Undernutrition and perioperative nutrition in cardiac surgery

Undernutrition is common in cardiac surgery and increases the risk of adverse postoperative outcome. As a high percentage of undernourished patients remains unidentified, screening and assessment of undernutrition has to be improved.

The ratio between the precursor and inhibitor of nitric oxide (NO), the arginine/asymmetric dimethylarginine (ADMA) ratio, may be a better indicator of cardiovascular function and clinical prognosis compared to ADMA solely. Increasing the arginine/ADMA ratio by supplementation of nutrition might be beneficial for cardiac perfusion and metabolism. Nutrition supplied before, during, and after surgery has not been investigated before while it can be hypothesized that avoidance of fasting might be beneficial for cardiac metabolism and postoperative recovery.

Therefore, the aim of this thesis was to improve identification of undernutrition, and to investigate the effect of the arginine/ADMA ratio and nutrition during surgery, in patients with cardiovascular failure.

In Chapter 2 it turned out that the Cardiac Surgery-Specific Undernutrition Screening Tool (CSSUST) was superior to the existing tools in identifying undernutrition in patients undergoing cardiac surgery. Chapter 3 showed that preoperative sarcopenic obesity (SO) independently increased the risk of postoperative infections in patients undergoing cardiac surgery. It was the low fat free mass (FFM) part (which is mainly muscle mass) and not the fat mass part of SO that was associated with infections. Though, the risk for infections was slightly higher for the undernourished (low FFM) patients whom were also obese - the SO patients - than for those patients with a low FFM solely. Furthermore, especially the low FFM part of SO was associated with worse muscle function, and low handgrip strength was independently associated with a prolonged time of mechanical ventilation after surgery. Chapter 4 showed that a preoperative low bioelectrical impedance phase angle (PA) was associated with well-established indicators of undernutrition (low BMI and low FFM index) and probably muscle strength in patients undergoing cardiac surgery. It was also shown that a low PA increased the risk of intensive care and hospital length of stay independently from other risk factors such as operative risk and severity of heart failure. These results imply that the bioelectrical impedance PA can help to identify undernutrition in patients admitted for cardiac surgery. Based on the results described in Chapter 2, 3 and 4, we advise to optimize screening of undernourished cardiac surgery patients by using the CSSUST. For undernutrition assessment, we recommend to use bioelectrical impedance to measure FFM and the PA, in both non-obese and obese patients. Now, research is needed to investigate the effect of nutrition and exercise on these bioelectrical impedance spectroscopy (BIS) parameters and clinical outcome in undernourished cardiac surgical patients.
Chapter 5 describes an observational study in which it turned out that the arginine/ADMA ratio was associated with circulatory failure, organ failure and mortality in patients with septic or cardiogenic shock. The results support our hypothesis that a low arginine/ADMA ratio is a better indicator compared to ADMA solely. We suggest that a low ratio contributes to endothelial and cardiac dysfunction with subsequent poor organ perfusion and organ failure thereby increasing the risk of mortality. Chapter 6 shows the results of the first randomized controlled intervention trial which investigated the effect of nutrition before, during, and after surgery on the heart. It was found that enteral or parenteral nutrition before, during, and after coronary artery bypass grafting (CABG) can increase the arginine/ADMA ratio in the human heart and plasma arginine/ADMA ratio and branched chain amino acids concentration. Furthermore, an increase in plasma arginine/ADMA was associated with an increase in myocardial glucose metabolism. We propose that revascularization in combination with the extra flow induced by a higher arginine/ADMA ratio and concomitant NO elevation further improves access of substrates to cardiac cells reflected by an increase in glucose uptake and metabolism in the heart. Future studies should focus on this hypothetical mechanism. In addition, this trial paves the way to further investigate the possibilities of nutrition during surgery. The results in Chapter 7 show that intramyocardial infiltration of lymphocytes decreased, neutrophilic granulocytes may decrease and complement activation may increase in myocardial tissue during off-pump CABG. Our results suggest that nutrition before and during surgery neither stimulates nor diminishes myocardial inflammatory response in patients undergoing this procedure.

Chapter 8 concludes that undernutrition in cardiac surgical patients can be identified by using the CSSUST and BIS parameters FFM and PA. Plasma arginine/ADMA ratio can help to evaluate cardiovascular function and prognosis. Continuing nutrition during surgery can be useful in avoiding a long fastening period, and can increase the arginine/ADMA ratio in the myocardium and blood plasma. An increase in plasma arginine/ADMA ratio was related to increased myocardial glucose metabolism. During off-pump CABG, lymphocytes decreases which was not influenced by supplying nutrition before and during surgery. Now, research is needed to investigate the effect of perioperative nutritional and exercise interventions on clinical outcome in (cardiac) surgical patients.