Application of Unmanned Aerial Vehicle Technology in Emergency Medical Situations

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Introduction

- One of the significant impacts on patient outcome in emergency medical situations is the response time taken for emergency medical services (EMS) to arrive at the scene.
- "response time" is measured from the time EMS is notified by dispatch, to the team's time of arrival, with the current average time in the US being 9.4 min.[1]
- 11.2% of all response times are >12 min,[2] but research suggests that a time of 6 min. is critical for sparing the life of a cardiac patient[3] and can improve survival outcome by 6.5%.[4]
- Unmanned Aerial Vehicles (UAV) have the potential to medical technology and supplies to a patient in much shorter time, while the medical team is en route.
- Our study, considered Phase 1 of a multi-stage project, examined this possibility by applying the use of UAV to a mock emergency of a cardiac patient.

Objectives

- To equip a UAV with i-Phone carrying ECG technology and fly it a 100 yard distance to a mock emergency situation with a "bystander" and "patient."
- To have the bystander utilize appropriately apply the delivered ECG technology in order to obtain a valid recording of patient's heart rate and rhythm.

Methods

- The UAV model we selected is a Phantom 2 Vision (Figure 2).
- The Vision is equipped with four rotary blades and four motors, along with a 14 Megapixel camera and HD video recorder.
- The weight of the UAV is only 1160g, which gives us maximum capability for addition of medical equipment.
- Medical equipment selected to test our UAV was a portable ECG.

Methods

- The ECG was an AliveCor Kardia model attached to an iPhone 5.
- Written instructions for a layperson to operate the ECG were included with the UAV. A summary of said instructions can be seen in Figure 1.

AliveCor ECG Protocol

1. Remove Smartphone device from drone.
2. Remove all other electrical devices at least 5 steps away from patient.
3. Position patient so that their back is flat on the ground.
4. Launch the AliveCor ECG application as shown below:
5. Remove shirt to expose chest. EKG will be placed on the left side of the chest below the breast.
   a. For female patients, elevate left breast to ensure accurate reading*
6. Clean area under breast with provided alcohol swab
7. Place phone on chest under breast with screen facing out, and red marker closest to middle of chest
8. Record EKG. Remain still until recording is complete.
9. Once recording is finished, you will be automatically directed to the "Journal" tab. Your EKG will be at the top of the screen (Please confirm with proper date and time).
10. Tap your EKG
11. At top right corner of EKG screen, there is an envelope icon. Tap this icon.
12. From the pop-up menu, select "EMAIL"
13. In "Send to" bar, email EKG to: projectdroneekg@gmail.com
14. Await EMT arrival

Figure 1. Alivecor Protocol summarized

Figure 2. Our fully equipped DJI Phantom 2 Vision UAV, with the i-Phone 5 AliveCor ECG software mantled to the underside.

- The UAV was flown 100 yards on an open field, with clear sky conditions and 5 MPH wind flowing in the direction of the UAV.
- Once the UAV landed, the ECG device was operated and applied to a mock patient (Figure 3).
- An ECG reading was obtained and sent to the appropriate personnel (Figure 4).

Figure 3. Our mock emergency situation: bystander applying i-Phone with AliveCor, delivered via UAV, to obtain an ECD reading of a cardiac patient.

Methods

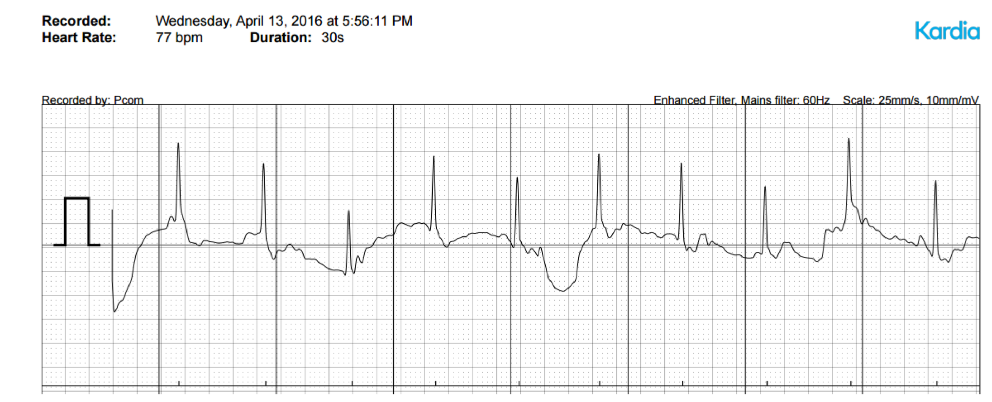

Figure 4. ECG Printout from trial patient.

Data and Results

- The total flight time for 100 yards across an open field was two minutes, or approximately 2.5 ft/sec.
- A chi-squared analysis of data (Table 1) showed a significant p-value (p<.01), proving that our UAV was successful in navigating faster than the national

Observed time (minutes)	2.5
Standard time (minutes)	9.4
p-value	.01

Table 1. Statistical analysis. Df=1

Discussion

- Bystander successfully accessed device from drone and generated ECG reading.
- Successful trials and data demonstrate that the UAV is capable of carrying the necessary equipment safely while maintaining short flight time.
- Because our p-value was .01 (<.05), we have proven that it was the UAV that allowed the ECG reading to be carried out in a manner that beats the national average time for emergency response.
- The ECG reading shown in Figure 4 shows a clear printout that could be evaluated by a medical professional, with a PQRST consistent with normal heart beat on a test subject.
- The ECG is diagnostically equivalent to the standard ECG used in an emergent setting.
- The ultimate aim is to be able to carry other medical devices, such as emergency medications or a defibrillator.

Discussion

- There is future potential to utilize UAV technology in both rural and urban environments with the end goal of using preprogrammed routes by GPS waypoint mapping.
- The video and audio systems on board can be utilized in the future to gather information from a patient as well as transmitting instructions from a receiving physician.
- It may be possible to utilize medical UAV technology in a military field situation.

Conclusion

- Unmanned Aerial Vehicles can significantly decrease the time needed for emergency medical response.
- This first phase of a multi-phase project provides incentive and justification to continue exploring UAV technology beyond a 12-Lead ECG.

References

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