## G61 Postmortem Lung CT in Hypothermia — A Retrospective Age Sex Matched Study

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After attending this presentation, attendees will have a better appreciation for the forensic pathologists use of postmortem scanning to investigate pulmonary anatomy and pathology.

This presentation will impact the forensic science community by adding a morphological clue to possible hypothermia cases. That finding is a low density of lung tissue in CT scans. This is a radiological correlate of acute emphysema or overinflation of the lungs. Pathophysiologically, this is possibly mediated by a shifted oxygen-hemoglobin dissociation curve in hypothermia.

**Methods and Material**: Since 2010, in the Institute of Forensic Medicine of the University of Zurich, all bodies undergo postmortem CT full body scanning before autopsy. Group H (hypothermia) was defined to contain all deceased between 2010 and April 2012 who died with the pathological diagnosis of hypothermia. Diagnosis of hypothermia had been based on a range of factors such as being plausible due to circumstances, gastric erosions, or a positive test for ketone bodies in urine and no radiological findings were used at the time to suggest hypothermia. Control group C was selected by randomly selecting individuals from the same period, in a way that allowed for an age and sex match. Cases with intensive care treatment for hypothermia and with no hypothermia immediately preceding death were excluded. Group C was selected to not contain strangulation, drowning, and macroscopic lung injuries. Axial CT slice images containing the lungs were used for further analysis. Each lungs area was examined in two locations, one above and one below the hilus. The whole lung area up to around 5-10mm underneath the outline of the pulmonary parenchyma was manually marked using software. Hypostatic dense tissue or subpleural bullous emphysema was not marked. The average CT density (HU: Hounsfield units) was then obtained for the marked areas. Readings were obtained twice independently by two readers and subsequently averaged. CT scans were obtained on Siemens CT scanners (Siemens, Erlangen, Germany). SECTRA PACS software (Sectra Imtec AB, Linkoping, Sweden) was used to view the CT scans and obtain CT density measurements. Statistical evaluation was done using the R package (R Foundation for Statistical Computing, Vienna, Austria). Approval of the relevant bodies was obtained, ethical regulations were respected.

**Results:** Hypothermic bodies contained lungs with significantly lower CT density (-764 +/- 67 HU) compared to age and sex matched controls (-546 +/- 154 HU; Wilcoxon $p < 0.001$). Keeping in mind the restricted scope of the control group (as we excluded a number of diagnoses), logistic regression would predict the hypothetic presence of hypothermia at exceeding 90% for CT lung densities under-780 HU.

**Discussion:** Hypothermic indivuals might exhibit pulmonary findings of suffocation such as the CT appearance of lower density, quite possibly indicating acute overinflation. This is not an unjustified assumption — at 20 – 22°C, the oxygen-hemoglobin dissociation curve resembles the curve found for carbonmonoxide poisoning with 60% carbon monoxide-hemoglobine blood levels. In hypothermia, ventricular fibrillation or asystole is preceded by a left shift of the hemoglobin-oxygen dissociation curve. Cold temperatures cause oxygen molecules to adhere to hemoglobin more. As a result, tissues cannot take up oxygen as well because hemoglobin does not release it that well. This in turn can cause a range of complications. One of these complications is that a left shift of the oxygen-hemoglobin curve in itself is a factor promoting metabolic alkalosis which in turn might entail hyperventilation but which appears to be counteracted, at least to a degree, by lactacidosis due to tissue hypoxia and by respiratory acidosis (reduced carbon dioxide exhalation). Shallow and slow breathing as well as progressive bradycardia seem to reflect an adapted response, but more likely in individuals whose metabolism has sufficiently slowed down as response to hypothermia. An increase in breathing volume, particularly while tissues and cells are not sufficiently cooled down themselves, might then explain our findings. With that, acute emphysema or overinflation of the lungs could indicate that internal suffocation and, in fact, increased and not decreased breathing volumes may play a role in hypothermic death. At any rate, low CT density of lungs in postmortem CT scans should be investigated as a possible clue for hypothermia.

**CT Scanning, Radiology, Forensic Pathology**