It's Complicated: Patient and Informal Caregiver Performance of Outpatient Parenteral Antimicrobial Therapy-Related Tasks

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Abstract

Outpatient parenteral antimicrobial therapy (OPAT) requires patients and caregivers to infuse antimicrobials through venous catheters (VCs) in the home. The objective of this study was to perform a patient-centered goal-directed task analysis to identify what is required for successful completion of OPAT. The authors performed 40 semi-structured patient interviews and 20 observations of patients and caregivers performing OPAT-related tasks. Six overall goals were identified: (1) understanding and developing skills in OPAT, (2) receiving supplies, (3) medication administration and VC maintenance, (4) preventing VC harm while performing activities of daily living, (5) managing when hazards lead to failures, and (6) monitoring status. The authors suggest that patients and caregivers use teach-back, take formal OPAT classes, receive visual and verbal instructions, use cognitive aids, learn how to troubleshoot, and receive clear instructions to address areas of uncertainty. Addressing these goals is essential to ensuring the safety of and positive experiences for our patients.

Keywords

outpatient parenteral antimicrobial therapy; home care; home infusion therapy; task analysis; human factors engineering

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To decrease length of hospital stays and reduce costs, complex medical therapies are increasingly provided in homes. One such therapy, outpatient parenteral antimicrobial

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therapy (OPAT), is a particularly complex and high-risk treatment in which patients and their caregivers infuse parenteral antimicrobial therapy through venous catheters (VCs). Patients receiving OPAT are at risk for complications such as those from VCs, medications, and the infection being treated.[1] However, little work has focused on patient perspectives on the performance of complex health care tasks such as those required for OPAT.[2–4]

To understand how to decrease OPAT complications, one needs to characterize the tasks patients and informal caregivers ("caregivers") perform in OPAT. Task analysis is a human factors engineering method that has been used to describe the complex work of professional care providers[5–8] and more recently patient self-management.[5,9–12] Patient self-management task analysis has focused on tasks such as management of oral medications at the hospital-to-home transition,[5] on performance of activities of daily living while managing a chronic condition,[10,11] or on shared caregiver–nurse tasks.[13] OPAT, on the other hand, requires patients and caregivers to accomplish tasks that highly-skilled health care workers (eg, nurses) perform in hospitals. Task analysis has not been used to understand patient-performed tasks that require as high a level of competency as those required for OPAT.

The research team elected to perform goal-directed task analysis (GDTA) because (1) it takes a patient-centered view by focusing on the goals (eg, taking a medication on time) and subgoals (eg, opening a pill bottle) of an individual working in a system (here, the patient working within the patient work system—their home[14]) and the tasks and subtasks required to achieve these goals and (2) it better describes the highly-complex, cognitively-intense processes required for OPAT completion than traditional task analysis, which typically focuses on one task constrained in space and time.[15] The objectives of this study are to (1) perform a GDTA of patient and caregiver-performed OPAT and (2) through the identified goals, describe associated hazards to and strategies for the successful performance of OPAT.

Methods

This study was conducted in the context of a larger, previously-described qualitative project focused on patient and caregiver performance of home-based OPAT.[16] The institutional review board at Johns Hopkins University School of Medicine approved this study.

Approach

Two qualitative approaches were used to understand patient perceptions of and patient and caregiver performance of OPAT-related tasks. With one approach, the research team performed semi-structured telephone interviews with OPAT patients. These semi-structured interviews involved using an interview guide to lead a conversation, and patients and interviewers could address other topics that arose. With another approach, the team performed contextual inquiries of patients and caregivers performing OPAT-related tasks at home 3 to 14 days post hospital discharge (eg, medication infusion, VC care), with second visits just prior to completion of therapy for a subset of patients on 4 weeks of OPAT.[16] Contextual inquiry involves observing workers (patients and caregivers) in their work system (the home) while they perform tasks (eg, VC maintenance, antimicrobial administration) and asking questions to understand motivations, approaches, and strategies.[17,18] The timing of the contextual inquiry allowed for a focus on patient and caregiver task performance instead

of home health nurseled training (as training typically occurs <1 day but occasionally 2 days post discharge).

Setting and Sample

The research team started with a convenience sample of patients discharged from 2 academic medical centers on OPAT. As the team was interested in the perspectives of adult rather than pediatric patients, eligible patients were 18 years of age, able to speak and read English, able to provide written consent, not in hospice care, and receiving OPAT after discharge from one of 2 academic medical centers. Patients could have used any home infusion or home nursing agency for medications and supplies, and training and support, respectively. Although the 2 academic medical centers had an affiliated home infusion and home nursing agency, the team wanted to describe a breadth of experiences, including those using different agencies. Therefore, the team performed purposive sampling within the convenience sample, including from unaffiliated home infusion agencies.[16]

Patients eligible for semi-structured telephone interviews had earlier consented for enrollment in a prospective cohort of OPAT patients, November 2015 to June 2018.[16,19] If they expressed interest, they were mailed a consent form to sign and return. Once consent was received, semi-structured interviews were scheduled, frequently 4 weeks post discharge.

Patients eligible for contextual inquiries lived within a 45-minute drive of the 2 hospitals and were not already enrolled in the semi-structured interviews. These patients were recruited via telephone post discharge and provided written consent at the time of the contextual inquiry.

Data Collection and Analysis

The semi-structured interview guide and contextual inquiry tools (online supplementary Appendixes 1–2) were based on the Systems Engineering in Patient Safety (2.0) work system model.[14,16] This model parallels the structure (work system)–process–outcome model of health care quality,[20] whereby the work system includes the interacting components of tasks, tools and technologies, organization, physical environment, and the worker, all within an external environment.[14] Three researchers (SCK, MK, AK) conducted semi-structured telephone interviews from November 2015 to June 2018. Interviews took approximately 30 to 45 minutes each and were audio recorded and transcribed.

Contextual inquiry sessions were performed from May 2017 to June 2018 and occurred with one or 2 investigators (SCK, MK).[16] Investigators asked clarifying questions and took handwritten notes describing what was seen and heard from initiation to completion of the OPAT-related task. Photographs were obtained with additional written consent.

The initial coding template was based on the SEIPS 2.0 model.[14] A preliminary coding template was developed after 2 researchers (SCK, RHC) each reviewed the same 3 randomly-selected transcripts and contextual inquiry notes. The 2 researchers coded the transcripts and notes independently prior to comparing codes. As subsequent transcripts and notes were reviewed, the coding template was revised and changes applied retroactively.

Next, directed content analysis was performed.[21] The directed content analysis focused on a GDTA, which involves identifying (1) users' major goals, (2) tasks and subtasks required to support major goals, and (3) perceptions of the barriers and strategies required to complete tasks.[22] Coding was reviewed after every 10 interview transcripts or contextual inquiry notes, until thematic saturation occurred. Thematic saturation was reached for the findings presented.[23] Analysis was facilitated with NVIVO software, version 11 (QSR International Pty Ltd, Doncaster, Victoria, Australia).

Results

Forty patients were enrolled in the semi-structured interviews and 20 in the contextual inquiries (Table 1). Of the 40 semi-structured interview patients, 32 (80.0%) received services from the affiliated home infusion agency. Of the 20 contextual inquiry patients, half received services from the affiliated home infusion agency, most had a caregiver present during the first visit, and half completed 2 visits (Table 1).

The subsequent sections first describe major goals for patients, and tasks and subtasks required to achieve goals (Table 2). Then, associated hazards to achievement of the goals (Table 3) and strategies patients and caregivers use to address barriers (Table 4) are described.

Goal: Learning About OPAT

Patients had the goal of learning about OPAT, which encompassed the tasks of understanding its purpose and risks and how to physically perform OPAT. Associated tasks occurred in the hospital just prior to discharge, in the hospital-to-home transition, and in the first few days post discharge. Patients and caregivers had to receive training in VC care and medication administration tasks. One patient noted that she had not felt prepared to go home:

> "That briefing of the [catheter] would have been nice to have done like a class. Show me a picture of how that thing's installed in my arm, show me what happens if I were to pull it, why shouldn't I pull [it], … what happens if I do? … You know, if I'd had that education before, it would have saved a lot of anxiety." (47-year-old white female)

Hazards to learning about OPAT included receiving misleading information in the hospital, rushed instruction, different nurses giving different instructions, and confusing or inaccurate instruction manuals. For example, one patient and her husband took copious notes to understand an infusion pump instruction manual (Figure 1A):

> "[The instruction manual] … uses the term 'needleless injection cap' several times and [the patient and her husband] didn't know what this was…. In addition … it says under 'how to start an infusion' that the 'RESUME' button should be pressed. The patient notes … [a] need to press 'RESTART' instead…." (66-year-old white female)

A strategy for the goal of learning about OPAT was "teach-back"—that is, having the patient "teach" the nurse what to do.

Goal: Receiving Supplies and Medications

An additional goal throughout the OPAT course included receiving supplies and medications on time. Hazards included uncertainty about where supply deliveries should be left if no one was home.

Goal: Administering the Medication and Maintaining the Catheter

The goal of administering the medication and maintaining the VC required many tasks, including timing administration, preparing medication, preparing infusion, initiating infusion, and stopping infusion, and device-specific tasks as well.

Timing Medication Administration—Patients and caregivers needed to administer the medication and maintain the VC. Hazards included uncertainty around the timing of the medication and needing to schedule infusions that dosed more than daily. For example, one patient struggled with whether to prioritize medication administration or attend clinic visits. Strategies included using a written schedule, a phone alarm, or developing a habit:

> My husband wrote out a schedule for me because … in the best of times I have a hard time remembering what I'm supposed to do…. So he'd write 'you take these this time and this this time' … (63-year-old white female)

Preparing the Medication—To prepare the medication, patients or caregivers ensured it was at an appropriate temperature by removing it from the refrigerator. The longer the medication was at room temperature, the less effective it was, but if the medication was too cold, it would both take longer to infuse and cause discomfort. A hazard was not knowing when to remove the medication from the refrigerator.

Preparing for the Infusion—Patients needed to prepare for their infusions. First, they identified and cleaned their workspace and set up their supplies. Then, they needed to wash their hands. Hazards included uncertainty about how to clean their hands and whether to use gloves. Some used gloves after washing their hands, some used gloves instead of washing their hands, and some did not use gloves at all. A strategy was thoroughly washing hands, which some did with soap and water, some did with hand sanitizer, and some did with both:

> The instruction sheet … puts more emphasis on using the antibacterial gel. I'm [wondering] why wouldn't you just wash your hands? So I always wash my hands, and then I use the gel also … (58-year-old white female)

Initiating the Infusion—Patients next needed to start the infusion. They needed to follow specific steps, including holding the VC, removing air bubbles, flushing with saline and heparin, swabbing the hub with alcohol, setting up the new medication, unclamping the VC and medication, and injecting the medication or connecting the delivery device. Hazards included the tasks being physically difficult to do because of poor strength or dexterity, and forgetting steps such as unclamping the VC or medication (preventing the medication from infusing), flushing the VC (increasing the risk of a VC occlusion), or removing air bubbles (increasing the risk of air embolism). Strategies included visual reminders (separating VC lumen instructions based on color) and auditory feedback (ie, hearing a click to know the

VC is unclamped). The saline-administer-saline-heparin (SASH) cognitive aid mat[24] was considered a helpful strategy by many (Figure 1B).

Stopping the Infusion—Patients then needed to stop the infusion. Hazards included stopping the infusion too early. Strategies to make the infusion go faster included warming the antimicrobial agent, maximizing the rate on a manual dial, walking to increase the heart rate, or have the most efficient caregiver perform the infusions.

Device-Specific Tasks—Certain tasks were related to specific medication delivery devices, required for delivery of particular medications. A hazard for patients with syringes or elastomeric devices was knowing when the infusion was complete. Strategies to ensure complete medication infusion included checking the time, ensuring the elastomeric device was "flat" (ie, empty), and squeezing the device.

Mini-bags required many subtasks. Patients needed to prime the tubing daily, which was time consuming. They needed to reconstitute the antimicrobial agent (Figure 1C), a complicated process requiring many steps. Hazards included missing steps, incompletely adding the medication, or needle injuries. At times, this even led to injuries (Figure 1C):

> The first time the mother (informal caregiver) [reconstituted the medication] they used a needle because they didn't know about the needleless connector and the mother stuck herself … (44-year-old white female)

Strategies to know when the medication has been completely added to the mini-bag is to squeeze the mini-bag "like milking a cow" (45-year-old African American female, 58-year-old African American male). Strategies to monitor infusion rates included using a clamp, counting drips, setting a dial, or trial and error.

Some patients also used pumps. Hazards included running out of power and finding the pumps difficult to program (Figure 1C):

> "If whoever manufactures these [pumps] were to get a design team to take a fresh look at it from the standpoint of ease of use, they might very well conclude that there are a number of ways in which the device could be simplified and made more user-friendly." (65-year-old white male)

Strategies included monitoring the battery and calling for assistance with the pump.

Goal: Perform Activities of Daily Living

Patients also had the goal of preventing harm to the VC while performing activities of daily living, including bathing, dressing, performing chores, and ambulating. Hazards included getting the line tangled. Patients found some delivery devices were easier than others:

> The [elastomeric device] ball is much easier than the [mini-] bag, because I can do that almost anywhere…. I could be in a movie theater. I could be in a restaurant…. The [mini-]bag is much more difficult because I have to have a stand and hook this up. (59-year-old white male)

Goal: Managing When Hazards Lead to Failures (Troubleshooting)

Patients also had the goal of managing when hazards led to failures, or "troubleshooting."[25] First, they had to recognize complications. Patients and caregivers then needed to contact home health staff about complications. The home health nurse or pharmacist had to remotely assess and determine which complications merited an in-person visit. As one patient experienced, nurses sometimes had to attempt several methods of troubleshooting:

> [The nurse] drew back, she tried to flush, drew back, tried to flush. Then finally she said, huh, she went to her car and got a new end piece, put it on…. (65-year-old white male)

Finally, patients and caregivers sometimes had to perform their own troubleshooting. Hazards included becoming anxious and forgetting steps: "But I just kind of calmed down … and then that's when I remembered, oh, I have to clamp it." (47-year-old white female)

Goal: On-Therapy Monitoring

In addition, patients had the goal of on-therapy monitoring throughout OPAT. Tasks required included VC dressing changes, timing phlebotomy, monitoring their overall condition, and identifying how clinicians could remove the VC at the end of therapy.

Discussion

The research team performed a GDTA to describe patients' perspectives on goals and associated tasks and subtasks required to successfully accomplish OPAT. The team showed that the processes required for OPAT performance are highly complex and have many hazards. Patients and their informal caregivers developed strategies to mitigate hazards. Although a few task analyses have shown how patients self-manage their medical conditions,[5,9–12,26] task analysis has not been used to understand patient-performed tasks as complex and requiring as high a level of competency as in OPAT.

This study described how patients learn OPAT. Instructions sometimes contained errors, patients frequently struggled to understand instructions, and different nurses sometimes gave different instructions. The research team suggests that teaching be standardized, and visual cognitive aids and teach-back be standard parts of OPAT training. In addition, the team suggests that training be risk-informed, focusing on specific barriers individual patients face (eg, arthritis that might make tasks difficult to perform) and on mitigating the impact of safety hazards in the patient work system. Training methods could include contingency planning, simulations, or other methods.

Performing medication administration and VC care required many daily tasks. Instruction manuals were considered difficult to use. Others have suggested that designing medication instructions based on human factors engineering principles would increase the likelihood of medication adherence,[27,28] and the same is likely true in OPAT. Meanwhile, many patients appreciated cognitive aids that used SASH[24] to remember subtasks. Using cognitive aids and simplifying processes could improve OPAT performance.

Many hazards around medication administration and VC maintenance were related to ambiguity.[29] Patients did not know how strictly they had to follow medication administration schedules, how to wash their hands, whether to wear gloves, at what temperature to administer medication, or how to ensure infusion completion. Clear standardized instructions could mitigate these hazards. Also, patients and caregivers frequently forgot certain subtasks, such as flushing both lumens of a double-lumen VC, swabbing sufficiently with alcohol, removing air bubbles, and clamping or unclamping VCs. Adding these steps to a visual cognitive aid such as SASH[24] could help.

This study also described the goal of troubleshooting. This is in keeping with a recent study of United Kingdom health care workers' home infusion pump-related incident reports, which found major concerns, including patients and caregivers not responding to alerts and struggling to detect and diagnose incidents.[25] Assisting patients with performing troubleshooting is essential.

This is one of the first studies to take a patient-centered approach to understanding patient and caregiver performance of a complicated medical task at home. This also is one of the first studies to use a GDTA to understand patient tasks. This approach allowed a fuller understanding of a highly complex series of tasks. The qualitative data set allowed the research team to gather a deep understanding of the complexity of the tasks required for successful OPAT. In addition, the approach was novel as it performed a GDTA over time and so assessed goals longitudinally instead of over one limited period.

This study had some limitations. Patients were discharged from 2 academic medical centers in one American city, and specific tasks required for OPAT may differ in different settings. However, patients from multiple home care agencies were enrolled. Because the goal was to learn about the patient perspective, health care workers were not interviewed. This was a qualitative study meant to be hypothesis-generating; the research team did not know a priori which hazards may have been associated with poorer outcomes. In addition, it is possible that some patients may have received OPAT in the past prior to the study's start or at a hospital not involved in the study, or received other home-based therapies in the past. Therefore, some patients or caregivers may have had prior experiences that allowed them to better perform tasks, potentially biasing the results. However, this also led to a broader breadth of experiences in the study. In addition, there was variation between the timing of the contextual inquiry (with the first visits occurring 3–14 days post discharge) and semi-structured interviews (typically 4 weeks post discharge and near the end of treatment). It is possible that patient and caregiver task performance could have changed during these time periods, introducing bias. However, the research team was able to learn about the experiences patients had had in OPAT to date with these methods.

OPAT requires patients and informal caregivers to conquer many tasks and subtasks to meet 6 overarching goals (ie, learning about OPAT, receiving supplies and medications in a timely manner, administering the medication and maintaining the VC, performing activities of daily living, troubleshooting, on-therapy monitoring). Health care workers who care for OPAT patients should support patients and caregivers in achieving these goals through minimizing hazards, standardized teaching with teach-back, use of cognitive aids, standardizing

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expectations, and improving instruction manuals. Although further research is needed to understand what specific strategies are required to improve OPAT, organizations should use these results to inform their education methods and content. Addressing patient OPAT goals is essential to ensuring that patients have positive, safe OPAT experiences.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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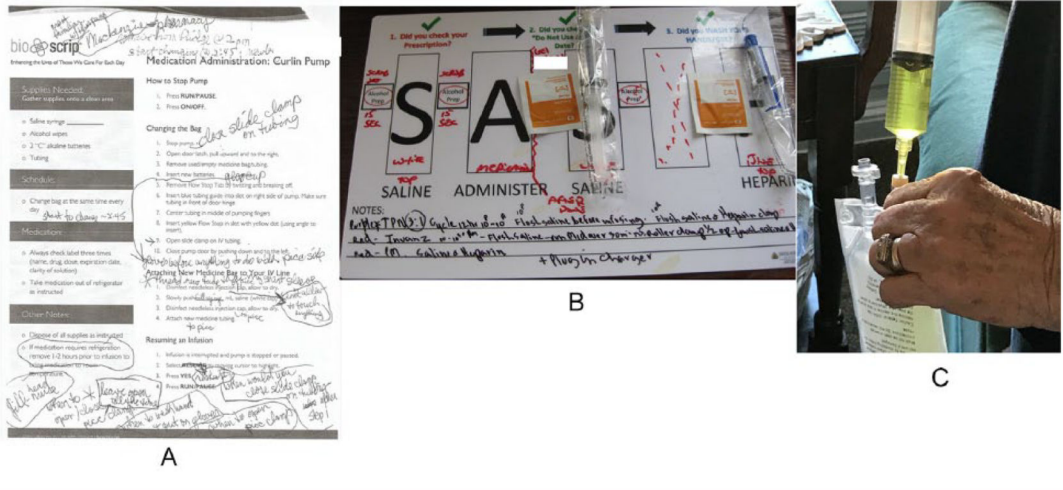
Figure 1.
Examples of patient and informal caregiver performance of tasks. (A) A patient and her informal caregiver took notes on an instruction sheet about how to set up their infusion pump, writing additional subtasks they were told also were necessary but were not written on the instruction sheet. (B) Patient receiving both total parenteral nutrition (TPN) and ertapenem uses the saline-administer-saline-heparin (SASH) system to start infusing his ertapenem. This laminated placemat allowed the patient and his home health nurse to take additional notes to tailor the task to his particular situation as well as reminders to scrub the venous catheter tip for 15 s with alcohol preparation pads prior to each subtask. (C) A patient's informal caregiver injects a reconstituted antibiotic (ceftaroline) into a mini-bag of saline prior to initiation of infusion using a needle. The week prior, the patient informed the study team that this subtask had resulted in the caregiver sustaining a needlestick injury.

Table 1.

Characteristics of Patients on Outpatient Parenteral Antimicrobial Therapy Who Participated in Semi-structured Interviews or Contextual Inquiries.

Characteristic or Demographic Variable	Semi-structured Interviews: Number (Percentage of n = 40)	Home Visit Contextual Inquiries: Number (Percentage of n = 20)
Female sex	19 (47.5%)	8 (40.0%)
Age (mean, SD)	55.4 (12.5)	52 (14.1)
Race/Ethnicity: white	33 (82.5%)	10 (50.0%)
Black/African American	6 (15.0%)	9 (45.0%)
Hispanic	0 (0.0%)	1 (5.0%)
Other	1 (2.5%)	0 (0.0%)
Home infusion agency: affiliated	32 (80.0%)	10 (50.0%)
Presence of caregiver at time of first visit	N/A	16 (80.0%)
Two visits completed	N/A	10 (50.0%)

Goals and Subgoals, With Associated Tasks Required to be Performed by Patients and Informal Caregivers, Required for OPAT Performance as Perceived by Patients.

Goal	Subgoal	Others Involved With Patient and Caregiver	Task
Learning about OPAT (at transition from hospital to home)	Become informed about OPAT	Inpatient nurse Inpatient clinician	Receive preliminary information in hospital Obtain understanding of venous catheter Obtain understanding of antimicrobial therapy
	Initiate start of care visit	Home health nurse	Schedule start of care visit Arrival of home health nurse
	Instruct in OPAT task performance with verbal information	Home health nurse	Receive instruction from nurse Choose who receives instruction
	Task performed with supervision	Home health nurse	Show nurse how to do task
	Receive written instruction about OPAT task performance	Home health nurse	Receive written instructions or protocols Receive additional instruction added to printed protocols
	Receive guidance on managing the venous catheter during activities of daily living	Home health nurse	Learn how to perform activities of daily living Learn how to care for line Learn how to keep dressing dry when bathing
	Receive instruction about troubleshooting	Home health nurse	Learn signs of problems Learn when to troubleshoot Learn when to ask for help Learn when to seek emergency attention
	Become accustomed to performing OPAT		Learn skills over time Learn what additional questions to ask Become accustomed to OPAT over time
Delivery of supplies and medications (ongoing while on OPAT)	Receives delivery	Courier or delivery person	Time delivery for when patient is home Assist delivery person with locating home
Administration of medication and maintenance of venous catheter (daily while on OPAT)	Schedule infusions		Develop a routine Remember to administer medication Take the medication on time Arrange administration around work, doctor visits, sleep, and nursing visits Arrange work and sleep around OPAT Adapt to schedule changes
	Manage the duration of infusion		Know when infusion starts Know when infusion stops Set infusion rate
	Clean the surface		Identify a clean workspace Wash off countertop or workspace
	Set up supplies		Set up equipment
	Clean hands		Wash hands with soap and water Use hand sanitizer

Goal	Subgoal	Others Involved With Patient and Caregiver	Task
	Keep the medication at an appropriate temperature		Keep the medication cool Keep the medication in the refrigerator Know when to remove the medication from the refrigerator
	Access the venous catheter		Remove clothes
	Administer the antimicrobial agent		Follow laid out steps Reach the venous catheter Set up new medication Put medication in case Flush out air Flush with saline Swab hub with alcohol Unclamp line Connect medication Inject medication Flush with saline and heparin
	Stop the infusion		Procedure to stop infusion Clamp line Disconnect used antibiotic
	Dispose of waste		Dispose of liquid waste and spills Identify where to dispose of used supplies
	Administer medication in syringe or elastomeric device: specific task		Know when the infusion is complete
	Prime the tubing when using mini-bags: specific task		Prime medication
	Reconstitute antibiotic when using mini-bag: specific task		Mix antibiotic Shake antibiotic Identify needleless connector
	Monitor infusion rate when using mini-bag: specific task		Set the medication drips to the appropriate rate Set the dial to the appropriate rate
	Program pump for continuous or intermittent infusion medication: specific task		Program pump for continuous or continuous intermittent infusion
	Monitor power level on pump for continuous or intermittent infusion: specific task		Verify battery is charged Know when battery needs to be charged Charge battery
Prevent harm while performing activities of daily living (daily while on OPAT)	Bathe		Keep dressing dry Cover dressing Acquire dressing cover Keep pump dry Keep line out of water
	Dress		Need to get sleeve over antibiotics
	Care for pets		Cover line Wash hands
	Move around		Run errands or chores Arrange line while driving

Goal	Subgoal	Others Involved With Patient and Caregiver	Task
	Cook and clean		Arrange line while running errands Arrange medications while moving
		Home health nurse	Keep line clean
Troubleshoot (daily while on OPAT)	Identify when things may be going wrong	Home health nurse	Look for signs of infection Look for signs of clot Identify problem Respond to beeping of pump
	Contact health care team when complications arise	Home health nurse Home health staff Outpatient doctor Home infusion pharmacist	Call nurse Call other home health staff Communicate with outpatient doctor Communicate with home health or home infusion team
	Assess for complications remotely	Home health nurse Home health staff Outpatient doctor Home infusion pharmacist	Describe complications over the telephone Describe complications over email or electronic health record messaging
	Assess for complications in the home	Home health nurse Home health staff Outpatient doctor	Arrange nurse visit Assist nurse while attempting troubleshooting Assist in decision to reassess complication
	Assess for complications in clinic	Outpatient doctor	Attend clinic visit Assist doctor or nurse in understanding complication
	Attempt own troubleshooting	Home health nurse	Attempt own troubleshooting Listen to nurse instructions for how to troubleshoot
Monitor status on treatment (ongoing and at end of treatment)	Change venous catheter dressing	Home health nurse	Determine who can change the dressing Determine where the dressing can be changed Troubleshoot problems with the dressing
	Draw blood and send for laboratory testing	Home health nurse	Time blood draws with medication administration
	Monitor of overall condition	Staff in outpatient clinic Outpatient clinicians	Travel to clinic appointment Time infusion around clinic appointment Attend clinic appointment
	Remove venous catheter at end of therapy	Outpatient clinicians Home health staff Home health nurse Home infusion pharmacist	Receive order to remove venous catheter Arrange for venous catheter removal

Abbreviation: OPAT, outpatient parenteral antimicrobial therapy.

Table 3.

Hazards in Patient-Described OPAT Goals.

Major Goal	Subgoal	Hazard
To be trained in catheter care and medication administration	Become informed about OPAT	Received misleading information in hospital
	Initiate start of care visit	No nurse arrived
	Instruct in OPAT task performance with verbal information	Rushed instruction
		Different nurses give different instructions
		Errors in instruction
		Patient did not understand training
	Task performed with supervision	Nurse did not watch patient perform OPAT task
	Receive written instruction about OPAT task performance	Instructions confusing
		Discharge information has differing information
	Receive guidance on managing the venous catheter during activities of daily living	
	Receive instruction about troubleshooting	
	Become accustomed to performing OPAT	
Delivery of supplies and medications	Receive delivery	Uncertainty: What to do if patient not at home
		Delivery person didn't wait for person to answer door
Administration of medication and catheter maintenance	Schedule infusions	Uncertainty: how strict the scheduling must be
		Misinformed about scheduling
		Frequent dosing
	Manage the duration of infusion	Rushes the infusion
		Takes longer than nurse says because of own decision making
	Clean the surface	
	Set up supplies	
	Clean hands	Ambiguity: hand sanitizer versus soap
		Ambiguity: to wear gloves or not
		Bandaged hand can't be clean
		Gloves hurt ability to feel to do task
		Only one glove worn
		Rubbed sanitizer on gloves, not hands
	Access the catheter	
	Keep the medication at an appropriate temperature	Instructions as to when to remove from refrigerator are confusing
		Unclear if medication needs to be refrigerated or not
	Administer the antimicrobial agent	Ambiguity: need for blood return
		Ambiguity: need to place on cap
		Can't flush in steady stream because of poor strength or physical ailment
		Flushing hard to remember
		Different syringes and supplies delivered than what patient expected
		Physically difficult to attach medication

Major Goal	Subgoal	Hazard
	Stop the infusion	Forgetting to unclamp line Wrong steps followed Forgets to flush out or creates more air bubbles Tubing too long Doesn't swab hub long enough
		Unclear: if heparin needed in continuous infusion medications Forgetting to clamp line
	Dispose of waste	Unclear if infusion complete Infusion stopped early
	Administer medication in syringe or elastomeric device: specific task	Tubing touches floor
	Prime the tubing when using mini-bags: specific task	Complicated process Many steps required Needing more than 1 antimicrobial agent Reconstituted medication with wrong amount of sterile water
	Reconstitute antibiotic when using mini-bag: specific task	Difficult to time flow rate Pole difficult to set up Unclear if empty
	Monitor infusion rate when using mini-bag: specific task	Uncertainty: unclear when to start and stop pump Hard to do Nurse unable to help Not realizing pump is on Pump continues to beep
	Program pump for continuous or intermittent infusion medication: specific task	Power cord stopped working Running out of power
	Monitor power level on pump for continuous or intermittent infusion: specific task	Dressing cover does not fit appropriately
Prevent harm to the venous catheter while performing activities of daily living	Bathe	
	Dress	Pets jump on patient Pet waste
	Care for pets	Mobility device and line getting tangled or tugged
	Move around	
	Cook and clean	
Troubleshoot	Identify when things may be going wrong	Person on phone doesn't understand the problem Difficulty understanding health care worker on phone Poor communication
	Contact health care team when complications arise	Understanding issues with clamps Understanding issues with medications being screwed on too tightly
	Assess for complications remotely	Unclear who can troubleshoot in clinic Lack appropriate tools to address complication in clinic
	Assess for complications in the home	
	Assess for complications in clinic	

Major Goal	Subgoal	Hazard
Monitor status on treatment	Attempt own troubleshooting	Complication not addressed Patient panics
	Change venous catheter dressing	Patient uncomfortable with troubleshooting dressing changes Each nurse does it differently Unclear who can change dressing
	Draw blood and send for laboratory testing	
	Monitor of overall condition	Primary care doctor unaware of situation Can't get to appointment because of mobility Infectious diseases doctor unsure of situation
	Remove catheter at end of therapy	Don't know how to remove catheter Unsure who can order catheter removal

Abbreviation: OPAT, outpatient parenteral antimicrobial therapy.

Table 4.

Strategies to Mitigate Hazards in Patient-Described OPAT-related Goals.

Major Goal	Goal	Strategy
To be trained in catheter care and medication administration	Become informed about OPAT	Watched nurses in hospital Suggestion of formal class in OPAT
	Initiate start of care visit	Taught at home care agency site
	Instruct in OPAT task performance with verbal information	Choose which instructions to follow
	Task performed with supervision	Teach-back
	Receive written instruction about OPAT task performance	Add own instructions to instruction manual Visual instructions more helpful than written instructions
	Receive guidance on managing the catheter during activities of daily living	
	Receive instruction about troubleshooting	
	Become accustomed to performing OPAT	
Delivery of supplies and medications	Receive delivery	
Administration of medication and maintenance of venous catheter	Schedule infusions	Developing a habit Use alarm on phone Schedule written out for patient
	Manage the duration of infusion	Warm medicine to room temperature so that it infuses faster Crank up rate to fastest rate Walks to speed up infusion rate Have a faster family member do the infusions
	Clean the surface	
	Set up supplies	Set up all equipment in advance Had supplies in a bag when traveling
	Clean hands	Places emphasis on washing hands Wash hands frequently, thoroughly or twice Change gloves Turn off faucet with arm Uses both hand sanitizer and soap Use hand sanitizer as this was easier than walking back and forth to the sink Gloves instead of washing hands
	Keep the medication at an appropriate temperature	Refrigerator Ice packs throughout the day Take out of refrigerator prior to starting Goes faster if take out night before Easier if doesn't need refrigeration
	Access the catheter	
	Administer the antimicrobial agent	Remember instructions for lines based on color Use SASH mnemonic or preparation mat as cognitive aid[24] Add extra steps Swab until hear a squeak

Major Goal	Goal	Strategy
	Stop the infusion	Push in bit by bit Know it's unclamped if it clicks
	Dispose of waste	Pad to collect drips
	Administer medication in syringe or elastomeric device: specific task	Marker on bag Check time Ball flat when done Squeeze at end
	Prime the tubing when using mini-bags: specific task	
	Reconstitute antibiotic when using mini-bag: specific task	Like milking a cow
	Monitor infusion rate when using mini-bag: specific task	Use clamp to time drip Trial and error to time drip
	Program pump for continuous or intermittent infusion medication: specific task	
	Monitor power level on pump for continuous or intermittent infusion: specific task	Charge overnight
Prevent harm to the catheter while performing activities of daily living	Bathe	Rigged solutions
	Dress	Thread line under clothes Use clothes to cover lines Use clothing to hold antibiotics
	Care for pets	Cleaning and washing hands after handling pets
	Move around	Position self so no tug from line Stay in a particular position Eclipse ball in pocket
	Cook and clean	Wear gloves
Troubleshoot	Identify when things may be going wrong	
	Contact health care team when complications arise	Take picture of central line to show nurse Text nurse
	Assess for complications remotely	
	Assess for complications in the home	Explaining to patient it's not their fault Make it easier for the patient Nurse looks up answer on internet search engine
	Assess for complications in clinic	
	Attempt own troubleshooting	Nurse told patient to tape down dressing Patient and nurse troubleshoot Learn over time to troubleshoot Just wait for nurse Stop and think
Monitor status on treatment	Change catheter dressing	Patient checks dressing
	Draw blood and send for laboratory testing	Timing lab draws

Major Goal	Goal	Strategy
	Monitor of overall condition	Timing medications for lab draws
		Told of importance of clinic visit
	Remove catheter at end of therapy	

Abbreviations: OPAT, outpatient parenteral antimicrobial therapy; SASH, saline-administer-saline-heparin.