Top Ten Things to Know
Reactive Oxygen Species, Reactive Nitrogen Species, and Redox-Dependent Signaling

1. Reactive oxygen species (ROS) and reactive nitrogen species (RNS) are produced endogenously in virtually all eukaryotic cells and regulate processes including differentiation, migration, and metabolism.

2. In excess, ROS/RNS lead to extensive tissue dysfunction and injury. These species have been implicated in the development of many types of cardiovascular disease (CVD), including hypertension, heart failure, atherosclerosis, and cardiovascular and renal complications of diabetes.

3. Despite extensive data in animal models, there is no conclusive evidence that ROS/RNS are fundamentally involved in the pathogenesis of CVD in humans. Research efforts have been hampered by the methodological challenges of accurately measuring ROS in the cardiovascular system.

4. Methods for measuring oxygen free radicals and their derived oxidants include chemical assays for reactive species generation, direct chemiluminescent assays or measurement of signal in the presence of chemilumigenic probes, fluorescence detection in the presence of redox-sensitive probes, and electron paramagnetic resonance (EPR) spectroscopy. These vary in sensitivity and accuracy.

5. Measurements of nitric oxide (NO) can be complicated due to its short half-life, contaminants in laboratory reagents, and the multiple reactions it undergoes, leading to a variety of end products. Most RNS cannot be detected in frozen or fixed tissue samples, but can be detected in live tissue or intact cells.

6. Though direct and indirect approaches can be taken to detect protein oxidation, indirect approaches are most often utilized in cardiovascular research due to their exploitation of conserved biochemical properties of the reversible oxidative modifications and the catalytic activity of certain proteins.

7. Measurements of lipid peroxidation products can serve as sensitive assessments of ROS generation while also providing mechanistic insights into the pathogenesis of ROS-induced injury.

8. A number of techniques can be used to assess oxidative DNA damage – one of the more severe consequences of excessive ROS production – depending on the nature of the research question and the precision that must be achieved.

9. Since an ideal biomarker has not yet been identified for assessing oxidative stress in humans, measurements of several independent indices of oxidative stress are recommended. Although multiple biomarkers are currently used in research laboratories, they have not become routine in clinical laboratories because their diagnostic value remains uncertain.

10. ROS/RNS have physiological and pathological roles, and precise measurements are necessary for consistency across studies. The information provided in this scientific statement is intended to provide a basis for selecting which assays to use in specific experimental conditions.