Group 9: Predicting hemorrhage related outcomes with CT volumetry for traumatic hemothorax (Room 4)

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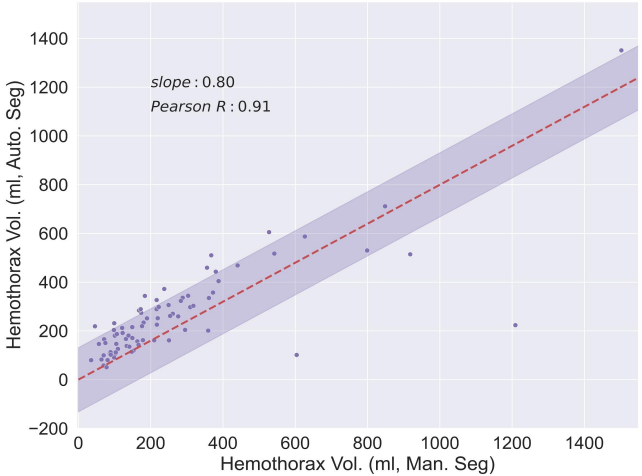
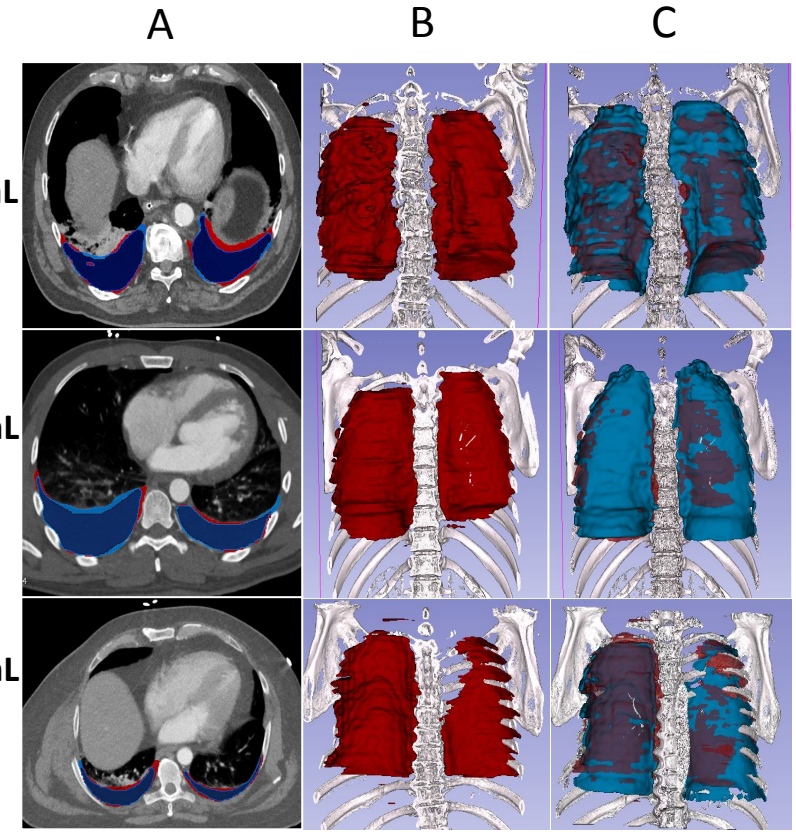
Goals/(Results):

- Automatically quantify blood volume (0.61 Dice)
- Predict the need for massive transfusion (0.944 auROC)

Significance:

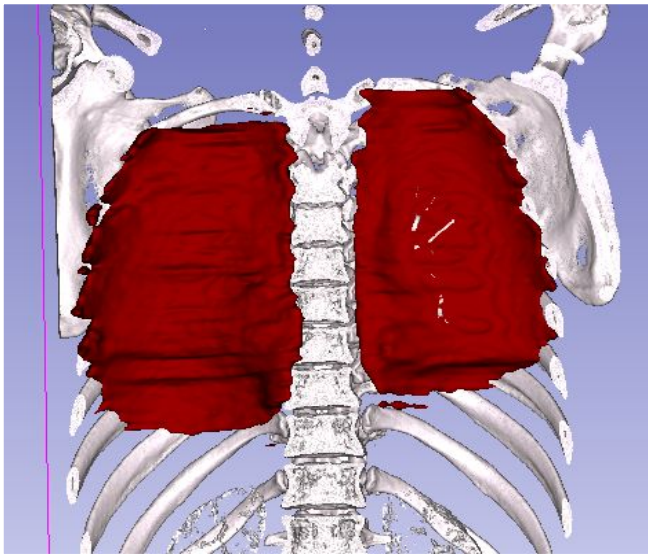
- Much faster and more accurate
- Removes the need for expert presence



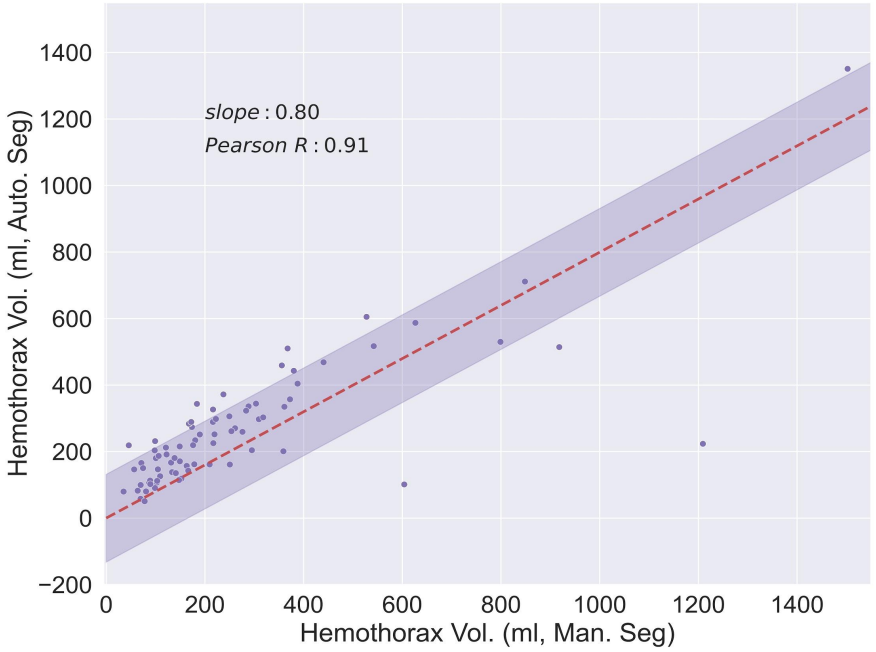


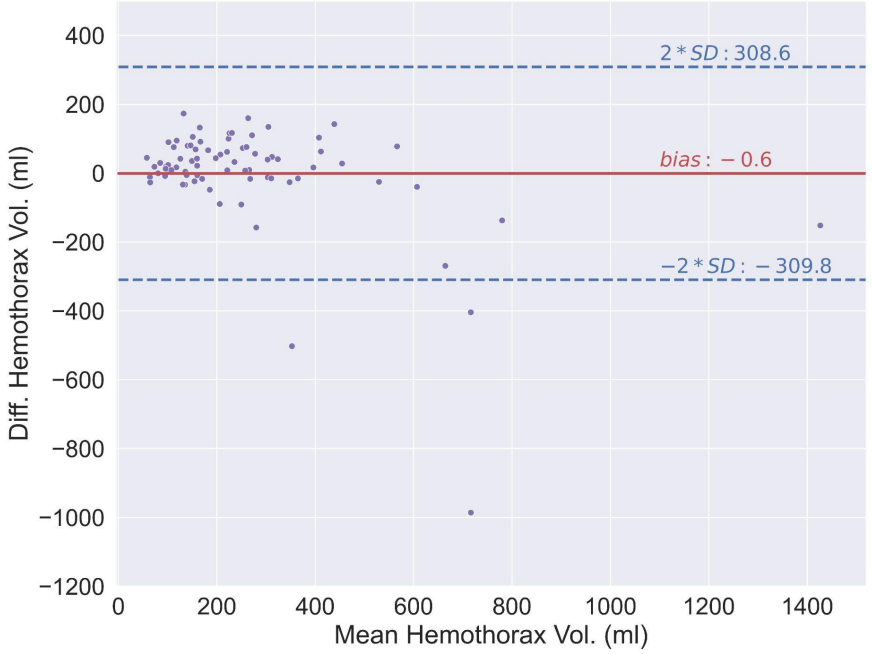
The Problem

- Doctors qualitatively estimate hemothorax volume (bleeding around the lungs) as low, medium, or high
- Life-saving decisions are thus made based on little and/or inaccurate information
- This project is the **first to automate hemothorax volume quantification**
- We also automate prognostics for a composite variable: patient requires massive transfusion or is likely to die



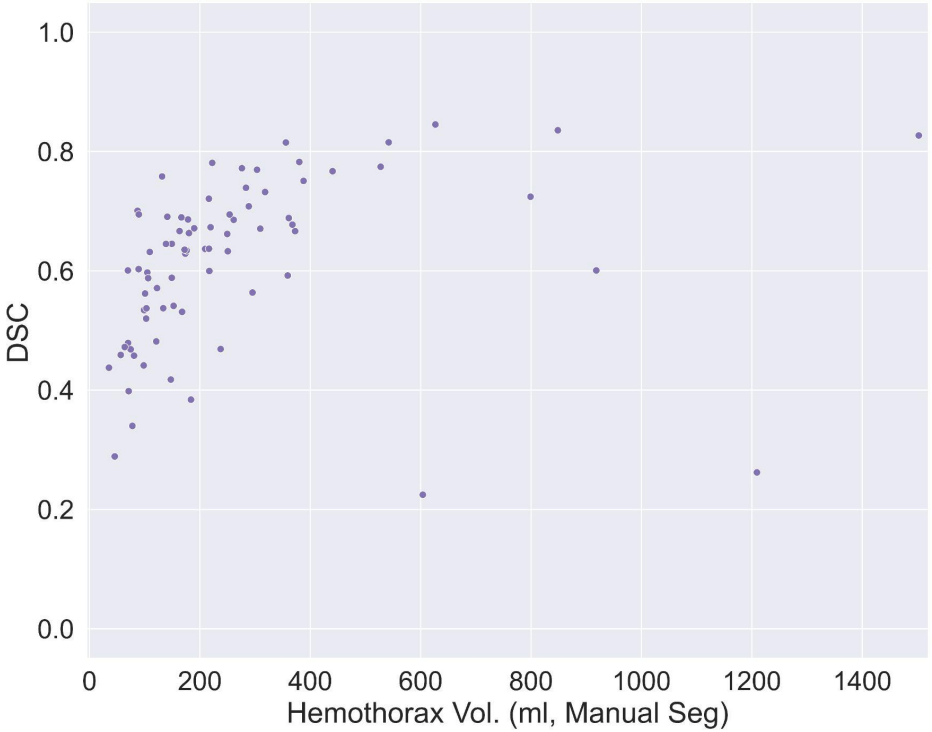
Our deep neural network achieved automated volume prediction that has excellent agreement with the manual volume: adjusted R = 0.91

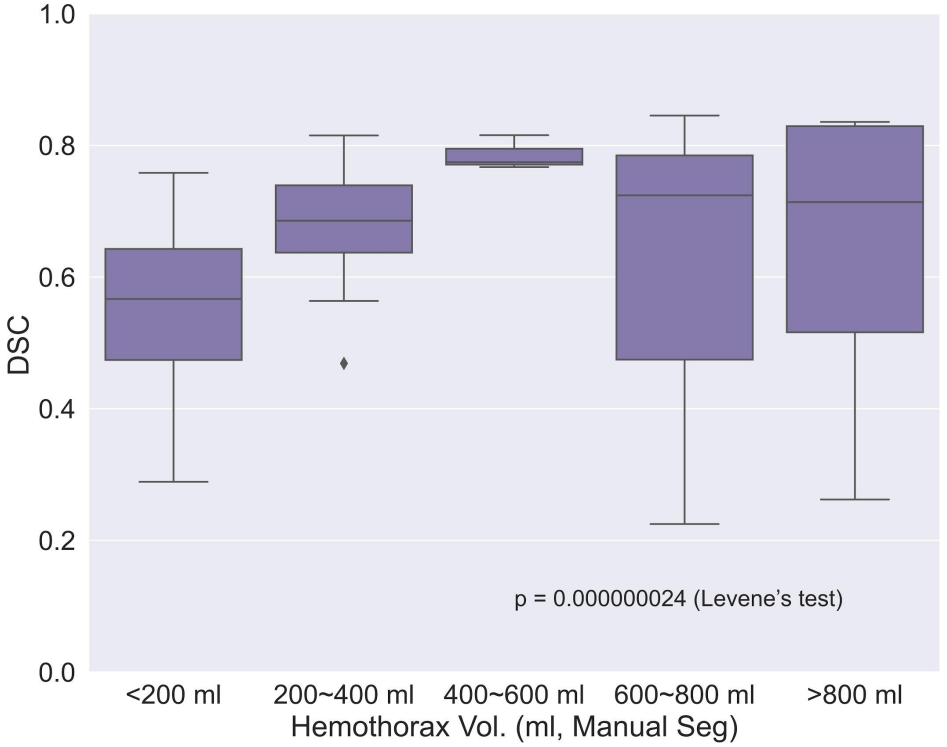




On average, there is only a 0.6-mL underestimation

Dice score vs. volume





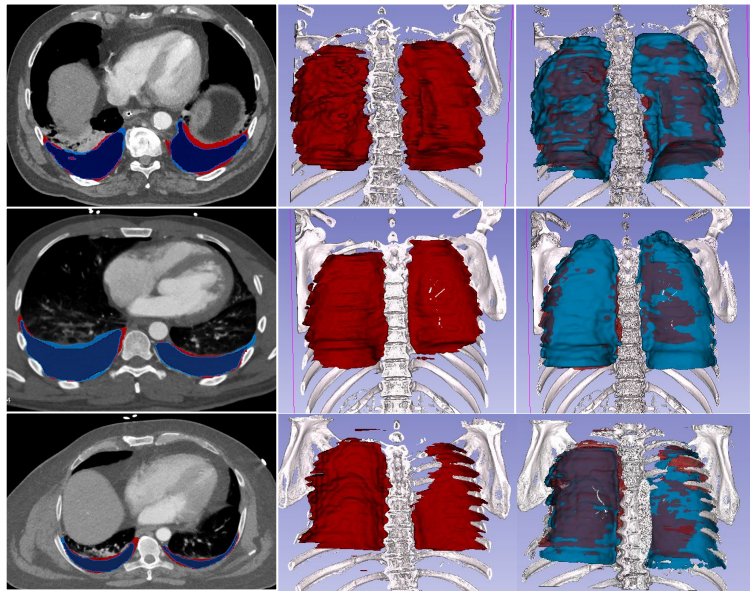
The Dice score improves and has less variance as the volume increase.

A B C

1 **Manual: 1502.5 mL**
Auto: 1350.8 mL
DSC: 0.83

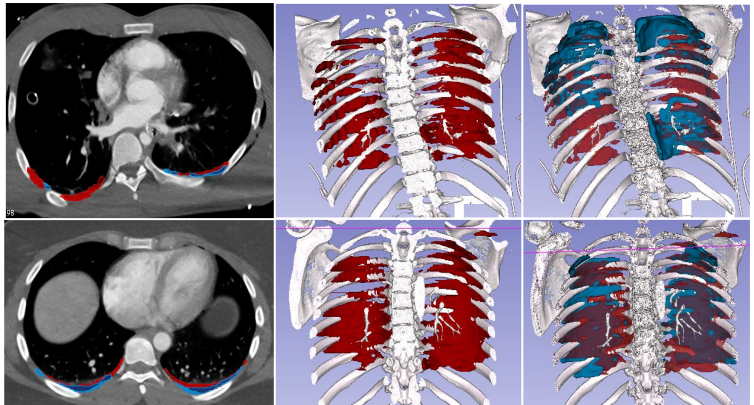
2 **Manual: 848.5 mL**
Auto: 711.2 mL
DSC: 0.84

3 **Manual: 527.5 mL**
Auto: 605.3 mL
DSC: 0.77



4 **Manual: 63.7 mL**
Automated: 82.5 mL
DSC: 0.47

5 **Manual: 80.6 mL**
Auto: 80.2 mL
DSC: 0.46



Visualizations

(A) Overlap (purple) of manual and automated (FAN UNET) hemothorax labels on axial images. **(B)** 3D rendering of automated label. **(C)** 3D rendering of overlap (purple) between automated (red) and manual (blue) labels.

Prediction of composite outcome (MT+IHM) using volumes and clinical data (Age, Sex, HR, BP, lactate, injury-type: blunt/penetrating)

Data	Model	MCC	AUROC	AUPRC_N	AUPRC_P	RMSE
uni_qual	Logistic	0.4931	0.7609	0.6219	0.6590	0.5390
uni_ufan	Logistic	0.1746	0.7081	0.7232	0.4900	0.5344
mul_qual	RF	0.6370	0.9450	0.9860	0.8550	0.2829
mul_ufan	RF	0.6870	0.9440	0.9870	0.7680	0.2831

Our prediction reaches an auROC of 0.9440. This is at least as good as using expert information from 2 radiologists.

Future Work

1. Add data augmentation
2. Use a more sophisticated loss function
3. Real-world clinical application

Lessons Learned

1. Under-estimated time needed for deliverables, especially for the maximal deliverables
2. Agile development was more effective than waterfall methods
3. Concentrate developer time on related tasks was most effective
4. Make scripts flexible with respect to directory structures was important

Acknowledgements

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