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Long-Term Follow-up of a Randomized Controlled Trial Evaluating a Mobile Health Intervention for Self-Management in Lung Transplant Recipients

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Abstract

Mobile health (mHealth) interventions may help transplant recipients follow their complex medical regimen. Pocket Personal Assistant for Tracking Health (Pocket PATH) is one such intervention, tailored for lung transplant recipients. A randomized controlled trial showed Pocket PATH's superiority to usual care for promoting the self-management behaviors of adherence, self-monitoring and communication with clinicians during post-transplant year 1. Its long-term impact was unknown. Here, we examine associations between Pocket PATH exposure during year 1 and longer-term clinical outcomes—mortality and bronchiolitis obliterans syndrome (BOS)—among 182 recipients who survived the original trial. Cox regression assessed whether (a) original group assignment and (b) performance of self-management behaviors during year 1 predicted time to outcomes. Median follow-up was 5.7 years post-transplant (range: 4.2–7.2). Pocket PATH exposure had no direct effect on outcomes ($p>0.05$). Self-monitoring was associated with reduced mortality risk (HR, 0.45; 95%CI, 0.22–0.91; $p=0.027$), and reporting abnormal health indicators to clinicians was associated with reduced risks of mortality (HR, 0.15; 95%CI, 0.04–

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0.65; $p=0.011$) and BOS (HR, 0.27; 95%CI, 0.08–0.86; $p=0.026$), regardless of intervention group assignment. Although Pocket PATH did not have a direct impact on long-term outcomes, early improvements in self-management facilitated by Pocket PATH may be associated with long-term clinical benefit.

Introduction

Mobile health (mHealth) interventions are becoming increasingly common as tools to promote self-management in individuals with chronic conditions, including transplant recipients. They may be particularly useful for lung transplant recipients, whose health depends on following a complex and demanding post-transplant regimen of taking immunosuppressants, monitoring signs and symptoms of lung function, and communicating promptly with clinicians about symptoms suggestive of complications. Despite the importance of the regimen for preventing graft rejection and infection (1–4), up to 70% of lung transplant recipients show poor adherence to various elements of the regimen during the first 3 years after transplant (5–7). Clinical outcomes, at least during the 2-year post-transplant period that has been most commonly studied, have been shown to suffer as a result (1, 4, 8–11). mHealth interventions that enhance recipients' performance of their post-transplant regimen may thus have a key role in improving post-transplant health.

Formal evaluation of mHealth interventions is pressing given their rapid pace of development and dissemination (12, 13), which has allowed many mHealth tools, particularly smartphone apps, to reach patients without the same level of scrutiny required of other evidence-based interventions. One notable exception is the Pocket Personal Assistant for Tracking Health (Pocket PATH), an mHealth intervention designed to enhance performance of the post-transplant regimen (14). Pocket PATH is one of the few mHealth interventions for self-management (15–17) to have undergone a rigorous process of development (18), pilot testing (19) and formal evaluation (14). Currently, its features are tailored to the specific elements that comprise the post-transplant regimen for lung transplant recipients, including alerts and reminders about taking immunosuppressants, customized data recording and graphing programs for tracking health indicators and symptoms, and decision-support to guide patients about when to seek clinical assistance. In a randomized controlled trial (RCT) that assessed 201 lung transplant recipients during the first year after transplant, Pocket PATH improved performance of the post-transplant regimen; specifically, recipients randomized to Pocket PATH adhered to more elements of the regimen, self-monitored more often and reported more abnormal health indicators to clinicians than recipients randomized to usual care (14). Recipients also reported high acceptance of Pocket PATH (20).

Consistent self-management during the early post-transplant period, while potentially important for habit formation, may also be reflected in lower rates of later complications. For instance, patients who consistently detect symptoms of rejection might be more likely to receive prompt treatment, which might ultimately prevent later complications. This link between early adherence to the regimen and longer-term clinical outcomes is particularly important given that rates of complications increase with time since transplant (21), while

clinical follow-up becomes less frequent over time. Whether Pocket PATH's short-term benefits on self-management behaviors translate into longer-term clinical benefits is unknown.

Here, we report clinical outcomes follow-up data from recipients who participated in the original Pocket PATH RCT (14). Our primary goal was to examine whether access to Pocket PATH during the first year post-transplant was associated with reduced risk of mortality and bronchiolitis obliterans syndrome (BOS), the clinical correlate of chronic rejection, at the time of long-term follow-up. Although lung transplant recipients experience many complications as they progress farther post-transplant (e.g., renal dysfunction, diabetes), we selected BOS as a key morbidity outcome because it remains the major obstacle to long-term survival (21) and is reliably documented in our medical center's medical record. Our secondary goal was to examine associations between performance of the self-management behaviors promoted by exposure to Pocket PATH and each long-term clinical outcome. These latter analyses address the key issue that Pocket PATH—like any other intervention—is likely to have positive long-term effects on health only in recipients who received the intervention and actually performed the behaviors the intervention promoted.

Materials and Methods

Study participants

The original Pocket PATH RCT (14) enrolled 201 lung transplant recipients during their hospitalization for transplantation at the University of Pittsburgh Medical Center (January 2009–December 2012) and followed them for 12 months after discharge. Eligible recipients were >18 years old and able to read and speak English. Recipients were excluded if they had received a previous transplant or were unable to perform their personal care post-discharge. The present follow-up study included the 182 recipients who survived to the end of the original RCT (i.e., 1 year following hospital discharge after transplantation) (see Figure 1) in order to ensure that all recipients in the follow-up study had equal time to use their assigned intervention. Studying survivors of the original RCT removed the potential for differences in long-term outcomes to be confounded by differences in intervention duration and focused our work on outcomes subsequent to those that had already been examined in the original RCT.

Procedures of the original Pocket PATH trial

The procedures for the original RCT were reported previously (14). Briefly, the original RCT randomized lung transplant recipients to the intervention or to usual care just prior to discharge following transplant. Recipients in both groups received identical discharge instructions regarding self-management and were interviewed at 2, 6 and 12 months post-discharge to assess performance of self-management behaviors, as described below.

Recipients in the intervention group received a smartphone loaded with custom Pocket PATH features. They were instructed to use Pocket PATH to set medication-taking and appointment reminders, record values for the health indicators they were required to self-monitor and follow Pocket PATH's decision-support messages. These automatic messages

instructed recipients to contact their transplant coordinator if they recorded health indicator values that fell outside the pre-established normal range and therefore required clinical attention (e.g., body temperature $>99^{\circ}\text{F}$, pulse <60 or >120 beats/min) (22).

Recipients in the usual care group received paper-and-pencil tracking logbooks. They were instructed to record values for the health indicators they were required to self-monitor into their logbooks, determine whether these values met criteria as abnormal, and, if so, contact their transplant coordinator.

After exiting the original trial, recipients in the Pocket PATH group retained the phone they were given as part of the trial. However, its Pocket PATH features were limited to setting alerts and reminders, data recording, and tracking and graphing data. The automatic decision-support feature was no longer supported because its data plan was disabled once the trial ended.

Data collection in the long-term follow-up study

The University of Pittsburgh Institutional Review Board approved the original RCT and this long-term follow-up study. All recipients provided written informed consent to participate in the original trial and have their medical records reviewed subsequently. This long-term follow-up study ascertained clinical outcomes from participants' medical records, beginning at their exit date from the original RCT and censoring at the earlier date of either patient death or February 22, 2016.

Baseline characteristics—The original trial collected data on sociodemographics, transplant-related factors (e.g., transplant indication, transplant type) and computer use (i.e., whether recipients reported previous or current use of desktop computers or handheld devices) (14).

Measures

Clinical outcomes at long-term follow-up—Medical record abstractors were blinded to participants' intervention assignment. Mortality was defined as time to patient death. BOS was defined using criteria established by the International Society for Heart and Lung Transplantation as grade 1 (20% decrease in forced expiratory volume in 1 second [FEV_1] relative to the mean of the 2 highest post-transplant FEV_1 values not explained by illness or infection) (23). (Recipients received at least quarterly pulmonary function testing according to our Cardiothoracic Transplantation Program's post-transplant surveillance protocol.) We recorded the earliest date of BOS grade 1. Although we collected data on graft survival, which we defined as time to graft loss by patient death or retransplantation, we did not analyze this outcome because only 1 patient underwent retransplantation during the follow-up period.

Performance of self-management behaviors during the first post-transplant year—The original RCT evaluated performance of self-management behaviors (adherence, self-monitoring, reporting abnormal health indicators) during the first year as trial outcomes,

and our follow-up study examined these behaviors as predictors of long-term clinical outcomes.

Adherence was determined based on a combination of self and collateral (family caregiver) report using the Health Habits Assessment, a validated instrument that assesses frequency of performing each element of the post-transplant regimen (24). We defined adherence as meeting our transplant center's minimum requirement for each element (see footnote "b" in Table 1 for specific requirements). As in the original trial, we created a composite measure of overall adherence that summed the number of elements (out of 9) to which recipients were adherent, and we dichotomized the composite measure into high adherers (adherent to 8 elements) and lower adherers (<8 elements) to reflect its skewed distribution. We considered recipients as having persistent high adherence during the 1-year original trial if they were high adherers at 2 consecutive interview assessments.

Self-monitoring was assessed by reviewing the health indicator values recipients entered into Pocket PATH or paper logbooks (usual care group). For each participant, we calculated a rate to indicate the cumulative number of days s/he recorded a value for a health indicator (i.e., spirometry, blood pressure, temperature, weight) during the 1-year original trial (numerator) as a proportion of the number of days during that year in which s/he was expected to self-monitor (denominator); any days recipients were rehospitalized, and therefore not expected to self-monitor, were removed. As in the original trial, the rates were categorized as having self-monitored on <25% of days, 25%–<50% of days or ≥50% of days. These cut-points reflected the skewed distribution of the self-monitoring rate, with a probability mass at 0%, and ensured sufficient numbers of patients in each group (14).

Reporting abnormal health indicators was assessed by, first, reviewing the health indicator values participants entered into Pocket PATH or paper logbooks (usual care group) to identify the number of abnormal health indicators recorded over the 1-year trial and, then, reviewing transplant coordinators' progress notes to determine whether participants had reported these findings. For each participant, we calculated a rate to indicate the cumulative number of abnormal health indicators s/he reported (numerator) as a proportion of the cumulative number of abnormal health indicators s/he identified cumulatively (denominator) over the 1-year trial.

Clinical outcomes during the first post-discharge year—Number of re-hospitalization days (collected to characterize the sample) and number of acute rejection episodes graded ≥A2 during the first year (considered an important covariate to be controlled in outcomes analyses) were abstracted from the medical record.

Statistical analysis

Baseline comparisons were presented by intervention group to replicate the original RCT results and describe the distributions across groups in terms of sociodemographic, transplant-related and computer use characteristics in our sample of recipients who survived to the end of the original RCT. Categorical variables were described as frequencies and percentages, and continuous variables were described as means and standard deviations (age) or medians and interquartile ranges (length of stay following transplant, reporting

abnormal health indicators, re-hospitalization days). Significance levels of group differences were measured by chi-square and Wilcoxon rank sum tests, as appropriate.

Primary analyses assessed whether intervention group assignment was associated with time-to-event rates for each clinical outcome using Kaplan-Meier curves and the log-rank test. Cox proportional hazards models, adjusted for covariates with known associations with each outcome (7, 21), were then fit for each long-term clinical outcome. Participants were censored at time of death in the BOS analyses.

Using the same cohort of 1-year survivors, secondary analyses examined whether short-term performance of the self-management behaviors (which were critical behaviors examined in the original Pocket PATH trial) was associated with time-to-event rates for each long-term clinical outcome. For this purpose, we used a Cox regression model fit with each self-management behavior (i.e., persistent high adherence, rate of self-monitoring, rate of reporting health indicators); whether recipients had received Pocket PATH vs. usual care alone was included as a covariate, in addition to other covariates with known associations with each outcome (7, 21). We used this approach because our goal was to examine the impact of specific behaviors rather than whether exposure to the intervention may have led to those behaviors, which had already been examined in the original RCT. Model assumptions and group by time interactions were assessed in all models, as appropriate.

Results

Participant characteristics

Eleven recipients assigned to Pocket PATH and 8 assigned to usual care died during the original RCT; there was no differential effect of intervention assignment on mortality. No recipients experienced BOS grade 1 during the original trial. Compared to the 19 recipients who died during the original trial, the 182 recipients who survived the original trial and were included in the follow-up study were more likely to have received a double (vs. a single) lung transplant (63% vs. 37%, $p=0.029$) and to have had a shorter length of hospital stay following the transplant surgery (median [IQR] days, 27 [18–42] vs. 46 [23–79], $p=0.029$).

Table 1 shows that intervention and usual care groups included in the long-term follow-up study were balanced on most sociodemographic and transplant-related characteristics; any imbalances were consistent with baseline differences observed in the original RCT. Recipients assigned to Pocket PATH were more likely than those assigned to usual care to be persistent high adherers (58% vs. 41%, $p=0.030$), to have self-monitored on more days during the first year (<25% of days: 40% vs. 80%; 25–<50% of days: 26% vs. 9%; 50% of days: 33% vs. 12%, $p<0.001$) and to have reported more abnormal health indicators during the first year (median [IQR], 100 [91–100] vs. 80 [10–100], $p=0.018$). Both groups were balanced in terms of 1-year clinical outcomes. At the time of the present study, median follow-up time (between date of transplant and date of data collection for the present study) was 5.7 years (IQR, 5.0–6.3, range, 4.2–7.2).

Early post-transplant predictors of long-term clinical outcomes

Primary analyses: effect of intervention exposure—Our primary goal was to determine whether exposure to Pocket PATH was associated with reduced risk of mortality and BOS over the long-term follow-up period, relative to usual care.

There were 29 deaths in the Pocket PATH group (33%) and 35 deaths in the usual care group (37%). Intervention assignment did not impact time to death in unadjusted (HR, 0.91; 95% CI, 0.56–1.49; $p=0.710$) or adjusted analyses (HR, 0.97; 95% CI, 0.58–1.61; $p=0.912$) (Table 2, section A; see footnotes to table for covariates included in the adjusted analyses), and there was no group by time interaction. Sensitivity analyses including all participants in the original RCT showed a similarly nonsignificant impact of intervention assignment on time to death (HR, 1.03; 95% CI, 0.67–1.60; $p=0.876$).

There were 36 cases of BOS in the Pocket PATH group (41%) and 34 cases of BOS in the usual care group (36%). Intervention assignment did not impact time to BOS onset in unadjusted (HR, 1.10; 95% CI, 0.69–1.76; $p=0.682$) or adjusted analyses (HR, 1.15; 95% CI, 0.71–1.87; $p=0.557$) (Table 2, section A), and there was no group by time interaction. There were no cases of BOS among recipients who died before the end of the original trial, so sensitivity analyses including all participants in the original RCT show the same results.

Secondary analyses: effect of self-management behaviors during the first year—Our secondary goal was to determine whether performing the three self-management behaviors targeted—and improved—by Pocket PATH during the first year (i.e., adherence, self-monitoring and reporting abnormal health indicators to the transplant team) was associated with reduced risk of mortality and BOS over the long-term follow-up period. First, persistent high adherence was not associated with time to death or BOS (both p 's >0.05) (Table 2, section B). Second, recipients who self-monitored on $\geq 50\%$ of days had less than half the risk of long-term mortality compared to those who self-monitored on $<25\%$ of days (HR, 0.45; 95% CI, 0.22–0.91, $p=0.027$); self-monitoring rate was not associated with time to BOS (all p 's >0.05) (Figure 2 and Table 2, section B). Third, among recipients who identified ≥ 1 abnormal health indicator, those who reported more of these abnormal values to their transplant coordinator had a lower long-term risk of mortality (HR, 0.15; 95% CI, 0.04–0.65; $p=0.011$) and BOS (HR, 0.27; 95% CI, 0.08–0.86; $p=0.026$) (Table 2, section B).

Discussion

This is the first study to evaluate the long-term clinical impact of an mHealth intervention developed specifically for lung transplant recipients, and ours is among the longest follow-up periods reported in the mHealth literatures to date. We address a critical, but less often studied, question that underlies most behavioral health interventions: does the intervention lead to behaviors that result in long-term health benefits? In our population of lung transplant recipients who survived the first year after discharge from transplant, we show that performance of the self-management behaviors promoted by exposure to Pocket PATH—specifically, self-monitoring and reporting abnormal health indicators to clinicians—was associated with reduced long-term risks of mortality and BOS. At the same time, however,

we did not find a direct effect of Pocket PATH on long-term morbidity and mortality, meaning mere *exposure* to Pocket PATH did not have long-term clinical impact.

Examining long-term outcomes in light of actual use of, rather than exposure to, the intervention is imperative for understanding Pocket PATH's potential impact, since an intervention can only be expected to have a benefit in individuals who use it (25). Thus, taken together with findings from the original Pocket PATH trial, in which Pocket PATH improved performance of self-management behaviors during year 1 (14), our findings may suggest that actually *performing* the behaviors Pocket PATH promoted was associated with benefits for long-term health. This is consistent with one of the mainstays of post-transplant care, namely, that patient self-management activities are critical for better short- and long-term health. Pocket PATH's potential to enhance this link in lung transplant recipients is encouraging not only in its own right but also for the broader population of transplant recipients, for whom Pocket PATH might be tailored with minimal modification.

Pocket PATH's potential value may be attributed, in part, to its ability to automate the process of detecting and interpreting real-time changes in clinical condition, a responsibility routinely left to patients. For instance, although Pocket PATH's data tracking feature required recipients to take an active role in recording the health indicators they self-monitored in the device, Pocket PATH provided graphical displays of these indicators over time to facilitate patient tracking of health trends. In addition, Pocket PATH employed a decision-support feature to provide immediate feedback to recipients about how to interpret the health indicators they recorded and how to take appropriate action to manage them. This decision-support feature may have prompted recipients to alert clinicians to clinical changes earlier than they typically would have, thereby initiating quick intervention and maximizing chances of treatment success. Our study cannot determine whether long-term clinical benefits were due to an increase in patient-initiated communication with the transplant team that itself may have been sustained beyond the original trial, or to an early clinical benefit that led to improved clinical status in the long-term. In either case, our study establishes a direct link between early post-transplant communication with clinicians and long-term reductions in mortality and BOS, which provides evidence to support encouraging patients to be engaged in their healthcare.

Although self-monitoring and communication with the transplant team during year 1 were both associated with improved long-term clinical outcomes, persistent high adherence, surprisingly, was not. Our adherence variable was a composite measure that accounted for adherence to 9 key elements of the regimen. We used a composite because (a) it is most reflective of the broad, multi-component regimen recipients must follow and (b) this composite was used in the original RCT, and one of our goals was to examine whether original RCT behavioral outcomes were linked to long-term morbidity and mortality. While clinically relevant, this composite variable may have attenuated any impact of important individual elements, such as adherence to immunosuppressants. Additionally, we were only able to assess adherence during the first year after transplant, a period that may have less impact on long-term outcomes than changes in adherence over time or overall duration of high adherence. Self-monitoring and communicating with the transplant team, on the other

hand, both have direct impacts on the immediacy of the clinical attention recipients receive, which often determines overall clinical outcome.

It is notable that rates of adherence and self-monitoring during the first year, while higher in the Pocket PATH than the usual care group, were relatively low in both groups. This reflects the challenges in following the complex post-transplant regimen and underscores the need for continued efforts to improve self-management. Because smartphones are now ubiquitous across all ages and socioeconomic groups (26), mHealth interventions utilizing this platform hold great promise in terms of their reach and scalability. Future mHealth interventions should take advantage of technologies that automate the process of data recording and tracking, such as electronic blood pressure cuffs and spirometers. Evidence from lung transplant recipients indicates that such features have high patient acceptability (27, 28). Moreover, mHealth interventions should refine their decision-support features so that patients can receive real-time feedback about all health data they record. By leveraging a range of existing technologies within any individual mHealth intervention, the likelihood that patients will use the intervention—and ultimately benefit from it—increases.

This study was limited by our selection of outcomes, which did not include other indicators of post-transplant health that may have been more sensitive indicators of health status, such as infections. Infections are not documented consistently in our transplant center's medical record, and documentation becomes less reliable over time as patients receive more of their routine healthcare from local, non-transplant providers. In addition, given our modest sample size and relatively small number of morbidity and mortality events, we were unable to perform subgroup analyses to identify specific patient populations that are most likely to benefit from Pocket PATH. Finally, we did not have information on recipients' ongoing use of Pocket PATH and rates of self-management beyond year 1. Future mHealth studies should strive to document intervention use over time in order to understand the intervention's long-term impact on behavior.

This work takes advantage of a unique opportunity to evaluate the long-term clinical impact of an mHealth intervention for self-management that has undergone rigorous testing since its inception (14, 18, 19). Such evaluation is pressing given that many such interventions, particularly smartphone apps, have reached patients without the support of a rigorous evidence base. (12, 29). With simple modification, Pocket PATH could be tailored to meet the needs of other transplant recipients as well as the large and growing population of chronic illness sufferers, all of whom face similar challenges related to performing a daily self-management regimen and interpreting clinical information (30, 31). An evidence-based understanding of mHealth interventions for self-management is just beginning to emerge, and more work is needed to understand whether, how, for how long and for whom these interventions will yield clinical benefits.

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Abbreviations

BOS	bronchiolitis obliterans syndrome
FEV₁	forced expiratory volume in 1 second
mHealth	mobile health
RCT	randomized controlled trial

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Figure 1.

Flow of participants from the original Pocket PATH RCT to the present long-term follow-up study. Participants enrolled, randomized and followed-up in the original RCT are denoted in the Enrollment, Allocation and Follow-up sections of the figure, respectively. Participants who survived to the end of the original RCT and were included in the present long-term follow-up study are denoted in the Analysis section of the figure.

Figure 2.

Cox regression curves depicting patient survival over the long-term follow-up period. Each curve includes subjects regardless of intervention assignment but represents a different frequency of self-monitoring during the original trial (dashed line: self-monitored on <25% of days; dot-dashed line: self-monitored on 25-50% of days; solid line: self-monitored on ≥50% of days). P values refer to the test of significance between the curves indicated with each bracket.

Table 1
Baseline Characteristics for 182 Lung Transplant Recipients Included in the Follow-up Study

	Pocket PATH (n=88)		Usual Care (n=94)		P
	%	(No.)	%	(No.)	
Sociodemographics					
Age at transplant, mean (SD), y	57	(13)	58	(14)	0.778
Male gender	51	(45)	56	(60)	0.252
White race	92	(81)	83	(88)	0.397
Married	74	(65)	67	(71)	0.696
Previous computer use	86	(76)	79	(74)	0.176
Transplant-related					
Transplant indication					
Non- α -1-antitrypsin deficiency COPD	42	(37)	32	(30)	0.157 ^a
Pulmonary fibrosis	27	(24)	40	(38)	
Cystic fibrosis	11	(10)	12	(11)	
Other	20	(17)	16	(15)	
Double lung transplant	84	(74)	83	(78)	0.041
Re-intubated	14	(12)	29	(27)	0.013
Length of stay for transplant, median (IQR), days	24	(16 – 37)	32	(21 – 47)	0.004
Self-management behaviors during year 1					
Persistent high adherence ^b	58	(44)	41	(36)	0.030
Self-monitoring ^c					
<25% of days	40	(35)	80	(74)	<0.001
25–<50% of days	26	(23)	9	(8)	
50% of days	33	(29)	12	(11)	
Reporting abnormal health indicators, median (IQR), percentage of identified abnormal indicators reported ^d	100	(91 – 100)	80	(10 – 100)	0.018
Clinical outcomes during year 1					
Re-hospitalization days, median (IQR), days	12	(3 – 30)	14	(3 – 32)	0.346
1 episode of A2 or rejection	63	(55)	59	(55)	0.582

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^gSignificance test was based on comparison of non- α -1-antitrypsin deficiency COPD vs. all other groups (32)

^h18 patients were missing 1 adherence assessment and could not be determined to be persistently adherent; thus, n=76 in the Pocket PATH group and n=88 in the usual care group. Adherence was defined for each element of the regimen as: missing immunosuppressant 1 time per month, missing other medications 1 time per month, attending every scheduled clinic appointment in past 2 months, getting all required blood work, monitoring vital signs >1 time per week, monitoring spirometry >1 time per week, following prescribed diet all the time, exercising >1 time per week, refraining from smoking

^cSelf-monitoring data could not be obtained from 2 patients; thus, n=87 in the Pocket PATH group and n=93 in the usual care group

^dBecause identifying an abnormal health indicator was a prerequisite for reporting one, the sample for this variable only includes lung transplant recipients who identified 1 abnormal indicator; thus, n=52 in Pocket PATH group and n=23 in the usual care group

Table 2

Early Post-transplant Predictors of Long-term Clinical Outcomes

Predictors	Long-term clinical outcomes			
	Mortality HR (95%CI)	p	BOS HR (95%CI)	p
A^a				
Intervention assignment				
Pocket PATH	0.97 (0.58–1.61)	0.912	1.15 (0.71–1.87)	0.557
Usual care	<i>Reference group</i>		<i>Reference group</i>	
B^b				
Persistent high adherence	1.44 (0.82–2.55)	0.208	1.11 (0.67–1.85)	0.684
Rate of self-monitoring				
<25%	<i>Reference group</i>		<i>Reference group</i>	
25–<50%	1.07 (0.54–2.09)	0.854	1.40 (0.75–2.61)	0.287
50%	0.45 (0.22–0.91)	0.027	0.81 (0.43–1.53)	0.516
Rate of reporting abnormal health indicators ^c	0.15 (0.04–0.65)	0.011	0.27 (0.08–0.86)	0.026

^a Adjusted for age at transplant, transplant indication, type of transplant and incidence of at least 1 episode of acute rejection grade A2 during year 1

^b In addition to the covariates listed in footnote “a”, each analysis in section B of the table also included intervention group assignment (Pocket PATH vs. usual care)

^c Sample only includes lung transplant recipients who identified 1 abnormal health indicator; thus, n=52 in the Pocket PATH group and n=23 in the usual care group