Caregiver Tracker

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The need for a caregiver attendance application

According to Johns Hopkins School of Medicine, medical errors are the third leading cause of death in the United States. Their research asserts that a large percentage of medical errors aren’t due to inherently bad doctors. Rather, they’re the result of poorly coordinated patient care and, as a result, unwarranted variations in medical care.¹ A caregiver “no-show” is an example of an unwarranted variation in medical care and, unfortunately, the cause of many preventable deaths.

A caregiver is defined as someone who cares for a person who cannot care for their self.² One of the most common complaints among home care clients is that their designated caregivers fail to show up for their shifts.³ Caregiver neglect has devastating effects on the health of the care client, including the introduction of new physical injuries. According to the federal Centers for Disease Control and Prevention, hundreds of thousands of seniors are intentionally neglected by caregivers each year.⁴ However, this statistic does not account for the many patients that are unwilling or unable to tell family, friends, or authorities about their experiences.

Despite their negligence, caregivers are still remunerated. According to a report from the U.S. Department of Health and Human Services, The Personal Care Services program, which exceeded $14.5 billion in the fiscal year 2014, is “rife with financial scams”.⁵ The risks increase because the care takes place out of view in people’s homes and because neglected patients may not advocate for their own care. For instance, in one Illinois case, a woman whose nursing license had been suspended for allegedly stealing drugs at work signed up as a caretaker. She billed Medicaid for $34,000 in caretaking services she didn’t provide — including charges made while she was on a Caribbean vacation.⁶

¹ Johns Hopkins Medicine, Based in Baltimore, Maryland, www.hopkinsmedicine.org/news/media/releases/study_suggests_medical_errors_now_third_leading_cause_of_death_in_the_us.
² Johns Hopkins Medicine, Based in Baltimore, Maryland
What is Caregiver Tracker?

Caregiver Tracker is a web application that detects caregiver “no-shows”. The motivation of the application is to prevent frequent caregiver no-shows and prevent caregivers from claiming hours that they did not work.

**Phase One:** The application will not monitor the caregiver’s physical location. To detect “no-shows”, once at a care client’s home, the caregiver will be expected to scan the care client’s unique code—a QR code—from the care client’s phone or input a code to confirm their arrival. Once the correct QR code or text code is successfully scanned or inputted, all user groups except the caregiver will be notified of the caregiver’s arrival. If the caregiver does not successfully scan the care client’s QR code—presumably because they did not show up—all user groups except the caregiver will be sent a “no-show” notification.

**Phase Two:** The application will monitor the caregiver’s physical location at the time they’re expected to visit their care client. The caregiver will be marked as “present” once within their care client’s geofence for a certain amount of time. For instance, a caregiver might be marked as present only if at the care client’s home for an hour. Once the caregiver is marked as “present”, all user groups except the caregiver will be notified that the caregiver showed up. If the caregiver is not marked as present—presumably because they did not show up or were not within the care client’s geofence for a certain amount of time—all user groups except the caregiver will be sent a “no-show” notification.

In both cases, the caregiver’s “attendance” will be stored in a database that can be accessed by certain user groups.

Geolocation

Beacons and Geofences are proximity tracking devices that are used to identify a user’s proximity to a location. A beacon is a Bluetooth-equipped device that transmits signals that other devices can see. More simply put, a beacon is a small Bluetooth radio transmitter. Analogous to a lighthouse, “a beacon repeatedly transmits a signal that other devices can see”. Once another bluetooth-enabled device detects the emitted signal, an application triggers a specific action. A geofence, on the other hand, can be defined as a virtual radius (or perimeter) around a phone’s geographic location. A user’s GPS coordinates are used to

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determine whether they’re within the geofence.\(^9\) The operating system triggers an application to perform a background task when the user enters or exits a geofence.\(^{10}\)

This application will use geofencing, as opposed to beacons, since a beacon’s capabilities are limited in a number of ways. First, a beacon is incapable of pinpointing a user’s location—it can only determine how close a user is the beacon’s signal.\(^{11}\) Such inexactness might produce a false positive (or false “present”). For instance, using beacons, the application might mark a caregiver as “present” when they are a house away from their care client. Second, a beacon can not be turned on every Android.\(^{12}\) This is problematic due to the fact that caregivers or care clients who do not have an iOS device will be rendered unable to use the application’s tracking feature. Third, even if a beacon is installed on the device’s operating system, an application must be installed to catch the emitted signal.\(^{13}\) Thus, in order to track the movement of the caregiver, the caregiver must be carrying their turned on mobile device at all times. Further, the device they’re carrying must: (1) have an application installed that can catch the emitted signal and (2) have their Bluetooth and Wi-Fi options enabled.

Geofences offers a number of advantages over beacons. First, Geofencing is built into both Android and iOS operating systems.\(^{14}\) Second, geofences trigger events even if the user’s phone is inactive or the application that the geofence is associated with is not open.\(^{15}\) Third, geofences offer an additional feature: they trigger an event only when the user has been within a geofence for a certain amount of time.\(^{16}\) This added feature can improve the effectiveness of CareGive

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application by only marking the caregiver as “present” once in their care client’s geofence for a certain amount of time.

Competitive Landscape

There are a number of existing applications in the application market that support caregivers. For instance, CareZone helps caregivers keep track of their care client’s medical information, including medication, allergies, and insurance information.17 CaringBridge is another example, enabling caregivers to seamlessly divide caregiving duties among other caregivers.18 Despite a litany of technologies tailored to support caregivers, no application has been created to ensure that the needs of the care client are being met by the caregiver.

According to the Department of Human Services, Illinois now requires caregivers to call in at the beginning and end of each client visit to detect impropriety. Their phone call is then recorded and stored in an electronic database.19 This solution does not adequately protect care clients for a number of reasons. First, the caregiver can call from anywhere. For instance, unless the location of the phone number is traced, the caregiver can mark themselves as present without seeing their client. Second, a phone call does not verify how long a caregiver cared for their client. By merely spacing out their calls, a caregiver can be remunerated for hours that they did not actually work.

Users

The application will have four user groups: caregivers, caregiver agencies, care clients and care client family members.

Caregivers:
To restrict attention to a more tractable subdomain, this application targets professional caregivers who belong to an agency. Such an application can effectively monitor the work of the aforementioned group since the reputation they generate matters for their future career. More descriptively, professional caregivers have an incentive to do as well as they can. In addition, professional caregivers would benefit from an application that can attest to their hard work and timeliness.

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Caregiver agencies:
To restrict attention to a more tractable subdomain, this application targets agencies that offer professional home care assistance. This care includes but it is not limited to 24-hour home care. The caregiver agency will track the attendance of their caregivers. In addition, the agency will receive an alert once the caregiver has failed to show a certain amount of times.

Care clients:
To restrict attention to a more tractable subdomain, this application targets individuals whose self-care behaviors are influenced and monitored by another person.

Care client family members:
To restrict attention to a more tractable subdomain, this application targets individuals who have a family member that receives professional home care assistance on a regular basis. The care client’s family can track the attendance of their family member’s caregiver. In addition, the family will be notified once the caregiver has failed to show a certain amount of times.

Minimum Viable Product
The MVP prototypes the attendance and matching process from the caregiver and caregiver agency’s perspective.

The caregiver agency will match caregivers with clients. Once matched, on the agency side, the agency’s list of their caregivers and their associated clients will be updated and redisplayed. On the caregiver side, their patient list will be updated and rerendered.

The MVP does not monitor the caregiver’s physical location. Rather, it determines if the caregiver showed up for their shift by checking if the QR code the caregiver scanned or the text code the caregiver inputted matches that of the care client being visited. To prevent spoofing, the care client’s QR and text code will change every 2 minutes. Once the correct client’s code is scanned (or inputted), the caregiver will be marked as “present” and their attendance record will be updated. The caregiver and their agency can view and comment on their attendance record. This record can be found on the caregiver’s “profile”. For more information, please follow https://github.com/tiloooor/CareGive.
Implementation (preliminary)

I developed a web application using the MERN stack. The MERN stack makes use of MongoDB, Express, React, and Node.js. I separated my development stages into front-end and back-end.

**Backend:**
First, I implemented a basic Node.js/Express server. Second, I created user schemas for the user group, caregiver, and the user group, caregiver agency using Mongoose. Third, I implemented caregiver and caregiver agency registration and authentication. I used the library, bcrypt to hash and check user passwords. Further, I used the library, JSON Web Tokens for user authorization. Fourth, I developed an authentication middleware. The authentication middleware protects selected routes by ensuring that a user has access to a specific route before redirecting them. Last, I implemented an Express route to process and verify whether the code inputted by the caregiver matches that of their care client.

**Frontend:**
First, I created a skeleton React application using the npm package, “create-react-app”. Second, I configured the Redux Store, which stores the application state in an immutable object tree. This process included creating Actions and Reducers for authentication and attendance tracking. Actions are “payloads of information that send data from your application to your store”. Reducers “specify how the application’s state changes in response to actions sent to the store”. Third, I developed React components for the landing, authentication, registration, dashboard pages. For these pages I created a number of smaller components. This includes but is not limited to a “Table” component to display a caregiver’s patient list and a “Private Route” component that restricts user access based on their credentials. Last, I connected the front-end to the back-end. In order to accomplish the aforementioned, I used axios to make API requests to the backend, Express application running on a separate server.

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Future Work

Due to lack of time, many different adaptations, tests, and features have been left for the future. Future work concerns deeper analysis of the following:

1. What happens if the care client’s or caregiver’s phone is dead or lost? How can they prove they were there if they fail to scan the code?

2. How will the application securely store (and protect) the caregiver and care client’s location data? One solution is to encode the geographic coordinates of both user groups. Encrypting the aforementioned data before storing it provides a layer of security since the plain-text coordinates will not be accessible.

3. Who owns that data? Does the caregiver own their data? Does their agency own the data?

https://redux.js.org/basics/basic-tutorial.

https://blog.beaconstac.com/2015/09/beacons-vs-geofencing-which-location-aware-technology-should-your-business-use/.


