



Nottingham  
Gastrointestinal  
& Abdominal  
Imaging Group



# Improved multiphase liver CT scan quality with implementation of an optimised IV contrast protocol: A quality improvement project

Dewen Meng, Rahul Munyal, Pedro Vicente, Joao Martins, Aloysious Aravinthan, Anmol Gangi-Burton, Christopher Clarke

Nottingham University Hospitals NHS Trust

# Background

- Technical variables that impact detection of liver lesions include time delay from the start of contrast injection, contrast dose, contrast concentration and injection rate [1].
- Hypervascular liver lesions including HCC rely on adequately timed and well opacified CT imaging for appropriate lesion detection and characterisation [2].
- Late arterial phase scan protocols should be **patient-specific** and use **rapid bolus injections** of **large** contrast material doses followed by a rapid bolus injection of saline [3].

## Aims

To *qualitatively and quantitatively* assess the quality of CT liver images pre- and post-implementation of a **bolus-tracked and weight-based** intravenous contrast CT liver protocol

# Methods

- A quality improvement project with retrospective data collection
- 50 consecutive patients in each group

	Pre-implementation (07/01/2021- 05/07/2021)	Post-implementation (06/03/2023- 08/07/2023)
<b>Contrast dose</b>	Fixed	Weight-based
<b>Contrast injection rate</b>	Fixed	Bolus-tracked

	Omnipaque 300			Omnipaque 350	
Weight (kgs)	Omni 300 (mL)	Flow Rate (mL/s)	Weight (kgs)	Omni 350 (mL)	Flow Rate (mL/s)
40	72	4.0	40	60	4.0
41	74	4.0	41	62	4.0
42	76	4.0	42	63	4.0
43	77	4.0	43	65	4.0
44	79	4.0	44	66	4.0
45	81	4.0	45	68	4.0
46	83	4.0	46	69	4.0
47	85	4.0	47	71	4.0
48	86	4.0	48	72	4.0
49	88	4.0	49	74	4.0
50	90	4.0	50	75	4.0
51	92	4.0	51	77	4.0
52	94	4.0	52	78	4.0
53	95	4.0	53	80	4.0
54	97	4.0	54	81	4.0
55	99	4.0	55	83	4.0
56	101	4.0	56	84	4.0
57	103	4.0	57	86	4.0
58	104	4.0	58	87	4.0
59	106	4.0	59	89	4.0
60	108	4.0	60	90	4.0
61	110	4.0	61	92	4.0
62	112	4.0	62	93	4.0
63	113	4.0	63	95	4.0
64	115	4.0	64	96	4.0
65	117	4.0	65	98	4.0
66	119	4.0	66	99	4.0
67	121	4.0	67	101	4.0
68	122	4.1	68	102	4.0
69	124	4.1	69	104	4.0
70	126	4.2	70	105	4.0
71	128	4.3	71	107	4.0
72	130	4.3	72	108	4.0
73	131	4.4	73	110	4.0
74	133	4.4	74	111	4.0
75	135	4.5	75	113	4.0
76	137	4.6	76	114	4.0
77	139	4.6	77	116	4.0
78	140	4.7	78	117	4.0
79	142	4.7	79	119	4.0
80	144	4.8	80	120	4.0
81	146	4.8	81	122	4.1
82	148	4.9	82	123	4.1
83	149	5.0	83	125	4.2
84	151	5.0	84	126	4.2
85	153	5.1	85	128	4.3
86	155	5.2	86	129	4.3
87	157	5.2	87	131	4.4

# Methods

## Quantitative approach

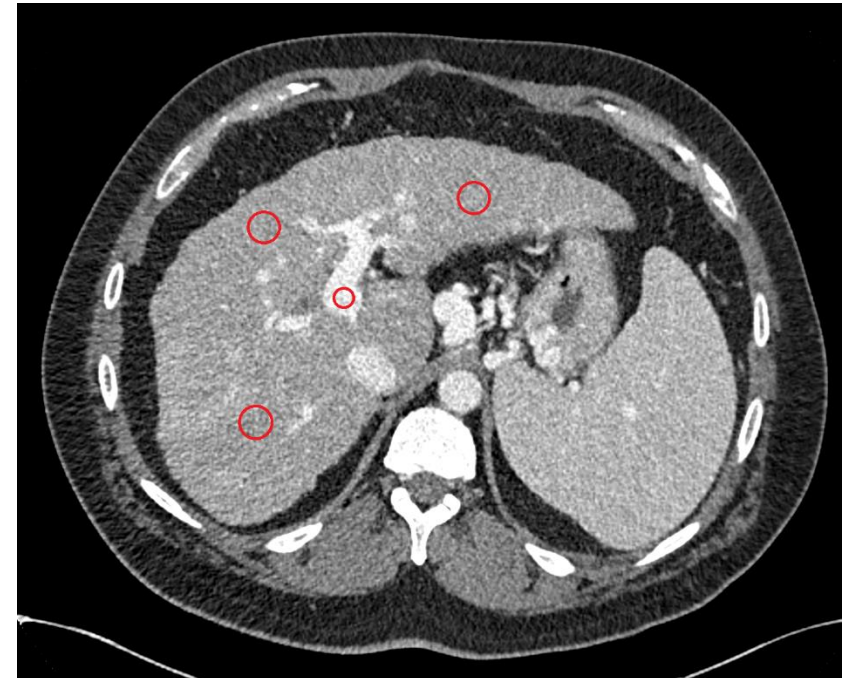
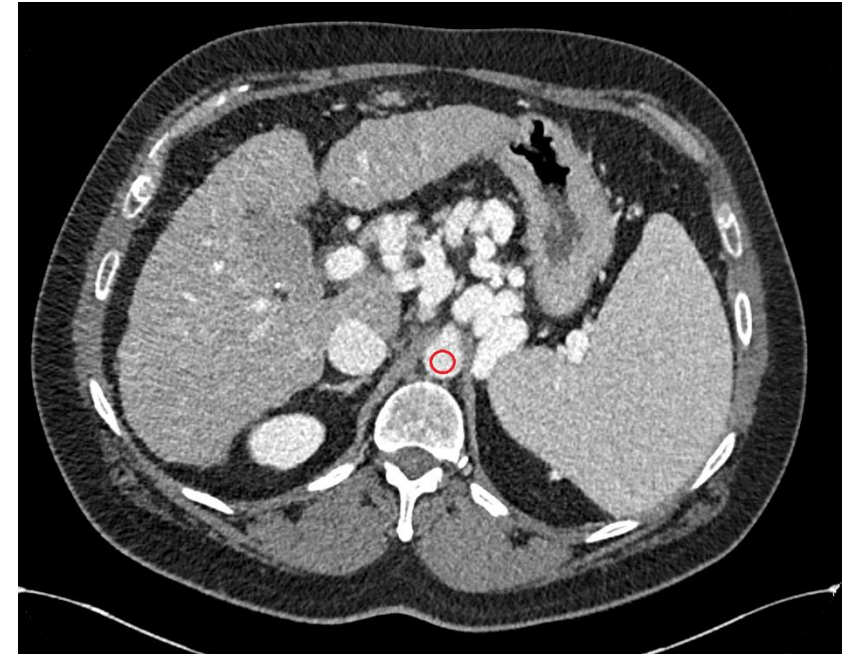
1. ROI delineation
  - One ROI (1 cm<sup>2</sup>) at the coeliac trunk level of abdominal aorta
  - Three ROIs (3 cm<sup>2</sup>) at the liver (avoid lesions and vessels)
  - One ROI (1 cm<sup>2</sup>) at the intrahepatic portal vein

## Qualitative approach

1. Visual assessment as to whether the late arterial phase was timed correctly

## Statistical analysis

1. Shapiro-Wilk test to check the distribution of continuous variables
2. T-test for group difference of normally distributed continuous variables
3. Mann Whitney U test for group difference of not normally distributed continuous variables
4. Chi-squared test for group difference of categorical variables

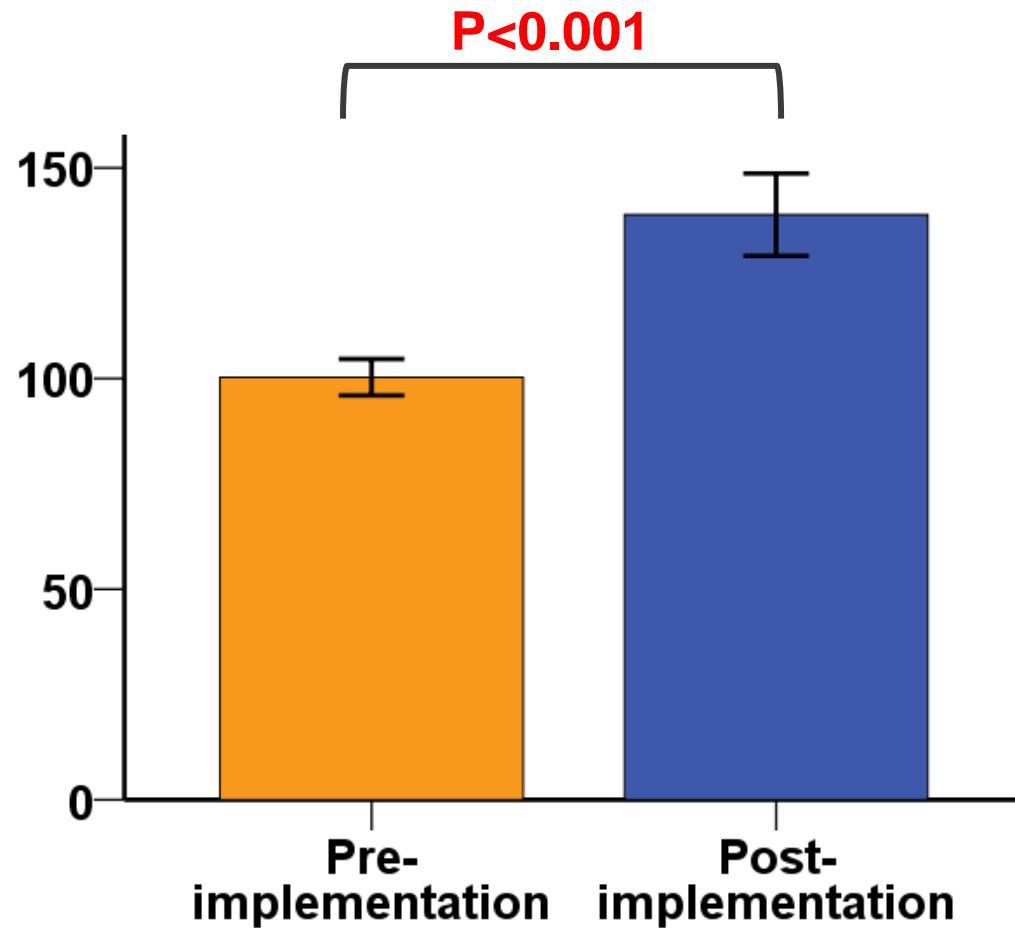


## Results: Demographics

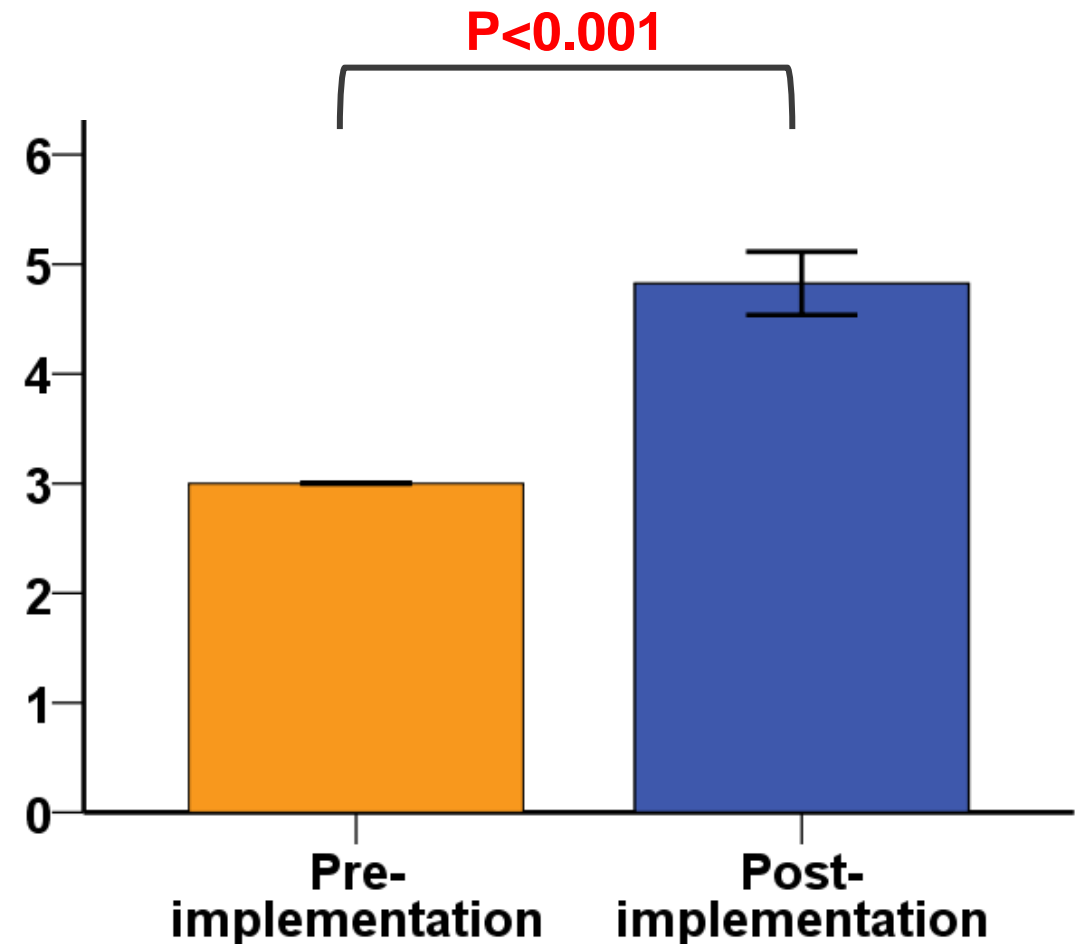
	Pre-implementation	Post-implementation	P
Age, mean (SD)	68 (9.4)	65 (11.4)	0.08
Female, n (%)	12 (24%)	11 (22%)	0.81

## Quantitative results: Contrast dose and rate

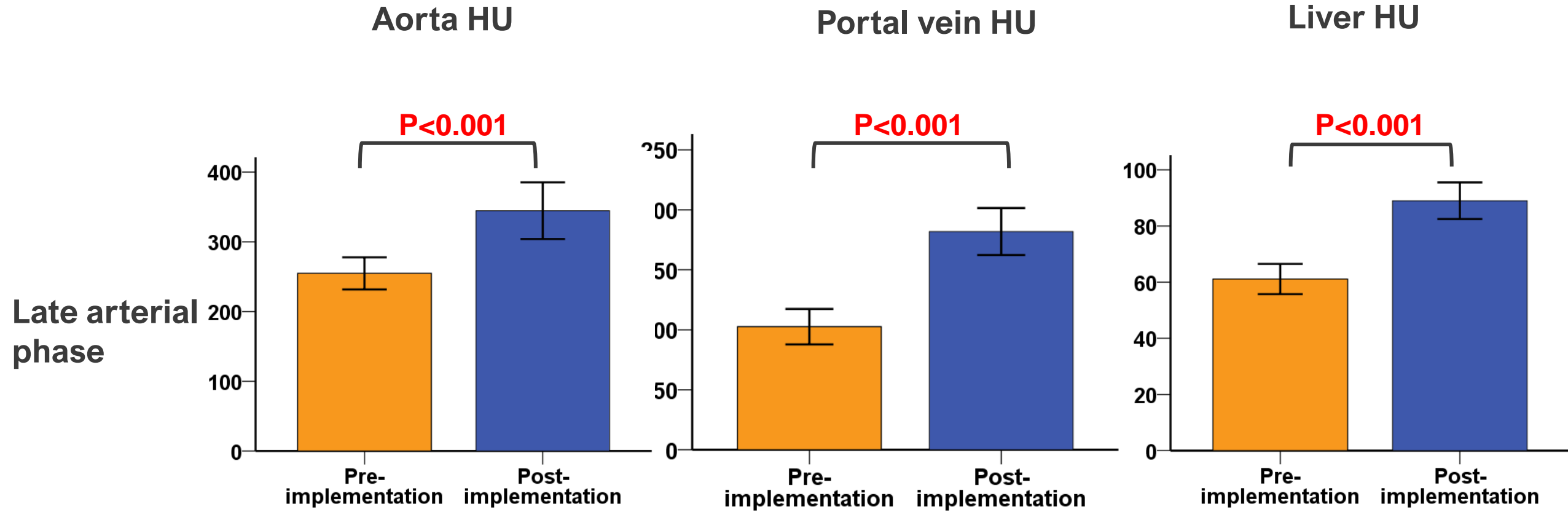
Mean contrast dose (ml)



Mean contrast injection rate (ml/s)

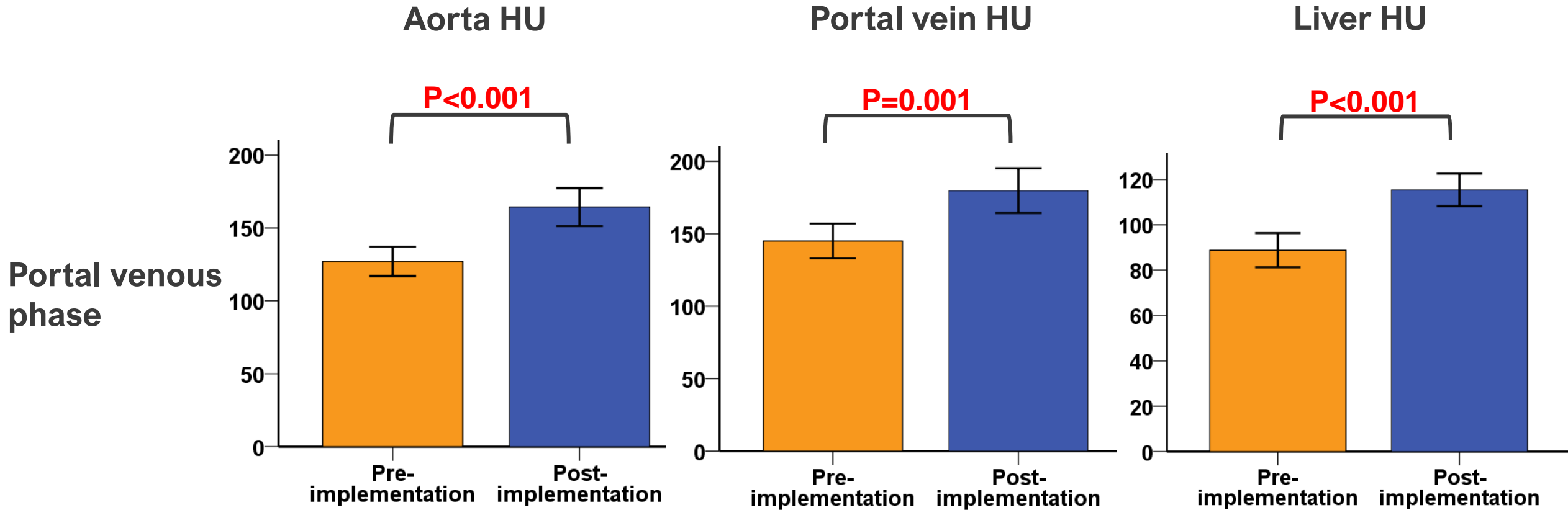


# Quantitative results





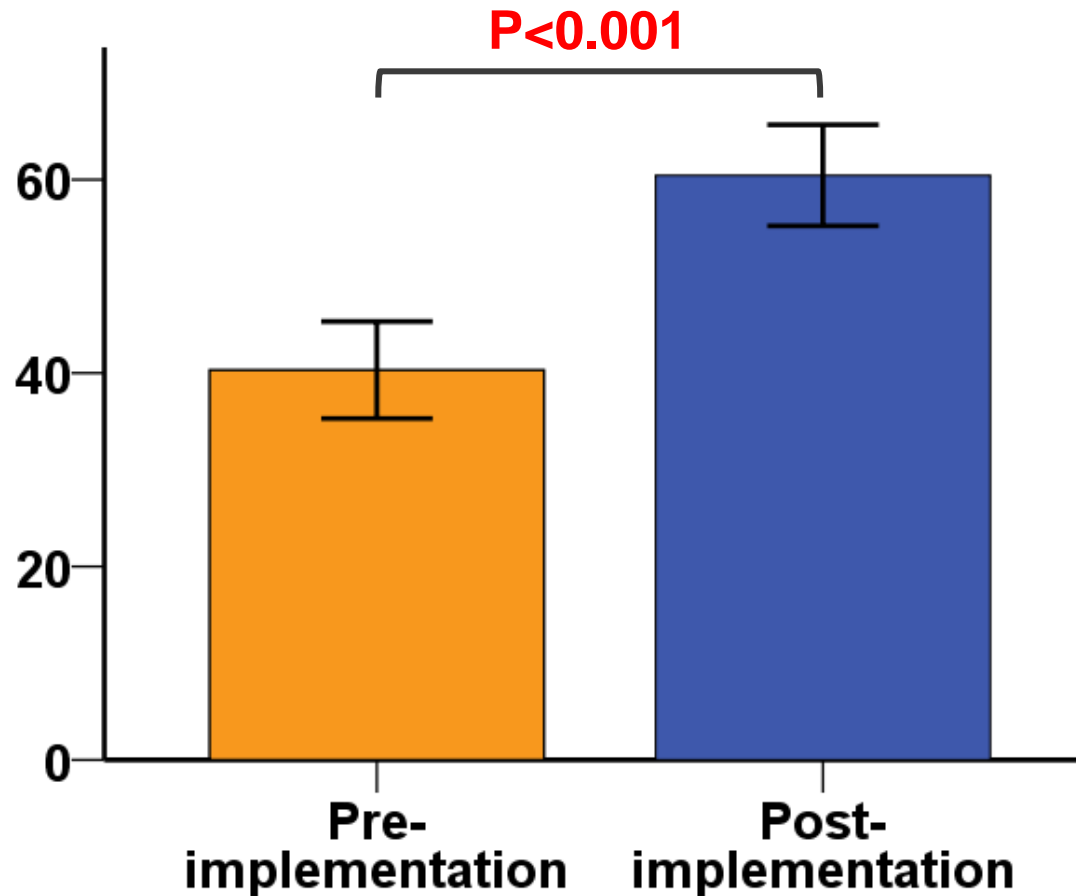
# Quantitative results



# Quantitative results

Mean of liver  $\Delta$ HU (from non-contrast phase to portal venous phase)

	Pre-implementation	Post-implementation
Mean $\pm$ SD	40.3 $\pm$ 17.7	60.4 $\pm$ 18.4

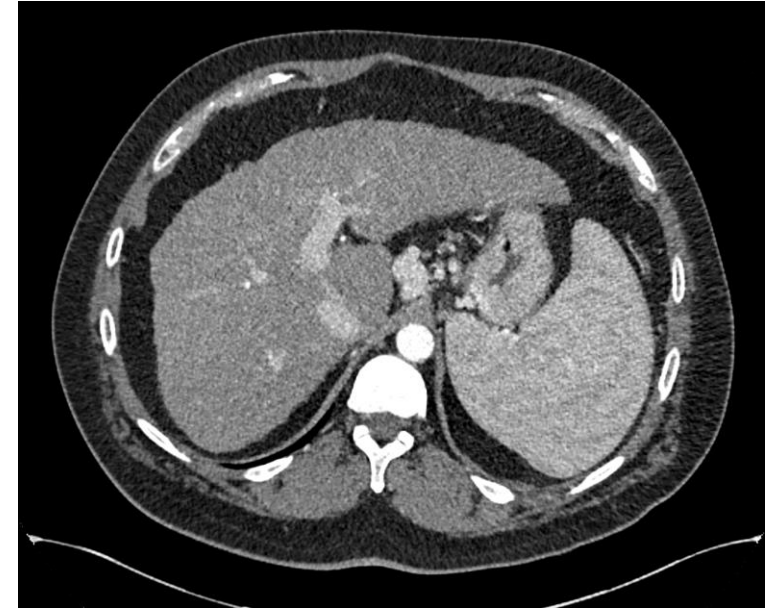
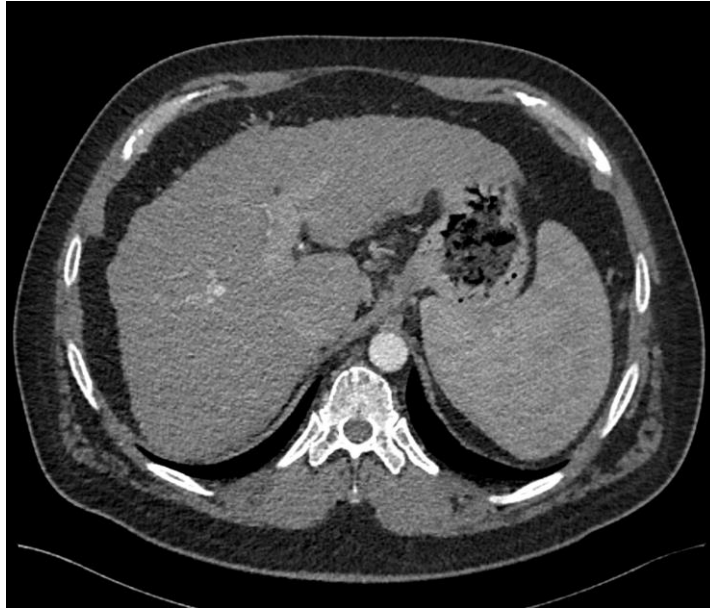


# Qualitative results

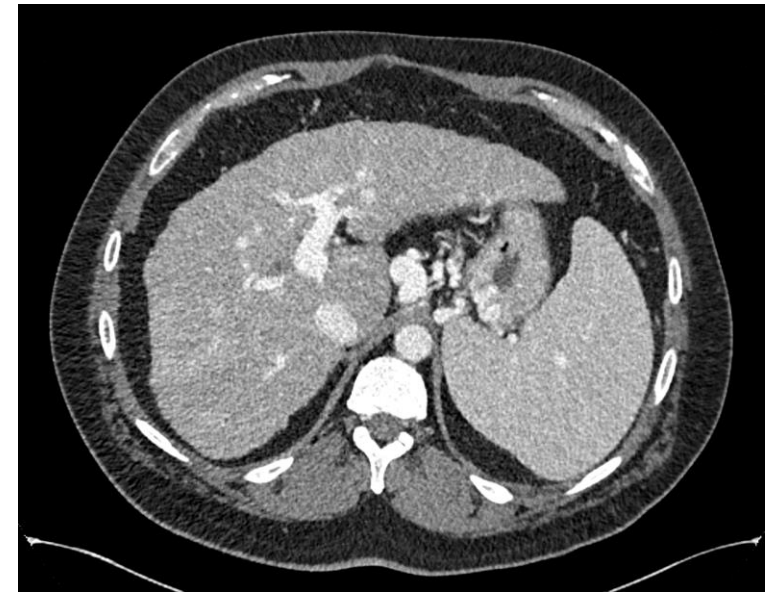
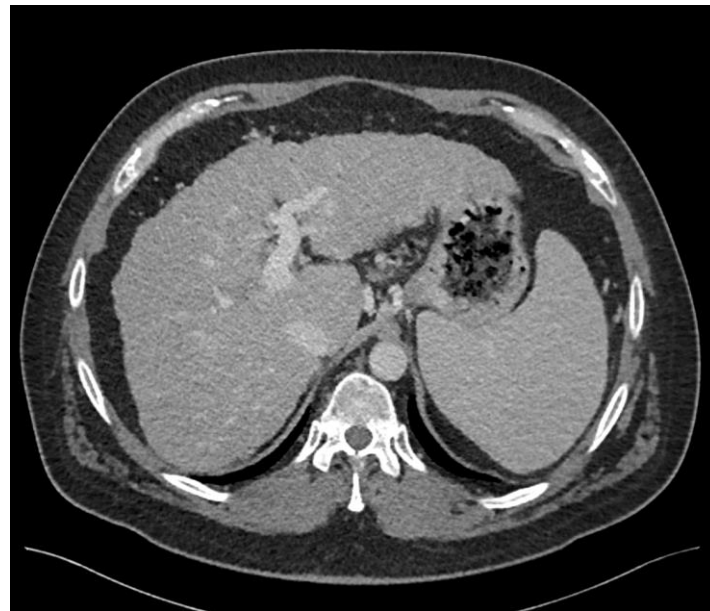
Pre-implementation

Post-implementation

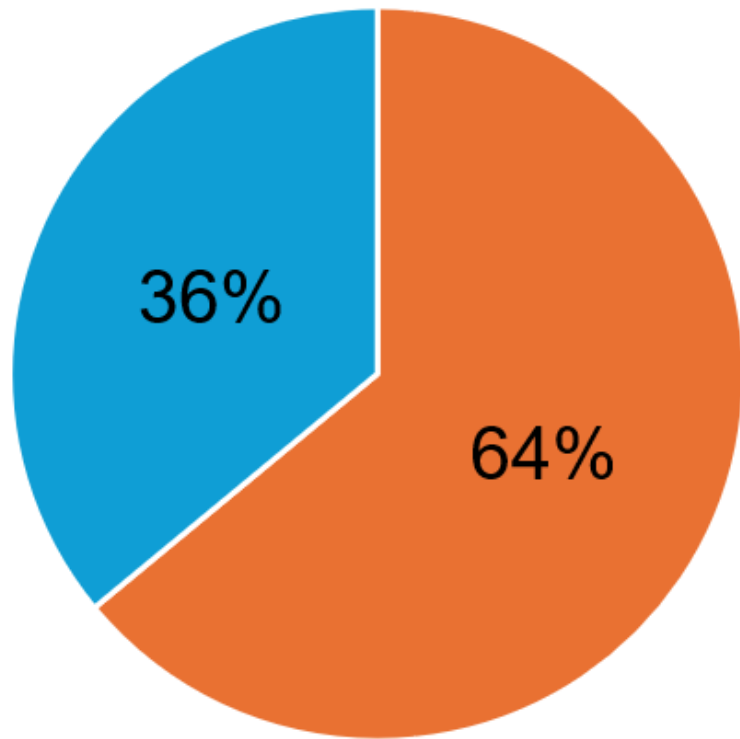
Late arterial phase



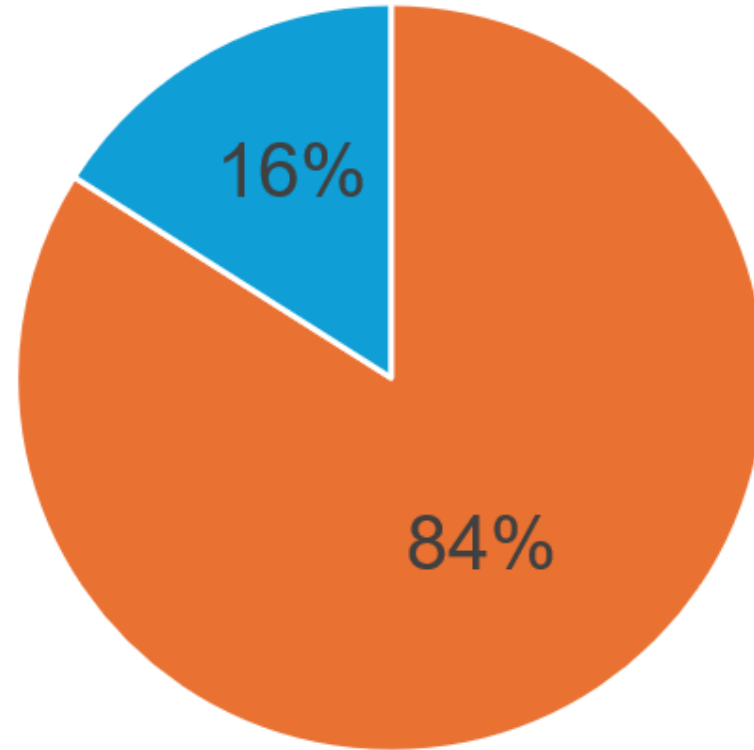
Portal venous phase



# Qualitative results: Scan timing for the late arterial phase scan



Pre-implementation



Post-implementation

- Appropriate
- Too early

	Pre-implementation	Post-implementation	P
Appropriate	32	42	0.039
Too early	18	8	

# Conclusion

- Implementation of a ***bolus-tracked, weighted-based*** IV contrast CT liver protocol ***significantly improved*** image quality and lesion depiction
- Relatively easy to implement and has been rolled out to regional hospitals
- Improve confidence for diagnosing lesions

# Acknowledgements

CT radiographer team, CT management team and data team in the NUH trust

## Reference

1. Bae, K. T. (2010). "Intravenous Contrast Medium Administration and Scan Timing at CT: Considerations and Approaches." *Radiology* 256(1): 32-61.
2. Jiang, J., et al. (2021). "An individualized Contrast-Enhanced Liver Computed Tomography Imaging Protocol Based on Body Mass Index in 126 Patients Seen for Liver Cirrhosis." *Medical Science Monitor* 27.
3. Kulkarni, N. M., et al. (2021). "Computed Tomography Techniques, Protocols, Advancements, and Future Directions in Liver Diseases." *Magn Reson Imaging Clin N Am* 29(3): 305-320.