Extending our reach & bringing care to the patients: Feasibility of remote robotic stroke care

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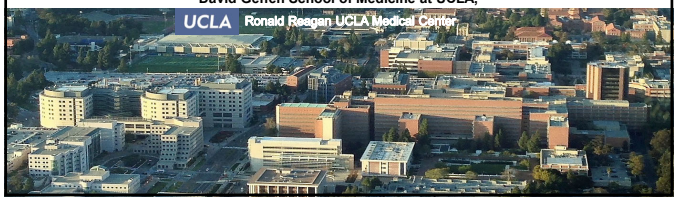

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Extending Our Reach

Air EMS?

Trends of Non-Fatal HEMS Accident-Related Injuries

Richard J. Simonson, Joseph R. Keebler, Alex Chaparro
Embry-Riddle Aeronautical University

We conducted an investigation into non-fatal helicopter emergency medical service accidents from January 26, 1991 to April 26, 2018 via the National Transportation Safety Board aviation accident database. Over this 28-year timeframe 247 accidents results in 251 fatalities and 179 non-fatal injuries. Exploratory analysis of the data indicate that more non-fatal injuries occurred in September compared to any other month during the study timeframe. Exploratory correlational analysis via elastic net logistic regression concluded that no linear relationship of NTSB accident database data provide insights into what factors are correlated with an increased likelihood of non-fatal injuries. Further, no linear relationships of available variables provide insights into the increased number of non-fatal injuries in September during this investigation's timeframe. Future research should identify if these null results are due to a true lack or no relationship between available data and non-fatal injuries or if these results are due to inaccessibility to relevant data.

Stroke Treatment & Tele Robotics

A Review of Robotic Interventional Neuroradiology

ABSTRACT

SUMMARY: Robotic interventional neuroradiology is an emerging field with the potential to enhance patient safety, reduce occupational hazards, and expand systems of care. Endovascular robots allow the operator to precisely control guidewires and catheters from a lead-shielded cockpit located several feet [or potentially hundreds of miles] from the patient. This has opened up the possibility of expanding telestroke networks to patients without access to life-saving procedures such as stroke thrombectomy and cerebral aneurysm occlusion by highly-experienced physicians. The prototype machines, first developed in the early 2000s, have evolved into machines capable of a broad range of techniques, while incorporating newly automated maneuvers and safety algorithms. In recent years, preliminary clinical research has been published demonstrating the safety and feasibility of the technology in cerebral angiography and intracranial intervention. The next step is to conduct larger, multisite, prospective studies to assess generalizability and, ultimately, improve patient outcomes in neurovascular disease.

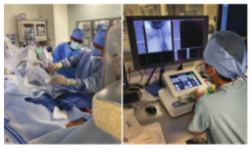

FIG 1. A, Sterile Corpath GRX patient-side robotic system during setup. *B*, Lead-shielded remote Corpath GRX control station during cerebral angiography procedure.

FIG 4. Telerobotic stroke network. A neurointerventionalist at the control station can operate multiple interventional robots to expand networks of care. "Robot" indicates potential sites of patient-side, interventional robots. Gray-scale indicates relative population size of each state.

Original Research Article

INR INTERVENTIONAL NEURORADIOLOGY

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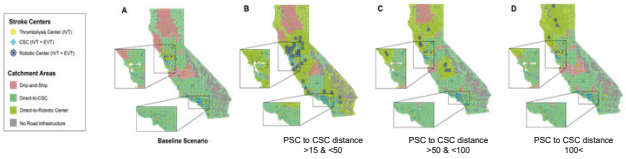
Modeling optimal patient transport in a stroke network capable of remote telerobotic endovascular therapy

Charles Beaman[1,2,*], Jessalyn K Holodinsky[1,*], Mayank Goyal[3], Satoshi Tateshima[4], Michael D Hill[3], Jeffrey L Saver[1,2] and Noreen Kamal[4,5]



Converting PSP to Robotic

Original Research Article

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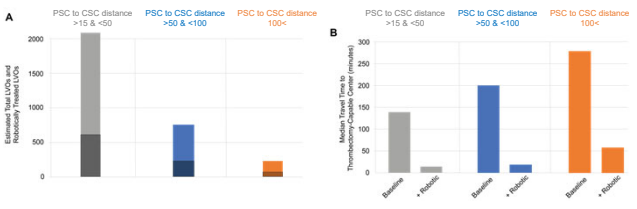
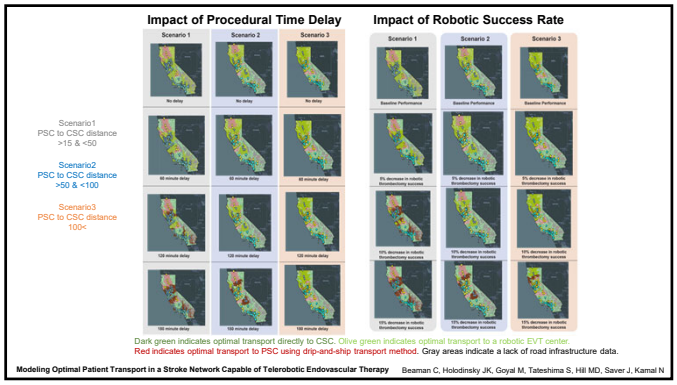
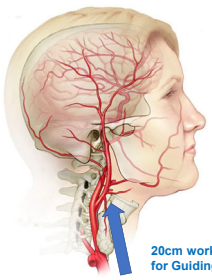
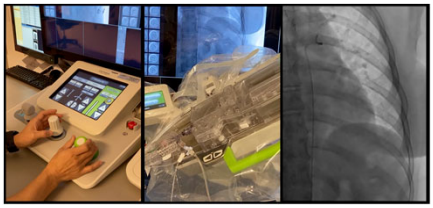




Robotic Catheter Procedure

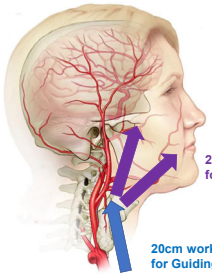




20cm working length
for Guiding-cath.

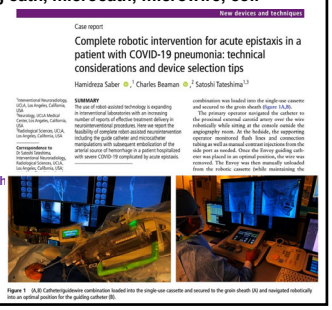
Complete Robotic Intervention

Robotic system controlled guiding cath, microcath, microwire, coil



20cm working length
for Micro-cath.

20cm working length
for Guiding-cath.



New devices and techniques

Case report

Complete robotic intervention for acute epistaxis in a patient with COVID-19 pneumonia: technical considerations and device selection tips

Hamidreza Saber, Charles Beaman, Satoshi Tateshima

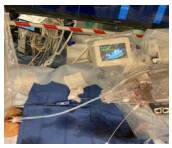
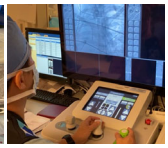
SUMMARY

The use of robot-assisted technology is expanding in interventional laboratories with an increasing number of reports of effective treatment delivery in neurointerventional procedures. Here we report the feasibility of complete robot-assisted neurointervention including the guide catheter and microcatheter manipulations with subsequent embolization of the arterial source of hemorrhage in a patient hospitalized with severe COVID-19 complicated by acute epistaxis.

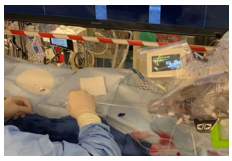
Figure 1 (A,B) Catheter/guidewire combination loaded into the single-use cassette and secured to the groin sheath (A) and navigated robotically into an optimal position for the guiding catheter (B).

Procedural Steps

Guide Cath Phase


Micro-Cath Phase




Complete Robotic Intervention
Selected vessels

Case 1) Bilateral VAs, Bilateral CCAs, Bilateral IMAX As (PVA/Coil)

Case 2) Rt CCA, Rt ECA, Rt APA, Rt Asc Palatine, & 2 pedicles (PVA/Coils)

Case 3) Rt CCA, Rt ECA, Rt APA (Coils)

Case 4) Lt CCA, Lt ECA, Lt Facial A, & 3 pedicles (PVA, NBCA, Coils)

Case 5) Bilateral CCA, Bilateral ECA, Bilateral Facial A (PVA, Coils)

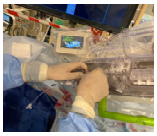
Case 6) Rt CCA, Rt ECA, Rt IMAX (PVA, Coils)

A total of 30 vessels selected (5 per case)

Interventional Neuroradiology 2023 in press

Complete Robotic Intervention
Fluoroscopy Time & Procedure Time

Fluoroscopy	27.1 ± 7.6 minutes
Procedure	75.9 ± 17.2 minutes




A total of 30 vessels selected (5 per case)

Complete Robotic Thrombectomy: In Vitro Study

Procedure Time, Fluoroscopic Time, Radiation Dose Recorded in Each Step

- **Navigation of guiding catheter from aorta to ICA**
- **Navigation of microsystem from ICA to M2 and thrombectomy**

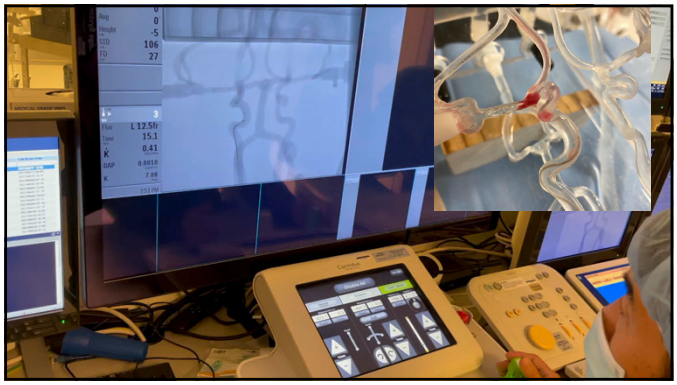
Robotic operator & on-site operator communicated with intercom to simulate remote robotic thrombectomy.

Guiding catheter: Benchmark 95 cm
Guidewire: Aristotle18

Microcatheter: Phenom21 150 cm
Microguidewire: Synchro SELECT Support

Stent retriever: Embotrap 5 x 37 mm

WFITN 2022 Abstract. Naoki Kaneko, Taichiro Imahori, Ariel Takayanagi, Hamidreza Saber, Charles Beaman, Satoshi Tateshima



RESULTS - Interventional Outcome

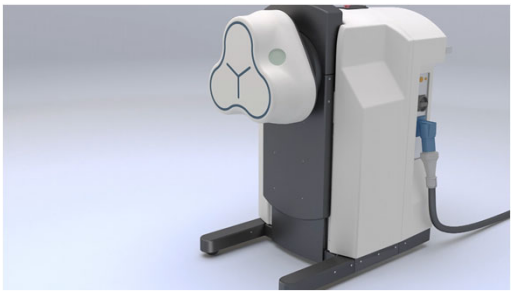
	Manual (n = 7)	Robotic (n = 7)	P value
Technical success*	100%	100%	p = 1
First-pass revascularization success	42.9%	28.6%	p = 0.577

* (Stent retriever deployed and retrieved)

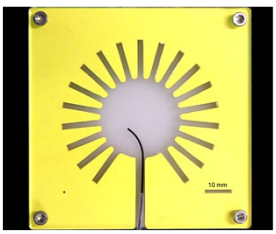
RESULTS - Procedural Time

	Manual (n = 7)	Robotic (n = 7)	P value
Total, sec [95% CI]	357 [314 - 401]	892 [673 - 1111]	p < 0.001
Guide-cath Portion, (Aorta - ICA), sec [95% CI]	74 [68 - 82]	177 [123 - 231]	p < 0.001 (technical difficulty)
Micro-cath Portion, (ICA - M2, thrombectomy), sec [95% CI]	283 [243 - 324]	715 [503 - 927]	p < 0.001 (device loading & unloading)

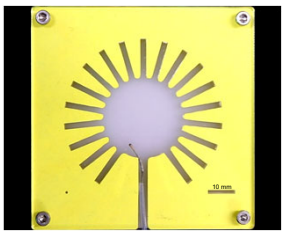
Magnetically-steered catheters are highly versatile by nanoflex



Magnetically-steered catheters are highly versatile by nanoflex



Conventional catheter



Magnetically-steered catheter

Our initial complete robotic thrombectomy using in vitro model suggests

1) robotic thrombectomy may be equivalent to manual in terms of first pass effect,

2) might be inferior to manual in final recanalization rate,

3) longer procedure time than manual (roughly twice as much)

Summary

- Our initial complete robotic thrombectomy using in vitro model suggests 1) robotic thrombectomy may be equivalent to manual in terms of first pass effect, 2) might be inferior to manual in final recanalization, 3) longer procedure time than manual
- Some PSC in California >100miles away of CSC may benefit from remote-robotic thrombectomy.
- Emerging technologies such as magnetically-steered catheters may help improve the procedural flow of remote robotic thrombectomy

Thank you for your attention