about physician completion of the organisation's required continuing medical education (CME) about ACP. After playing the video game, physicians will complete a questionnaire with items related to usability, fidelity of intervention receipt and mediators of intervention receipt (see Fidelity of Intervention Receipt). See [figure 1](#) for schedule of enrolment and data collection.

Hospital characteristics

We have crude and adjusted ACP billing proportions for each candidate hospitals between January 2017 and June 2020, the number of hospitalists employed at each location as of January 2020, the presence or absence of a nurse liaison and the hospital's geographic location. We will obtain additional information about the organisational characteristics of each hospital using the 2018 CMS Healthcare Cost Report Information System (HCRIS). HCRIS contains facility-level characteristics of all non-federal hospitals, including geographic location (state

and region), participation in a hospital network, total bed count, ICU bed count, ownership and teaching status.

Patient characteristics

The practice will provide the study team with discharge abstracts for all the patients treated by its hospitalists during the study period. These abstracts include patient demographics, admission diagnoses, discharge diagnoses and physician claims filed during the hospitalisation. We will abstract information about comorbid conditions from the International Classification of Diseases 10 - Clinical Modification (ICD10-CM) diagnosis codes. We will link these data to patient-level CMS claims and Social Security Administration (SSA) records to collect post-discharge, episode-based outcomes.

Fidelity of intervention delivery (intervention dose)

The *Hopewell Hospitalist* application collects data on each player's behaviours and actions (eg, total time spent in game, number of gameplay sessions, average number of minutes per session, cases completed, decisions made, feedback reviewed) during gameplay. These data will be reported and stored in Google Analytics. Additionally, participants are asked to self-report their play time and details of the most memorable case they encountered.

Fidelity of intervention receipt

We will measure the fidelity of intervention receipt by capturing physicians' attitudes towards ACP before and after completion of the game using items adapted from published studies.^{7 27} Additionally, we will measure

**Table 1** List of outcomes measures

Type of measure	Measure target	Description of measure
<i>Fidelity of intervention enactment</i>		
Primary	Advance care planning (ACP) performance	ACP billing proportion
Secondary	ACP performance	Self-report MIPS ACP quality measure ACP conversations assessed using chart abstraction of a random 20% of patients
	Patient outcomes	Disposition status In-hospital mortality 90-day mortality Resource utilisation (length of stay, admission to ICU, mechanical ventilation, placement of tracheostomy, insertion of gastric feeding tube, new onset dialysis, palliative care consults, 90-day spending) Length of stay 90-day episode based spending
<i>Fidelity of intervention receipt</i>		
Secondary	Physician attitudes	Physician attitudes towards ACP conversations (vignette-based) Physician attitudes towards ACP conversations (questionnaire-based)

MIPS, Merit-based Incentive Payment System.

narrative engagement, the proposed mediator of the intervention, using the Narrative Engagement Scale.²⁸ Finally, we will assess the game's usability, using a validated instrument and open-ended questions.²⁹

Fidelity of intervention enactment (outcome assessment)

We summarise our outcomes in the [table 1](#).

Primary

Our primary outcome will be the patient-level binary variable indicating whether an ACP bill occurred during their hospitalisation. The study sample will be restricted to patients over the age of 65 before-and-after dissemination of the video game intervention: each hospital will contribute a minimum of 3 months and a maximum of 8 months of data while exposed to the intervention arm and the reverse (between 8 to 3 months) to the enhanced usual care arm depending on their step (see [figure 1](#)). We will screen the practice's discharge abstracts for the presence/absence of ACP charges (billing codes 99497 and 99498) and will categorise each patient as having had (or not had) an ACP conversation during their hospitalisation. The rationale for using ACP billing as the primary outcome is: (1) it can be obtained administratively for all patients and (2) it is a less sensitive but more specific measure of a comprehensive ACP conversation than the Merit-based Incentive Payment System (MIPS) self-report measure of ACP because it is a time-based billing code requiring an ACP conversation of at least 16 min in length.

Secondary

Secondary measures of physician ACP behaviour will include a self-report measure and a chart-abstraction

based measure. We will collect each physicians' self-report MIPS ACP quality measure (the proportion of patients who have an ACP or surrogate decision maker documented in the medical record (or declined to participate in the process) of all patients 65 years and older treated by the physician). Additionally, practice nurse liaisons will provide a 20% random sample of the charts of eligible patients. We will review these charts for documentation of a conversation about ACP. This will allow estimation of the sensitivity and specificity of claims-based and MIPS-based measurement of ACP relative to chart review.

Secondary measures of patient outcomes (ie, downstream consequences of intervention enactment) will include: disposition status, in-hospital mortality, 90-day mortality and resource utilisation during the index hospitalisation. Index hospital outcomes will be drawn from the practice's data; post-discharge 90-day episode-based outcomes will be drawn from linked CMS and SSA data.

Analyses

We will summarise sample hospital and consented physician characteristics using means (SD) for continuous variables and proportions for categorical variables, and will compare the distribution of characteristics between the five 'steps' in the trial using χ^2 and F tests as appropriate. We will summarise and compare patient characteristics between 'steps' of the trial similarly.

Participation

We will calculate an enrolment (cooperation) frequency for the trial as the proportion of physicians at randomised hospitals who agree to participate in the trial, and a completion (response) frequency as the proportion of

physicians who agree to participate and complete all the study tasks.

Usability

For physicians who use the video game, we will summarise responses to free-text response questions to assess usability, and will categorise this qualitative, open-ended feedback as positive or negative.

Fidelity of intervention delivery

We will summarise the length of time that physicians spend playing the game as captured by the application and reported by the participant in the post-intervention questionnaire. We will also summarise additional characteristics of gameplay (eg, number of cases completed). We will compare participation at hospitals in different steps of the trial using chi-square tests and the duration of exposure using χ^2 tests and F tests. This information will allow for secondary analyses into the mechanism of the intervention's success or failure.

Fidelity of intervention receipt

We will compare physician attitudes towards ACP before and after use of the intervention using a vignette-based instrument and questionnaire, as well as narrative engagement and user experience questionnaires after completion of the intervention.

Fidelity of intervention enactment

We plan to conduct intention-to-treat analyses of all patients treated at a hospital during the time period of the study who received care from at least one consenting

hospitalist who received an iPad during the intervention period for that hospital, regardless of whether they actually played the game. All statistical tests will be performed with two-tailed significance testing at an alpha of 0.05 for the primary outcome. We list our hypotheses in [table 2](#) and describe our analytic plan in detail in the online supplemental appendix.

In unadjusted descriptive analyses, we will begin by calculating ACP billing proportions among participating physicians at each randomised hospital in the preintervention and postintervention periods. The minimum length of each period is 3 months (one quarter).

$$\text{ACP billing proportion} = \frac{\text{Number of treated patients} \geq 65 \text{ years with an ACP charge}}{\text{Number of treated patients} \geq 65 \text{ years}}$$

Next, we will compare ACP billing proportions for the period before and after intervention distribution among enrolled physicians using a Student's t-test.

To test the efficacy of the intervention, we will fit a mixed effects patient-level logistic regression model for patients treated by physicians enrolled in the trial (ie, physicians who were sent an iPad with the game during the intervention period), with presence of ACP billing during the hospitalisation as the dependent variable. Since the linkage of a patient to a specific physician is inexact, we do not involve physician attribution in our primary outcome analysis. Instead the key predictor will be a time-varying variable indicating whether the patient received care—as measured by daily billing—by a hospitalist who consented to receive the intervention before (0) or after (1) the hospital was randomised to intervention roll-out. The model includes dummy variables for time-period to

Table 2 Hypotheses to be tested

Hypotheses	
<i>Fidelity of intervention enactment</i>	
Primary	Physicians will have a 3.5% greater increase in advance care plan (ACP) billing in the quarter after dissemination of the intervention than would be expected based on secular trends alone.
Secondary	Physicians will have an increase in MIPS self-report of ACP and chart-abstracted ACP documentation after dissemination of the intervention.
	The difference in physician billing proportion after dissemination of the intervention will be correlated with participants' minutes of gameplay; narrative engagement scores and changes in ACP attitudes (mediators).
	The difference in physician billing proportion before-and-after distribution of the intervention will be positively associated with the proportion of physicians who have completed the practice's e-curriculum (baseline knowledge—moderator).
	The difference in physician billing proportion before-and-after distribution of the intervention will be positively associated with the proportion of physicians at each hospital who use the game (peer effects—moderator).
	The difference in billing proportion before-and-after the distribution of the intervention will be associated with differences in patient-level outcomes, including reduction of resource utilisation during the index hospitalisation and during the 90-day illness episode (patient care outcomes).
Exploratory	Billing for ACP conversations (at the hospital level) will correlate positively with documentation of ACP conversations in patients' charts and with MIPS self-report of ACP.
<i>Fidelity of intervention receipt</i>	
Secondary	An increased proportion of physicians will describe ACP as part of their role responsibility, measured before-and-after the distribution of the intervention.

MIPS, Merit-based Incentive Payment System.

absorb trends across time and random-effects for hospital to account for the clustering of observations within hospitals. In addition, we will adjust for patient and hospital covariates hypothesised to influence the likelihood of an ACP conversation (eg, cancer diagnosis).

A range of dependent variables are analysed in the secondary analyses. In analyses that involve physician variables, the mixed-effects generalised linear model will be extended from a two-level model to a three-level model (see online supplemental appendix for details) for ACP billing. We will also test the efficacy of the intervention on secondary outcome measures, and the effect of mediators and moderators on the effect of the intervention. We will account for multiple comparisons when reporting analyses of secondary outcomes.

Human subjects and power calculation

We arrived at our sample size using a combination of feasibility (cost) and assumptions regarding effect size, absence of any pilot data about the latter. For each step, we plan to recruit 25–30 physicians from 4 to 8 hospitals. Assuming a baseline ACP rate of 22% (rising by 1.5 percentage points per quarter), a hospital ICC coefficient of 0.01–0.10, and 160 evaluable patients per physician quarter, we can detect between a 1 percentage-point absolute difference with a power of 80% and a 3.5 percentage-point absolute difference with power of 99% using a two-sided test at the 0.05 level between ACP billing rates before and after the distribution of the intervention.

The method of computing power for this stepped-wedge design follows the commonly used strategy for cluster randomised trials of first determining the design effect, which can be thought of as a measure of the inefficiency of the given design in comparison to a completely randomised design that is expressed in terms of a ratio of the sample sizes needed to obtain equally precise estimates and then applying conventional power calculations (see online supplemental appendix).^{30 31}

Ethics and dissemination

Data security

On enrolment in the trial, participants will receive a unique identifier. They will use that identifier to login to *Hopewell Hospitalist* and to the website that hosts the questionnaire. Only the study team will have access to the linkage file connecting the identifier to the physician's name and contact information. This file will be encrypted and stored on a secure server at Dartmouth-Hitchcock.

Ethics

The Dartmouth Committee for the Protection of Human Subjects has approved this study (STUDY00031980). The Data and Safety Monitoring Board convened by the funding agency, the National Institute on Aging, reviewed and approved the protocol and the data and safety monitoring plan. We do not plan any interim analyses and, therefore, have not included any stopping guidelines. However, the PI will ask participants to communicate any

adverse events or unintended effects of participation via email, which she will in turn relay to the review boards. Physicians may opt to withdraw from the trial at any point, at which point we will exclude all self-reported data from analysis. Patients or the public were not involved in the design, or conduct, or reporting or dissemination plans of our research.

Dissemination of results

Results from the study will be reported to the public through manuscripts and oral presentations at national meetings. Access to the deidentified dataset will be made available on written request to the study team.

Patient and public involvement

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

DISCUSSION

This protocol paper outlines a clinical trial to test the efficacy of the video game at increasing ACP conversations among hospitalised patients.³² *Hopewell Hospitalist* uses stories designed to immerse participants in playing the role of a physician concurrently solving both clinical and personal problems.³³ Research indicates the power of stories to facilitate behavioural change.¹³ Stories facilitate processing and retaining new data.^{19–23} Stories also can engage players cognitively and emotionally in ways that transcend traditional education.^{13 32 34} Additionally, video game and simulation-based environments allow learners to practice desired behaviours in a safe environment, which supports the development of self-efficacy.^{35 36} We designed the video game to achieve the intervention goal (simplifying the decision for ACP (to any patient 65 years and older)) by influencing a specific target (attitudes to ACP (positive, valuable for patient well-being and role-aligned)).³⁷ This design combined research insights regarding human behaviour from the psychological literature and clinical insights regarding both descriptive and normative assessments of ACP for hospitalised older adults.^{36–38}

We designed the protocol to complement best practices in system-level QI initiatives. We struggled with three design challenges, which we resolved both by reviewing the existing literature and through iterative consensus when data did not exist. First, we debated the unit of randomisation. We considered and then rejected physician-level randomisation for both conceptual and pragmatic reasons. Conceptually, shift-based hospital physicians practice collaboratively, so that the work flow of one individual can have important implications for colleagues' role responsibilities. As we considered peer effects, we imagined that, on one end of the spectrum, unexposed physicians might also shift their practice patterns, and, on the other hand, exposed physicians might be pulled back to conform to group norms. Either scenario risks

biassing results towards the null if physicians are the unit of randomisation. Pragmatically, patients (particularly the sickest ones) may have contact with multiple physicians during the course of one hospitalisation. Consequently, physician-level randomisation risks the misclassification of patients. In contrast, hospital-level randomisation alleviates these concerns, although it decreases power (due to increasing within-cluster correlation) and increases the complexity of ensuring adherence to the intervention.

Second, we debated how to deliver the intervention. We decided to deliver the intervention using the platform of a video game to encourage utilisation and to harness the power of narrative engagement to stimulate behaviour change. Although potentially more enjoyable than standard didactic text-based CME, it does not rise to the level of entertainment. To further incentivise participation and engagement, we decided to deliver the game preloaded on a new iPad. In prior work, we found providing a fixed material honorarium (ie, an iPad) produced adherence rates of up to 80%.³⁹ We considered, but rejected, alternative strategies of distributing the intervention, including requesting that physicians download the game onto personal devices or using refurbished iPads. Providing an honorarium to promote adherence restricts the use of the intervention to the research setting, but maximises the fidelity of the intervention delivery and receipt across participants.

Third, we debated how to assess the impact of the intervention. Direct observation has the greatest validity but limited feasibility. Review of charts or electronic health records provide an alternative. Although dependent on the quality of physician documentation, this method allows for the evaluation of a larger number of physicians. However, the resources and time required to abstract charts would limit our ability to detect small (although significant) effect sizes. We therefore opted to use billing proportions as our primary outcome measure. In 2016, CMS rolled out a time-based billing code for ACP conversations held in the hospital. We anticipate that the use of billing codes will bias our results towards the null and plan to perform secondary analyses using alternative methods of measuring ACP practices to test the validity of our primary analyses.

Advances in technology hold the potential to transform the means by which behavioural and social science interventions are delivered. They ensure treatment fidelity and can extend treatment duration, thus improving behavioural maintenance. We have developed one such behavioural intervention to encourage hospital-based physicians to initiate ACP conversations for hospitalised older adults, and plan to test its efficacy. We intend that results of this trial will contribute to the literature on physician QI and the efficacy of video games as behavioural interventions.

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