MESA Lung IV and
MESA Lung Non-Smokers
Lung Computed Tomography (CT)
Manual of Procedures

September 1, 2022 - Version 1.2

1. Background

1.1 The MESA Lung Study IV

The MESA Lung Study IV is measuring lung structure among over 2,000 MESA participants who previously enrolled into the MESA Lung Study. The MESA Lung Study IV is examining the role of lung perfusion in chronic obstructive pulmonary disease (COPD) and emphysema. COPD is now the third-leading cause of death in the US and much of the world; however, few preventative strategies are available for COPD besides smoking cessation and avoidance.

1.2 The MESA Lung Non-Smoker Study

The MESA Lung Non-Smoker Study is measuring lung structure among 650 non-smokers in MESA. The MESA Lung Non-Smoker Study is examining if airway anatomy is a risk factor for COPD in non-smokers.

1.3 Combined Protocol for the MESA Lung Study III and Non-Smoker Study

The MESA Lung IV Study and the MESA Lung Non-Smoker Study CT are designed to be well-integrated into MESA Exam 7. Participants in both studies with undergo lung CT, in addition to spirometry and a lung questionnaire. We therefore have one Manual of Procedures for CT for MESA Lung Study IV and MESA Lung Non-Smoker Study. The details of the spirometry are included in the MESA Lung IV Non-Smokers Spirometry Manual of Operations. The additional procedures are summarized in the following table:

Procedure	**MESA Lung IV** (n=~2,000, all FC)	**MESA Lung Non-Smoker** (n=650, all FC)
Spirometry Pre-bronchodilator Post-bronchodilator	 X if airflow obstruction	 X if airflow obstruction
Lung CT scan Non-Contrast Contrast	X 1,000 1,000	X 650 0
Selection form/questionnaire	X	X

X= all participants

1.4 Lung CT

The non-contrast lung CT protocol permits measurement of pulmonary emphysema, airways disease, and gas-trapping.

2.1 Participant Selection

All MESA Exam 7 participants, except those with a cumulative radiation dose from prior MESA CT studies > 26 mSv, will be asked to consent for MESA Lung IV / Non-Smoker procedures including the non-contrast lung CT protocol.

3 CT Certification and Quality Control

3.1 Certification of Imaging Technologists

CT technologists at each site will receive webinar and certification provided by the CT Reading Center. A test will be administered at the end of the online tutorial.
Technologist privileges with respect to MESA CT scanning can be revoked as deemed necessary by the Radiology Coordinating Center, site Radiologist, site PI or overall PI.

3.2 Breath Hold Technique for Scanning Procedure

In order to obtain appropriate image data, unique breathing instructions are required. These instructions are found in Appendix B. Before the scans are acquired, the MESA coordinator or trained CT technologist will review the breathing instructions with the participant and emphasize the importance of following them as closely as possible during the actual imaging of the lungs.

3.3 Quality Control

The site study coordinator will take responsibility to provide the radiology technologist with the tech form and subject specific Procedural Verification Software (PVS) form upon delivery of the subject to the CT suite and will remain in the CT control room during scanning to assure that appropriate breath hold instructions are being given.

The MESA CT protocol should be saved in the protocol list of the designated CT scanner and used for each subject. All CT scanners used in MESA must be certified with a phantom (COPDGene Phantom) scanned with the study settings. These settings are confirmed by the CT Reading Center prior to each site starting the study. This phantom scan will provide checks for protocol adherence and proper calibration of the CT scanner. The initial phantom scan from any new CT scanner must be sent to the University of Iowa via DISPATCH for scanner approval prior to scanning human subjects. Phantom scans not meeting the scanning protocol defined by this MOP (See Appendix A for CT protocols) will be rejected by the Radiology Center with an explanation regarding the nature of the failure and how to correct for it. If it is a post-processing issue such as the wrong DFOV, slice thickness or slice spacing, it can be fixed with an additional reconstruction as opposed to a rescan. If the problem is related to scan acquisition, i.e. wrong mA/mAs, kV, pitch, or exposure time, the phantom must be re-scanned. Scanners may also be rejected if the scanner does not meet calibration criteria. Once the scanner is approved, monthly scans must be completed for quality assurance purposes and transmitted via DISPATCH. These ongoing phantom scans should be continued through the course of the study. If phantom scans show a scanner to deviate from the approved baseline measures, decisions regarding continuation of scanning will be made through a consultation between the Radiology Center, site Radiologist

and Site PI. Questions or concerns regarding scanning of the phantom may be referred to the University of Iowa.

3.4 Monitoring

All MESA datasets from participants and phantoms will be transferred to University of Iowa Radiology Center within 5 working days of its performance to ensure protocol compliance. A monthly report will be generated and sent to the DCC and each site's PI, lead coordinator and radiologist.

Once the scan is received, the Radiology Center will confirm that the radiation dose utilized was consistent with the radiation risk language in the site's Informed Consent and with the MESA CT Manual of Procedures.

For any apparent violation of the proposed range of radiation exposure and from the site's Informed
Consent, the University of Iowa will send an electronic violation report describing the issue to the DCC, site PI, coordinator, and PI. CT scanning will be suspended at that site or overall for major violations. All violations will be reported to their sites' local IRB's.

Other types of protocol errors will be classified as "deviations" and are those protocol issues that do not result in non-approved radiation exposure. Examples of these deviations are, excessive clipping of the lungs, incorrect reconstruction kernel used, CT data lost, and CT tech not certified, etc.

3.4 Data Transfer & Storage

DISPATCH (DICOM Selection Parser and Transfer Check), University of Iowa, is an automated system that imports medical image data that has been stored in a standardized file format known as DICOM (Digital Imaging and Communications in Medicine) and provides a mechanism of transmitting that data elsewhere via the internet in a secure manner. DISPATCH runs on the transferring site's local machine and uses a web-based application to transfer imaging data. Only deidentified scan data should be transmitted.

Subsequently deidentified scans may be transmitted via secure FTP to CUMC.

All MESA reconstructions must be archived and stored at the site.

3.5 Over-reading

As described elsewhere in the MESA protocol, all scans will be over-read by a radiologist in a timely manner. Local radiologists will perform these reads at Wake Columbia, Johns Hopkins, and Northwestern. Central (CUMC) radiologists will perform these reads for Minnesota and UCLA scans.

As described and defined elsewhere in the MESA protocol, alerts will be reported as soon as read. Nodules will be reported following the LungRADs recommendations for participants who

meet USPTF criteria for lung cancer screening (defined by data self-reported by MESA participants to MESA elsewhere in the exam); for other participants who are at lower risk of lung cancer (eg the 50+% of nonsmokers in MESA), a more conservative threshold of >=8mm nodules will be used for reporting.

Written reports of alerts and nodules meeting the above criteria will be provided to participants and, if they chose, their physicians. Nodules not meeting these criteria will not be reported.

The presence or absence of emphysema will be included in the MESA results letter for all participants.

APPENDIX

A. CT Protocols

***IMPORTANT: Dose modulation enabled – To ensure optimal dose modulation and reduction, the below parameters must be input after first selecting a Siemens default routine adult chest protocol. To determine your scanner's software version and, in turn, which quality reference mAs value to use, please navigate in the scanner's top toolbar to Help > About Somaris/7, and the version will be listed under the logo at the end of the first line of text (e.g. "Somaris/7 syngo CT VB20"). This protocol was developed with all three thorax dose configurations (CARE Dose curves) set to average. Please verify the thorax dose configurations on your scanner (Options > Configuration > Examination > Dose card), and contact us if any of the thorax body types are set to anything other than average. Additionally, for each subject, a lateral scout MUST be performed for iso-centering adjustment followed by an AP scout before any helical scans are performed.**

Parameters	Siemens SOMATOM Definition Flash	Siemens SOMATOM Drive	Siemens SOMATOM Force
Organ Characterisitc	Thorax: Ensured by first selecting a Siemens default routine chest protocol before proceeding with the below parameters and saving the protocol to the scanner		
Detector Configuration (amount x mm)	128 x 0.6	128 x 0.6	192 x 0.6
Rotation Time (s)	0.5	0.5	0.25
Pitch	1.0	1.0	1.0
kVp	120 (CARE kV Off)	120 (CARE kV Off)	120 (CARE kV Off)
Dose Modulation	CARE Dose4D On	CARE Dose4D On	CARE Dose4D On
Quality Reference mAs - Software Versions 2012B, VA48/VG76, VA50	62	62	Inspiratory: 36 Expiratory: 15
Quality Reference mAs - Software Versions VA62, VB10, VB20/VG80	43	43	Inspiratory: 25 Expiratory: 10
Slice Thickness x Spacing (mm)	0.75 x 0.5	0.75 x 0.5	0.75 x 0.5
Kernel & Iterative Settings - Software Versions 2012B, VA48/VG76, VA50	Q30/5	Q30/5	Qr40/5

Kernel & Iterative Settings - Software Version VB20	Qr40/5	Qr40/5	Qr40/5
Approximate Dose For Single 30cm Scan for Average-Sized Adult	CTDIvol: 3.51 mGy Eff. Dose: 2.36 mSv	CTDIvol: 3.42 mGy Eff. Dose: 2.30 mSv	**Inspiratory** CTDIvol: 2.21 mGy Eff. Dose: 1.49 mSv **Expiratory** CTDIvol: 0.87 mGy Eff. Dose: 0.58 mSv

B. Breathing Instructions

Inspiration – Total Lung Capacity (TLC)

"For this scan I am going to ask you to take a couple of deep breaths in and out before we have you breathe all the way in and hold your breath.

Take a deep breath in *(watch chest to ensure a deep breath in)*
Let it out *(watch chest to ensure air is out)*
Take a deep breath in *(watch chest to ensure a deep breath in)*
Let it out *(watch chest to ensure air is out)*
Now breathe all the way IN... IN... IN and HOLD IT IN *(watch chest to ensure a deep breath in as far as possible)*

Keep holding your breath – DO NOT BREATHE
At end of scan or practice - **Breathe and relax**."

Expiration – Functional Residual Capacity (FRC)

"For this scan, I am going to ask you to take a couple of deep breaths in and out before breathing in one last time and then gently letting your breath out, similar to a sigh, and holding it out.

Take a deep breath in *(watch chest to ensure a deep breath in)*
Let it out *(watch chest to ensure air is out)*
Take a deep breath in *(watch chest to ensure a deep breath in)*
Let it out *(watch chest to ensure air is out)*
Take another deep breath in *(watch chest to ensure a deep breath in)*
Now relax, and gently let your breath out *(watch for relaxed expiration and neutral chest position)*
Now hold your breath – DO NOT BREATHE
At end of scan or practice - **Breathe and relax**."

Expiration – Residual Volume (RV)
ONLY PERFORMED AT SITES WITH A SIEMENS SOMATOM FORCE

****Designate and practice hand signal before beginning.***

Take a deep breath in *(watch chest to ensure a deep breath in)*
Let it out *(watch chest to ensure air is out)*

Take a deep breath in *(watch chest to ensure a deep breath in)*
Let it out *(watch chest to ensure air is out)*
Take another deep breath in *(watch chest to ensure a deep breath in)*
Now let it all the way OUT... OUT... OUT... as much as possible, and signal to me when you have no more air left and HOLD IT OUT *(watch chest to ensure all air is out and for hand signal before starting the scan)*

Keep holding your breath – DO NOT BREATHE
At end of scan or practice **- Breathe and relax."**