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Good morning, and thank you for asking me to describe my research with Gulf War veterans to you. I am Roberta White, professor and chair of the Department of Environmental Health at the Boston University School of Public Health.

With a large group of colleagues from many fields, I began studying Gulf War veterans and their health problems in 1993 and was research director and principal investigator for one of the initial three centers funded by the Department of Veterans Affairs to study Gulf War-related illnesses. I have received funding as principal investigator or co-principal investigator for several successive grants to study Gulf War-related illnesses; I was fortunate to have this work supported by VA, the Department of Defense, and the Centers for Disease Control. For many years I was a member of the federal inter-agency committee on Gulf War illnesses. I have also seen Gulf War veterans as a clinician at VA, where I was a staff neuropsychologist before taking my current job.

Over the years of my career as a scientist, I have studied how chemicals and environmental hazards affect the functioning of the human brain. In Boston, we approached the problem of symptoms and illnesses in Gulf War veterans by investigating the relationships between exposures to hazardous chemicals and conditions in the Gulf War theater and health outcomes. In this research, we have used brain imaging and behavioral tests as ways of understanding abnormalities in brain function that may be seen in Gulf War veterans. This work culminated recently in the publication of two papers focusing on Gulf War veterans who were in the vicinity of Kamisiyah at the time of the detonation of the weapons depot there and a neurology meeting abstract on brain imaging differences between Gulf War veterans with high and low symptom complaints.

The two papers that summarize our work on exposures experienced by troops during the Kamisiyah detonation used data from DoD that modeled the amount of exposure to sarin and cyclosarin nerve gas agents among troop units located around Khamisiyah over a 3-day period. We had brains scans or data from performance on standardized tests of hand dexterity and intellectual function from individuals under the plume in Khamisiyah and from some who were in locations where nerve gas agents are thought to have been absent. We analyzed the relationship between degree or "dose" exposure to sarin/cyclosarin, ranging from none to a level

above the recommended minimal daily exposure level, and outcomes on the brain scans and performance tests. Our results showed that there was a dose-effect relationship between degree of exposure to nerve gas agents and adverse outcomes on the brain scans and behavioral tests. For example, higher exposure was associated with smaller measurements of the volume of white matter in the brain and with poorer performance on a test of hand dexterity and speed while completing a pegboard task.

The neurology meeting poster presentation featured initial results from a study that has just been completed and for which we are still analyzing outcomes. The results suggested that certain brain structures are smaller in Gulf War veterans with higher numbers of symptom complaints than in veterans with few symptoms. For example, an area of the cingulate gyrus, which is involved in memory function, was smaller in the high-symptom veterans.

There has been widespread dismissal of Gulf War veterans' health complaints as being "psychiatric" or imagined. However, the data from our studies, combined with the increased rates of ALS and brain tumors described by Dr. Steele, provide objective evidence of brain damage among Gulf War veterans. This damage appears to range from subtle effects on brain structure and function to clinical disease.

The greater definition of objective outcomes and possible causes of Gulf War-related symptoms 15 years after the war is not unexpected and parallels the identification of critical factors in illnesses among other veteran populations. For example, almost 20 years passed before Agent Orange exposure was linked to certain health outcomes in Vietnam veterans.

Given the role of the nervous system in their symptomatic complaints and the appearance of neurological illnesses in Gulf War veterans, it is essential to consider the diagnostic, treatment, and intervention implications of the research that I have described. I believe that concerted planning for treatment interventions should begin immediately. It should focus on neurological symptoms, including diminished energy; strategies aimed at enhancing brain function, including thinking, memory and mood; and approaches to neuro-immunological and auto-immune dysfunction.

Thank you for listening to my perspectives on the serious issue of continued ill health among our Gulf War veterans.