Journal of the History of Medicine and Allied Sciences, Vol. 77, No. 1, pp. 24–47
doi: 10.1093/jhmas/jrab044
Advance Access Publication: 13 December 2021
Original Article

A Scientific Method to the Madness of Unit 731's Human Experimentation and Biological Warfare Program

KISHOR JOHNSON

University of Toronto, Canada, Kjohnson2020@meds.uwo.ca

ABSTRACT

The Japanese Imperial Army Unit 731's Biological Warfare (BW) research program committed atrocious crimes against humanity in their pursuit of biological weapons development during the Second World War. Due to an American cover-up, the details behind Unit 731's human experimentation were slow to be revealed. The recent literature discloses the gruesome details of the experiments but characterizes the human trials as crude in nature. Further, there is a lack of clarity as to how human trial results were extrapolated for use in real world missions.

Through an examination of testimony from the Soviet Union's Khabarovsk War Crime Trials, this paper argues that Unit 731's inoculation and airborne warfare experiments on prisoners of war were scientifically rigorous. The scientific method is used as the basis against which the scientific rigor of the experiments is tested. The paper reveals that the successes and failures of the human trials were extrapolated to BW missions during the Sino-Japanese war. American researchers' expectations of BW data were fulfilled, thus paving the way for an immunity deal. Ethical standards in medicine before WWII were not well established, but wartime medical practices and experimentation reveal the context in which the pursuit of scientific knowledge has no boundaries.

KEYWORDS: Unit 731, Human Experimentation, Biological Warfare, American Immunity Deal, Shirō, Ishii, Research Ethics

Unit 731 was a Japanese biological warfare research unit that covertly conducted human experimentation during the Second World War for the purpose of biological weapons development. The secret Kwantung Army Unit was based in Harbin, Manchuria and officially titled the Epidemic Prevention and Water Supply

Department.[1] During the program's nine years of operation from 1936 to 1945, thousands of victims were experimented on and ultimately killed.[2] Despite the crimes committed by various Japanese physicians and scientists, many members of the program went largely unpunished. Unlike the Nazi Doctors Trial, there was no United States led prosecution of Unit 731 physicians. Rather, the Russians, who joined the Asian war only at the very end, prosecuted 12 members of the program for war crimes in the 1949 Khabarovsk trials.[3]

The pursuit of biological weapons development began well before the establishment of Unit 731. Historian Jeanne Guillemin has usefully defined "biological warfare" and "biological weapons." Biological warfare is defined as the military use of biological agents to produce death or permanent harm in humans, animals, or plants for a military objective. Biological weapons include the means of delivery, such as bombs or aircraft spraying devices.[4]

Germany and France developed state-sponsored biological warfare programs prior to the inception of Unit 731. The German program, which was implemented during World War I, is best described as a sabotage enterprise.[5] The interwar period led to sophisticated French research efforts into biological weapons development.[6] Scientists from the United Kingdom, Canada, and the United States also developed their own programs prior to and during World War II.[7] Various nations were secretly developing their own programs during WWII, but the Nazis and the Japanese uniquely utilized humans as research subjects.

The Nazi human experimentation program is more well-known than the Japanese program in both popular and scholarly literature. At least 15,754 victims were subjected to various unethical experiments.[8] These experiments included high-altitude, freezing, and mustard gas trials.[9] The largest group of victims were Polish nationals, of both Jewish and Catholic descent. However, many other groups of victims were also

1 Tsuneishi Keiichi, "Unit 731 and the Japanese Imperial Army's Biological Warfare Program," trans. John Junkerman, in *Japan's Wartime Medical Atrocities: Comparative Inquires in Science, History and Ethics*, ed. Jing-Bao Nie, Nanyan Guo, Mark Selden and Arthur Kleinman (London: Routledge, 2010), 60, 62-64.

2 Howard Brody, Sarah E. Leonard, Jing-Bao Nie, and Paul Weindling, "United States Responses to Japanese Wartime Inhuman Experimentation after World War II: National Security and Wartime Exigency," *Cambridge Quarterly of Healthcare Ethics* 23 (2014): 220.

3 Materials on the Trial of Former Servicemen of the Japanese Army Charged with Manufacturing and Employing Bacteriological Weapons (Khabarovsk Trials) (Moscow: Foreign Languages Publishing House, 1950), 2.

4 Jeanne Guillemin, *Biological Weapons: From the Invention of State-Sponsored Programs to Contemporary Bioterrorism* (New York: Columbia University Press, 2005), 2.

5 Rebecca L. Frerichs, Reynolds M. Salerno, Kathleen M. Vogel, Natalie B. Barnett, Jennifer Gaudioso, Lauren T. Hickok, Daniel Estes, and Danielle F. Jung, *Historical Precedence and Technical Requirements of Biological Weapons Use: A Threat Assessment* (New Mexico: Sandia National Laboratories, 2004), 16.

6 Guillemin, *Biological Weapons*, 24.

7 Ibid., 40-74.

8 Paul Weindling, Anna von Villiez, Aleksandra Loewenau, and Nichola Farron, "The Victims of Unethical Human Experiments and Coerced Research under National Socialism," *Endeavour* 40 (2016): 1.

9 Vivien Spitz, *Doctors from Hell: The Horrific Account of Nazi Experiments on Humans* (Colorado: Sentient Publications, 2005), 65-82, 85-100, 135-138.

subjected to experimentation.[10] After the end of the war, German doctors and medical assistants were indicted on counts related to the human experiments in the subsequent Nuremburg trials.[11] Those who were found guilty were given sentences ranging from ten-years imprisonment to execution.[12] During the adjudication of the Nazi Doctors, American judges and others formulated the now well-known Nuremburg Code.[13] The Code described requirements for human experimentation, including voluntary and informed consent as well as the right for subjects to withdraw from experiments.[14] While the Code was developed in response to Nazi wartime human experimentation, by contrast, the Japanese human experimentation atrocities were ignored due to American immunity agreements.[15]

As medical science and laboratory research were continuing to develop in the twentieth century, there was a concomitant transformation of ideas concerning the research ethics of human experimentation.[16] These ideas were being debated around the globe. As early as 1900, the Prussian Minister of Religious, Education and Medical Affairs introduced a strict directive to all physicians-in-chief of state clinics regarding consent for procedures. This directive prohibited research not directly related to diagnostic, therapeutic, or immunization procedures on minors or other incompetent individuals, unless the patient was made aware and consented to possible risks.[17] Walter Reed, who led the yellow fever experiments in Cuba, introduced written contracts for human experimentation. These contracts, which were available in both Spanish and English, described the risks and benefits involved in participating in the study.[18] The contracts stipulated that subjects had to be at least 25 years of age because this was the Spanish age of legal capacity.[19] Despite these world-wide developments on issues surrounding

10 Weindling, Villiez, Loewenau, and Farron, "Victims of Unethical Human Experiments," 4.

11 Spitz, *Doctors from Hell*, 41.

12 Ibid., 263-264.

13 Multiple individuals have been identified as authors of the code. These include one of three US Judges, Harold Sebring, as well as two American physicians who helped prosecute the Nazis, Leo Alexander and Andrew Ivy. Evelyn Shuster clarifies that ultimately the authorship is thought to be shared and that the code grew out of the trial itself. Evelyn Shuster, "Fifty Years Later: The Significance of the Nuremburg Code," *New England Journal of Medicine* 337 (1997): 1436-1437.

14 Ulrich Tröhler, "The Historical Development of International Codes of Ethics for Human Subjects Research," in *The Cambridge World History of Medical Ethics*, ed. Robert B. Baker and Laurence B. McCullough (Cambridge: Cambridge University Press, 2008), 569; Shuster, "Fifty Years Later," 1439.

15 The Americans halted all further investigation into Unit 731 once Japanese scientists began to cooperate with the revelation of biological warfare information. Interagency Working Group, "Select Documents on Japanese War Crimes and Japanese Biological Warfare, 1934-2006," compiled by William H. Cunliffe, November 2006, https://www.archives.gov/files/iwg/japanese-war-crimes/select-documents.pdf., p 37 JWC261/4, p 38 JWC 285, p 43 JWC257/6, p 44 JWC 243/17.

16 Susan Lederer, "The Ethics of Experimenting on Humans" in *Cambridge World History of Medical Ethics*, 558.

17 Tröhler, "Historical Development of International Codes of Ethics for Human Subjects Research," 568.

18 Lederer, "Ethics of Experimenting on Humans," 562; Laura Cutter, "Walter Reed, Yellow Fever, and Informed Consent," *Military Medicine* 181 (2016): 90.

19 Laura Cutter, "Walter Reed, Yellow Fever, and Informed Consent," 90; Sorin Hostiuc, "A Short Introduction to the History of Informed Consent in Great Britain and the United States," in *The Age of Informed Consent: A European History*, ed. Sorin Hostiuc and Octavian Buda (Newcastle upon Tyne: Cambridge Scholars Publishing, 2018), 30.

consent, the rights of research subjects were irrelevant to Japanese physicians because experimentation with prisoner of war (POW) bodies was simply a means to an end for gaining knowledge.[20] The objectification of POW bodies is evidenced by researchers' reference to the prisoners as *maruta*, which translates to log.[21] The physicians believed that the potential Japanese lives saved, as a result of the knowledge gained in the field, far outweighed the sacrifice of POW bodies.[22]

Notably, the yellow fever experiments had also included self-experimentation. Several researchers succumbed to yellow fever after being bitten by *Aedes aegypti* mosquitoes, which was the vector of transmission for the disease.[23] Historian Susan Lederer argues that physicians sometimes used self experimentation to promote cooperation of research subjects for subsequent human experimentation.[24] Additionally, she states that self-experimenters who were well versed in scientific methodology could potentially provide more meaningful qualitative observations regarding the experimentation results.[25] While Nazi scientists, such as Otto Bickenbach who conducted research on phosgene gas, used self experimentation as a pathway to human experimentation during the war, self experimentation was not a known tradition amongst Japanese researchers and was not used during the war.[26]

Unit 731 primarily focused on human experimentation, but the larger Japanese research program also studied other possible routes of biological warfare. Unit 100, which was led by veterinarian Major Wakamatsu Yujiro, primarily focused on plant and animal biological warfare.[27] Unit 100 explored the production and deployment of livestock and crop viruses.[28] Units 731 and 100 were independent of one another but would cooperate in experiments when necessary.[29] General Shirō Ishii's Unit 731 was focused on producing biological weapons for use against humans, which he regarded as "the weapons of the future" in comparison to conventional weapons.[30] In contrast, Wakamatsu's Unit 100 was primarily focused on developing plant and animal based biological agents that could be used in sabotage missions.[31] Plant and animal

20 Yuki Tanaka, *Hidden Horrors: Japanese War Crimes in World War II*, 2nd ed. (Lanham, MD: Rowman and Littlefield, 2018), 212.
21 Ibid., 188, 212.
22 Ibid., 212.
23 Lederer, "Ethics of Experimenting on Humans," 560; Susan Lederer, *Subjected to Science: Human Experimentation in America Before the Second World War* (Baltimore: Johns Hopkins University Press, 1995), 19-20.
24 Ibid., 18-19.
25 Ibid.
26 Gerhard Baader, Susan E. Lederer, Morris Low, Florian Schmaltz, and Alexander V. Schwerin, "Pathways to Human Experimentation, 1933-1945: Germany, Japan and the United States," *Osiris* 20 (2005): 215-217.
27 Sheldon Harris, *Factories of Death: Japanese Biological Warfare, 1932-45, and the American Cover Up* (New York: Routledge, 2002), 115.
28 Ibid., 118.
29 Ibid., 115.
30 Ibid., 21; Khabarovsk Trials, 231. Ishii's ultimate goal was to induce artificial epidemics.
31 Harris, *Factories of Death*, 115.

experimentation were not of much value to Ishii's goal of understanding the physiological conditions of humans to induce artificial epidemics.[32] However, Unit 100's research did eventually prove to be useful for one of Unit 731's real world missions.[33]

The Japanese human experimentation program remains less well known than the Nazi program for several major reasons. First, less evidence survived to incriminate Unit 731 because the Japanese Imperial Army burned almost all the records of the experiments as the war ended.[34] During the Unit's operation, roughly 500 to 600 individuals were annually experimented on and ultimately killed.[35] Unlike the Nazi experiments, there were no known survivors of the Japanese camp and thus no victim testimony exists.[36] Finally, and most notably, American investigators halted all investigations on Japanese war crimes once Japanese scientists began revealing biological warfare data.[37]

Despite these barriers to the release of information, medical historians have explored the Japanese program of research and experimentation. Hal Gold aimed to reconstruct the activities of Ishii's human experimentation program through a unique eyewitness investigation in *Unit 731: Testimony*. Because there were no survivors of the camp, Gold interviewed various Unit 731 employees, ranging from youth corps members to pharmacists. These interviewees described the daily activities of running a human experimentation camp such as the "growing of bacteria in glass dishes" to the "cleaning of human specimen rooms."[38]

In *Factories of Death*, Sheldon Harris provided a comprehensive review of the actions of various Japanese biological warfare units including Unit 731, Unit 100, and Unit Ei 1644.[39] Harris also explored the post war U.S investigations and the subsequent cover up of the Japanese experiments.[40] Although the Americans established their own research program, American scientists lacked vital information about biological warfare. If the Japanese could provide biological warfare data that used humans as research subjects, postulated on delivery systems, and demonstrated adequate field trials, this data would be of immeasurable value to the Americans.[41] However, Harris concluded that the Japanese data did not meet American expectations. He argued instead that the data produced from the camp was at best of minor significance.[42] According to Harris, the Japanese camp's research results were lackluster.

32 Khabarovsk Trials, 231.
33 Harris, *Factories of Death*, 123.
34 Khabarovsk Trials, 49.
35 Khabarovsk Trials, 13, 82. Due to the secretive nature of the program, prisoners were delivered to the camp through underground tunnels. This was likely a limiting factor in the numbers of prisoners that were experimented on annually.
36 Brody, Leonard, Nie and Weindling, "United States Responses," 221.
37 Interagency Working Group, "Select Documents on Unit 731," p 37 JWC261/4, p 38 JWC 285, p 43 JWC257/6, p 44 JWC 243/17; Brody, Leonard, Nie, and Weindling, "United States Responses," 220.
38 Hal Gold, *Unit 731: Testimony* (North Clarendon, VT: Tuttle Publishing, 1997), 178, 220.
39 Harris, *Factories of Death*.
40 Ibid., 239-284.
41 Ibid., 264.
42 Ibid., 306.

Historians, including Harris, have also criticized the scientific efficacy of the Japanese research program. While Harris revealed the details of the various types of human experimentation, he ultimately agreed with the findings of Lt. Col. Murray Sanders, a postwar US investigator, that the experiments were "crude" and "ineffective."[43] Harris, however, neglected to independently examine the experiments for the presence of scientific rigor.[44] The contemporary understanding of scientific rigor, as defined by the National Institute of Health (NIH), is "the strict application of the scientific method to ensure unbiased and well-controlled experiment design, methodology, analysis, interpretation and reporting of results."[45] Historian Till Bärnighausen specifically argued that many of the Unit's experiments lacked scientific rigor.[46] Bärnighausen suggested that there were a few exceptions to this broad classification. He cited a "reliable and valid" data collection process to support the claim that Unit 731's mustard gas, freezing, and tuberculosis experiments were rigorous.[47] According to these historians, the Japanese scientific process was also seemingly underwhelming.

The conclusions that the Japanese experiments were crude, ineffective, and mostly lacking scientific rigor, and that the data produced from the human trials was at best a minor significance are only part of the story. This paper suggests that when looking at the methodology of the experiments in a different context and compared with the results of real-world biological warfare missions, new conclusions can be drawn. This paper demonstrates that the scientific rigor of the Japanese experiments and utility of the data have largely been neglected in the literature.

Building from the contemporary understanding of scientific rigor, which highlights the application of the scientific method, I propose utilizing the scientific method as a lens through which to analyze the scientific rigor of Unit 731's experiments. The scientific method, which is explored in this paper, consists of hypothesis generation, experimental testing, and extrapolation of results to prompt further testing.

Drawing on primary literature from the Khabarovsk trials, this paper challenges the findings that Unit 731 experiments mostly lacked rigor and that the data were of limited utility. After exploration of the scientific method and the choice of research subject, this paper will first investigate the assertion that Japanese experiments mostly lacked scientific rigor by demonstrating the use of the scientific method in two significant types of Japanese human experimentation: inoculation and airborne warfare experiments. This paper will also challenge the conclusion that the biological warfare data was of poor utility by demonstrating that experimental results were extrapolated for use in three real world missions in China, thereby fulfilling American expectations of the data.[48]

43 Ibid.

44 Ibid., 75-112.

45 National Institutes of Health, "Enhancing Reproducibility through Rigor and Transparency," 27 November 2018, https://grants.nih.gov/policy/reproducibility/index.htm.

46 Till Bärnighausen, "Data Generated in Japan's Biowarfare Experiments on Human Victims in China, 1932-1945, and the Ethics of Using Them," in *Japan's Wartime Medical Atrocities*, 138, 151.

47 Ibid., 134, 142-149.

48 Harris, *Factories of Death*, 264.

There have been conflicting ideas surrounding the merits of the American Immunity Deal. Unlike Harris, who criticized the quality of the Unit's data and questioned why such a deal would be struck, other investigators praised the data that was obtained through the American Immunity Deal.[49] In 1947, the Chief of Basic Sciences claimed, "Evidence gathered in this investigation has greatly supplemented and amplified previous aspects of this field."[50] As details surrounding Unit 731 continue to be released, it is imperative to clarify the quality of the research produced by the Japanese camp.[51] However, even if the Japanese camp did engage in rigorous science, this paper ultimately asserts that the American Immunity Deal is still not justified.

THE SCIENTIFIC METHOD

Prior to the establishment of Unit 731, Japanese scientists were already competent in the field of bacteriology. During the 1904-1905 Russo-Japanese war, a US physician, Louis Livingston Seaman, studied the preventive measures used by the Japanese military for managing infectious disease. He recorded his extensive observations in *The Real Triumph of Japan: The Conquest of the Silent Foe*, crediting Japan's sanitation procedures and investment in preventable disease research as a major reason for the nation's victory in the 1904-1905 war.[52] As Seaman's records reveal, Japan's investment into bacteriological research and production was significant. As one example, Japanese scientists produced 55,000 bottles of antitoxin serum to combat diphtheria.[53]

Interestingly, Seaman also revealed that Japanese scientists closely collaborated with world-renowned microbiologist Robert Koch. Japanese scientist Kitasato Shibasaburō, who also held a worldwide reputation as an expert in the field of microbiology, was an assistant to Koch in the study of infectious diseases, including tetanus, diphtheria, and tuberculosis.[54] It is thus apparent that even prior to the institution of a state-sponsored biological warfare program in 1936, Japanese scientists could have had access to the most recent literature on epidemiology and microbiology of various pathogens.[55] Moreover, during the operation of Unit 731, Ishii and colleagues actively contributed to the medical literature.[56] The scientists continued to publish scientific reports, albeit disguising their use of human subjects by describing their research subjects as "monkeys."[57] One of the published studies was authored by Ishii's colleague,

49 Ibid., 305-306.
50 Ibid., 263.
51 Staff Report, "Names of 3,607 Members of Imperial Japanese Army's Notorious Unit 731 Released by National Archives," *The Japan Times*, 16 April 2018, https://www.japantimes.co.jp/news/2018/04/16/national/history/names-3607-members-imperial-japanese-armys-unit-731-released/#.XmFWFGg3mHs.
52 Louis Livingston Seaman, *The Real Triumph of Japan: The Conquest of the Silent Foe* (New York: D. Appleton and Company, 1906), 1.
53 Ibid., 224.
54 Ibid., 221-222.
55 Ishii himself established an Epidemic Prevention Research Laboratory as a part of his larger biological warfare enterprise. Harris, *Factories of Death*, 76.
56 Ibid., 83.
57 Ibid.

Yoshimura Toshihito, and was titled "Tōshō ni tsuite (On hypothermia)."[58] Given the Japanese scientists' wealth of background knowledge in microbiology, access to the most recent literature, and active participation in the broader scientific community, the investigators were well prepared to integrate the scientific method into their program of human experimentation.

The scientific method was articulated in the seventeenth century by Francis Bacon and Rene Descartes, but the roots of the method can be traced back thousands of years.[59] The meaning of the scientific method has evolved over time. Historically, acquisition of scientific knowledge has been separated into two camps: the inductive method and hypothetico-deductive method. When the scientific method was first founded, Bacon insisted on systematic and objective observations for the purposes of knowledge acquisition, rather than metaphysical speculations. This pathway of knowledge acquisition was called the inductive method.[60] However, Scottish philosopher David Hume rejected the inductive method in the eighteenth century, arguing that past experience, or observations, could not be used to predict the future.[61] Francisco J. Ayala aptly describes this fault of inductive thinking: "Even if all trees so far observed have leaves, or all swans observed are white, it remains a logical possibility that the next tree will not have leaves, or the next swan will not be white."[62] As the inductive method fell out of favour, a new model for scientific knowledge acquisition emerged.

The hypothetico-deductive (HD) model, also known as the traditional scientific method, became the predominant method of scientific knowledge acquisition.[63] This acclaimed model led to Galileo and Newton's demonstrations on the laws of motion, William Harvey's demonstration on the circulation of blood, and Louis Pasteur's fermentation and putrefaction experiments showing that this process was caused by living organisms.[64] Unlike the inductive model which relies on a series of objective observations, the HD model is based on formulating and testing hypotheses.[65] The HD model itself underwent revision when philosopher of science Karl Popper proposed that a scientific hypothesis can never be verified, but that it could be negated by a single counterexample. Thus, Popper introduced the notion that scientific hypotheses had to be falsifiable.[66]

58 The original article is available in the National Record Office in Japan. Daqing Yang, "Documentary Evidence and Studies of Japanese War Crimes: An Interim Assessment," in *Researching Japanese War Crimes Records: Introductory Essays*, ed. Edward Drea, Greg Bradsher, Robert Hanyok, James Lide, Michael Petersen, and Daqing Yang (Washington, DC: National Archives and Records Administration for the Nazi War Crimes and Japanese Imperial Government Records Interagency Working Group, 2006), 35.

59 Eberhard O. Voit, "Perspective: Dimensions of the Scientific Method," *Public Library of Science Computational Biology* 15 (2019): 2.

60 Ibid.

61 David J. Glass and Ned Hall, "A Brief History of the Hypothesis," *Cell* 134 (2008): 379.

62 Francis J. Ayala, "On the Scientific Method, Its Practice and Pitfalls," *History and Philosophy of the Life Sciences* 16 (1994): 209.

63 Ibid., 210; Voit, "Perspective," 2.

64 Ayala, "On the Scientific Method," 222.

65 Voit, "Perspective," 2.

66 Ibid.

The simplified version of HD model, or the scientific method, is often presented in a series of discrete steps.[67] However, the model is more complicated than that, and arguably captures a form of critical thinking.[68] The presentation of discrete steps may aide with ease of understanding and application of the model, and thus these steps will be applied in the analysis of Unit 731's experiments. While the number of steps in the model vary from source to source, there are three main concepts in the scientific method. First, a falsifiable hypothesis is generated based on a phenomenon of interest. Second, the hypothesis must be experimentally tested. Finally, the test results either support or reject the hypothesis, thus triggering a new round of hypothesis formulation and experimental testing.[69] Throughout the section on the inoculation and airborne warfare experiments, these three key features of the scientific method will be highlighted in Unit 731's work. Although the definition of the scientific method continues to evolve in the twenty-first century, the HD model was widely utilized by scientists during the twentieth century and thus serves as the model by which I analyze Unit 731's experiments.[70]

The first step of the scientific method is to generate a falsifiable hypothesis based on a phenomenon of interest. In order to appreciate Ishii's phenomenon of interest of human experimentation with biological agents, I first explore his educational and research background. After graduating with an MD in 1920 from Kyoto Imperial University, Ishii joined the military as a Surgeon-First Lieutenant.[71] His scientific ambition eventually led to him earning a PhD in microbiology.[72] Ishii's interest in creating a biological warfare program began almost immediately after the signing of the 1925 Geneva Protocol.[73] Along with the US, Japan was the only other nation that did not ratify the protocol.[74] Ishii was enamored by the possibilities of biological warfare, including the relatively low cost of weapons development in comparison to conventional weapons, and he regarded biological weapons as agents of the future.[75]

Ishii was eager to further understand the possibilities of biological warfare. He subsequently embarked on a two-year worldwide tour to various countries including the United States, Canada, and various European nations.[76] Based on his research, Ishii learned that natural plague epidemics arose more easily than artificially induced ones.[77] Ishii's scientific phenomenon of interest was clear. Why were artificial epidemics so difficult to induce? Ishii assumed that it was necessary to possess good knowledge of

67 Ibid., 3.
68 Ibid.
69 Ibid., see figure 1 and supporting text.
70 New dimensions of the scientific method are a result of the -omics revolution in the 21st century. Ibid, 4.
71 Harris, *Factories of Death*, 16.
72 Ibid., 18.
73 Ibid., 19.
74 Bureau of International Security and Nonproliferation, "Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare (Geneva Protocol)," archived webpage, 25 September 2002, https://2009-2017.state.gov/t/isn/4784.htm.
75 Harris, *Factories of Death*, 21.
76 Ibid., 20.
77 Khabarovsk Trials, 231.

physiological conditions and properties of human beings to produce artificial epidemics, thus justifying his need for human experimentation trials.[78] With his specific phenomenon of interest in mind, Ishii moved forward with the rest of the scientific method for Unit 731's experimentation.

CHOICE OF RESEARCH SUBJECT

In order to conduct their human trials, Japanese scientists needed to select their research subjects. Chinese, Manchurian, and Russian POWs were primarily used as research subjects in human experiments, while Chinese military and civilian populations were targeted in real-world missions. Racism, and more precisely exceptionalism, played a significant role in the choice of Unit 731's research subjects.

Japanese racism did not focus on the denigration of other Asian races. Rather, the Japanese often focused on why they should be considered the superior race, revealing cultural exceptionalism.[79] The Japanese referred to themselves as the "Yamato" race, also known as the Divine race.[80] They placed a strong emphasis on the divine origins of the Japanese Imperial line.[81] Japan also avoided colonization by Western powers, whilst adopting Western-style societal systems and establishing a fiercely competitive military force, which gave Japan a sense of perceived superiority over other Asian nations that could not accomplish the same.[82]

Militaristic racism was not confined to Unit 731, as other bodies of the Japanese Imperial Army also exploited vulnerable populations. During the Nanking Massacre, Japanese troops mobilized toward Nanking in November of 1937 after three months of intense fighting. During this mobilization, Japanese forces committed acts of violence toward the Chinese people, including mass slaughter of up to 350,000 civilians as well as the rape of up to 80,000 women.[83] The cruelty toward the Chinese and other Asian peoples, who were perceived as inferior, continued as the Japanese created the "Comfort Women" system, whereby women were forced into sex slavery.[84]

During the war, the Japanese produced an ideological report titled "Investigation of Global Policy with the Yamato Race as Nucleus." Historian John Dower argues that the secret report provides a revealing lens into Japanese racial attitudes during the war.[85] The report focused on outlining the "proper place" of various ethnic groups. Of all the ethnic groups in Asia, Japan was to be the leading race. The overarching goal of the

78 Ibid.

79 John W. Dower, *War Without Mercy: Race and Power in the Pacific War* (New York: Pantheon Books, 1986), 183.

80 Ibid., 130.

81 Ibid., 185.

82 Tanaka, *Hidden Horrors*, 286.

83 Iris Chang, *Rape of Nanking: The Forgotten Holocaust of World War II* (New York: Basic Books: 1997), 6.

84 George Hicks, *The Comfort Women: Japan's Brutal Regime of Enforced Prostitution in the Second World War* (New York: W.W Norton & Company, 1997), 18; Bonnie B.C Oh and Margaret D. Stetz, *Legacies of the Comfort Women of World War II* (Armonk, NY: M.E Sharpe, 2001), 8, 12-13.

85 Dower, *War Without Mercy*, 242.

Japanese was to "[plant] Japanese blood on the soil of all Asia, while simultaneously avoiding intermarriage, and preserving the purity of the Yamato race."[86]

Dower also highlights the conceptual similarities between Japanese and Nazi ideas surrounding racial prejudice. Similar slogans such as "blood and soil" or "proper place" were utilized by both groups.[87] The Japanese, akin to the Nazis, protested mixed marriages and placed an emphasis on a racially bonded organic community, known in German as the *Volk*.[88] The Japanese also shared the Nazi concept of *Lebensraum*, which is understood as the living space. The Yamato were to expand and secure this living space through their new order titled "Greater East Asian Co-Prosperity Sphere (GEACPS)."[89] The GEACPS, which was established in 1940 and lasted until the end of the war, theoretically set out to be a realm freed from suppression of the White race, where people would co-exist under the protection of Japan.[90] However, the *Nucleus* report reveals that the Japanese intended to establish permanent dominance over all races in Asia.[91]

Both Japanese and Nazi racial prejudices led to their choice of research subject. The Japanese choice of Chinese and Manchurian POWs for airborne and inoculation experiments were directly related to their racial prejudice and exceptionalism. Nazi racial prejudice led to the utilization of Polish and Jewish victims for human experimentation. Polish women, who were assumed to be racial inferiors, were subjects in sulfonamide as well as bone, muscle, nerve regeneration and bone transplantation experiments.[92] Jewish victims who were condemned to *Rassenschande*, which directly translates to racial shame, were used in high altitude freezing experiments. The Germans defined racial shame as marriage or intercourse between Aryans and non-Aryans.[93] Despite the similarities between Japanese and Nazi racial prejudice relating to their choice of research subject, there remains one stark difference in their policies: Nazi racial prejudice translated to formal policies of genocide.[94]

The Japanese did not just wish to dominate all of Asia, but also sought to eventually change the Eurocentric cartography of the West and situate Japan and Asia at the center of the map.[95] In popular Japanese writings, Europe was designated as part of the Asia continent.[96] Accordingly, the GEACPS revealed the step by step process in which the enlargement of Japan-Asian territory would take place. One of the major steps of GEACPS was to capture Soviet Union territory.[97]

86 Ibid., 245.
87 Ibid., 245-246.
88 Ibid., 245.
89 Ibid., 257.
90 William L. Swan, "Japan's Intentions for Its Greater East Co-Prosperity Sphere as Indicated in Its Policy Plans for Thailand," *Journal of Southeast Asian Studies* 27 (1996): 139.
91 Dower, *War Without Mercy*, 244.
92 Spitz, *Doctors from Hell*, 115.
93 Ibid., 65.
94 Dower, *War Without Mercy*, 246.
95 Ibid., 252.
96 Ibid.
97 Ibid.

While the expansion of the GEACPS, which was spurred on by Japanese exceptionalism, reveals one reason that the Japanese were willing to use Russian POWs in their experiments, other factors may also explain this choice of research subject. The Japanese condemned the Russians because of rising tensions which took shape over the course of a century. In the early nineteenth century, Japan and Russian began trade relations, but these relations were not always positive experiences and sometimes led to raids and clashes. Tensions continued to escalate and almost a century later the conflicts surrounding land wars climaxed into the Russo-Japanese War.[98]

Although the war ended after one year, the conflict created a lasting rift between the two nations. In the 1930s, tensions continued to worsen because each nation feared the other's imperialistic ambitions. These tensions led to the battle of Khalkhin-Gol in 1939, which was lost by Japan.[99] The rivalry that developed between the two states carried forward into future generations, thus providing a lens into Unit 731's conscious targeting of Russian soldiers and civilians. With Chinese, Manchurian, and Russian POWs chosen as the research subjects, the Japanese could now initiate their human experimentation trials that were based in the scientific method.

INOCULATION AND AIRBORNE WARFARE HUMAN EXPERIMENTATION

The Japanese proved their ability to mass produce antitoxins during the 1904-1905 Japanese Russian War, and thus Unit 731 had little difficulty in transitioning to the production of large quantities of lethal microorganisms for offensive biological warfare purposes. The Production Division of Unit 731 bred the microorganisms. Through analyzing testimony in the Khabarovsk trials, it is apparent that there was a specific focus on the production of four microorganisms: *Yersinia pestis* which causes plague, *Bacillus anthracis* which causes anthrax, *Vibrio cholera* which causes cholera, and *Salmonella typhi* which causes typhoid fever.[100] During the trials, Japanese soldiers testified that the research program could produce on a monthly basis: 300 kg of plague, 500-700 kg of anthrax, 800-900 kg of typhoid, and 1000 kg of cholera.[101] Although large quantities of the bacteria were produced, even small amounts of the bacteria had devastating potential for injury and death.

All four of the above described microorganisms cause high rates of morbidity and mortality when left untreated, which was the case for Unit 731's prisoners. Infection with plague can result in symptoms that include distinct enlargement of the lymph nodes and severe bacterial infection in the blood, and mortality rates range from 40%

98 David I Hitchcock, "Joint Development of Siberia: Decision-Making in Japanese-Soviet Relations," *Asian Survey* 11 (1971): 279-280.

99 Ibid.

100 This paper references the disease in place of the microorganism itself, as this nomenclature was used in the testimony of the Khabarovsk trials. Khabarovsk Trials, 39.

101 Ibid., 39, 189. *Salmonella paratyphi*, which causes paratyphoid fever and is clinically similar to typhoid fever, were also bred. The total of 800-900 kg of typhoid germs produced within a month refers to both typhoid and paratyphoid.

to nearly 100%. [102] Anthrax may result in intense skin lesions, severe shock, and meningitis, with mortality rates as high as 60% depending on the method of infection.[103] While cholera and typhoid do not cause as much mortality as the other two pathogens, the organisms cause significant morbidity. Cholera results in "rice water" diarrhea with severe dehydration and typhoid infection results in very high fevers.[104]

Ishii decided that fleas were an effective vector for plague transmission, and thus Unit 731 was also required to breed large quantities of fleas to supplement their enormous production of plague. To accomplish the task, Unit 731 possessed roughly 4500 flea incubators. The incubators produced at least 45 kg of fleas every production cycle.[105] The staggeringly large quantity of plague and fleas that were produced, coupled with the high morbidity and mortality rates of plague infection, demonstrate the sheer power that the Japanese wielded with their biological warfare production capabilities. If production of microorganisms had been the sole measure of success in the realm of biological warfare, the Japanese were far ahead of the competition. Japanese researchers possessed the materials necessary to utilize the scientific method for the inoculation and airborne bacterial bomb experiments.

The first type of human experimentation that utilized the scientific method to test routes of biological warfare dissemination was inoculation with lethal microorganisms. These group-based inoculation experiments possessed the three key features of the scientific method: generation of a falsifiable hypothesis, experimental testing, and results extrapolation for further hypothesis generation and testing.

Food products were the most popular method of delivering the bacteria. For instance, in one Unit 731 experiment, melons and cantaloupes were infected with typhoid. The Unit also set aside uncontaminated melons and cantaloupes. After the fruits were contaminated with typhoid, the density of bacteria was recorded. When the density of typhoid was determined to be high enough, the fruit was given to a small group of prisoners, with the aim of infecting the entire group with typhoid.[106]

Analysis of the trial documents reveals Unit 731's falsifiable hypothesis. A threshold density inoculation of typhoid into melons and cantaloupes would result in disease transmission. It is likely that this hypothesis was generated based on existing data surrounding the dose-response theory. In the context of toxicology research, the dose

102 Stefan Riedel, "Plague: From Natural Disease to Bioterrorism," *Proceedings (Baylor University Medical Center)* 18 (2005): 119, 120. Mortality rates, without antibacterial therapy, depend on the form of disease, ranging from 40% with bubonic plague to nearly 100% with septicemic and pneumonic plague. Ingo Stock, "[Yersinia pestis and plague – an update] (German)," *Medizinische Monatsschrift für Pharmazeuten* 37 (2014): 441.

103 Daniel A Sweeney, Caitlin W. Hicks, Xizhong Cui, Yan Li, and Peter Q. Eichacker, "Anthrax Infection," *American Journal of Respiratory and Critical Care Medicine* 184 (2011): 1333-1335.

104 Jason B. Harris, Regina C. LaRocque, Firdausi Qadri, Edward T. Ryan, Stephen B. Calderwood, "Cholera," *Lancet* 379 (2012): 2469; Zulfiqar A. Bhutta, "Current Concepts in the Diagnosis and Treatment of Typhoid Fever," *British Medical Journal* 333 (2006): 79.

105 Khabarovsk Trials, 81.

106 Ibid., 285.

response describes the quantity of toxins to produce a harmful effect.[107] Analysis of the primary literature does not reveal that Japanese scientists specifically cited the use of dose-response in their hypothesis generation. However, Robert Koch is credited with the emergence of the research-based dose-response concept, and as Japanese scientists worked closely with Koch in the past, it may be postulated that the Japanese were at least aware, if not utilizing, the concept of dose-response.[108]

The experimental design possessed various steps in order to seek verification or falsification of the hypothesis. A Unit 731 witness noted, "After this fruit was contaminated with typhoid with the aid of a syringe, the density of the bacteria was tested; for this purpose the fruit was taken to the laboratory and there analyzed to see how much bacteria had multiplied in the fruit."[109] The scientists' attempts to extrapolate data using bacterial multiplication and density calculations shows an information gathering and analysis phase. Additionally, it is apparent that Unit 731 applied "control" and "treatment" arms in their experimental design.[110] In the context of the Unit's experimentation, the contaminated fruits thus represented the treatment arm while the control arm was the uncontaminated fruits. The transmission rate, which was reported as the "entire group being infected," represented the results section of the experiment. Taken together, the experiment supported the hypothesis that a threshold density of typhoid into melons and cantaloupes could result in disease transmission.

This individual experiment merely served as a protocol for years of perfecting inoculation experiments until the most effective food medium could be determined for the induction of artificial epidemics. The experiment possessed a small sample size of roughly five to six Manchurian POWs. While this may seem to be a weakness of the experimental design, there are two additional factors to consider. First, sample size is not one of the three key features of the scientific method. Second, although the trial testimony does not reveal the exact number of victims for food-based inoculation experiments, the inoculation-based experiments were repeated numerous times, suggesting that many more POWs fell victim to these experiments. One Unit 731 member testified, "The most suitable medium for spreading infectious diseases, according to what Ishii said, were vegetables; next in order came fruit, fish, and last, meat."[111] The testimony reveals that the hypothesis regarding the dose-response was repeatedly applied to other food media, until the most optimal method of inoculation was found. This iterative nature of analyzing results and generating new hypotheses and experiments represents the third key feature of the scientific method.

107 Aristidis M. Tsatsakis, Loukia Vassilopoulou, L Kovatsi, Christina Tsitsimpikou, Marianna Karamanou, G Leon, Jyrki Liesivuori, A. Wallace Hayes, Demetrios A. Spandidos, "The Dose Response Principle from Philosophy to Modern Toxicology: The Impact of Ancient Philosophy and Medicine in Modern Toxicology Science," *Toxicology Reports* 5 (2018): 1109.

108 Edward J Calabrese, "The Emergence of the Dose-Response Concept in Biology and Medicine," *International Journal of Molecular Sciences* 17 (2016): 2.

109 Khabarovsk Trials, 285.

110 The earliest use of control groups was in the early 1900s, which is a check or standard of comparison. Edwin G. Boring, "The Nature and History of Experimental Control," *American Journal of Psychology* 67 (1954): 573-574.

111 Khabarovsk Trials, 72.

Ishii's concluding remarks about the spread of microorganisms in various food demonstrates Unit 731's extensive work and subsequent success in this particular field of study. Other non-biological warfare units in the Japanese Imperial Army began implementing poisoned foods in their attacks, reaffirming the success of Unit 731's research. In 1944, the American military intercepted a secret report prepared by the Japanese that stated, "Great results can be obtained by contaminating [enemy] food and drink in kitchen by bacterial strategy."[112] While it would be reasonable to assume that this statement was prepared by a Unit 731 official, in fact it came from the E 33rd Force of the Army, a Unit completely unrelated to biological warfare efforts. Biological warfare originated with Unit 731; however, due to the Unit's success, other factions of the army adopted Unit 731's strategies. Notably, not all of Unit 731's biological warfare endeavours proved to be successful.

The second type of human experimentation to utilize the scientific method to test routes of biological warfare dissemination were airborne bacterial bombs. The perceived benefit of bacterial bombs, in comparison to inoculation of foods, was that bombs could be used for long-range targets. Additionally, bacterial bombs would hypothetically reduce the risk of self-inflicted infection, as the bombs would be designed to explode and disseminate pathogens only after reaching their targets.

In the decades leading up to WWII, at least two other scientists were fascinated with the potential of airborne biological warfare. One prominent French scientist, Auguste Trillat, argued that the most efficient type of biological weapon would be an aircraft bomb. He hypothesized that liquid microbe cultures could be loaded into bombs and detonated to cause widespread harm.[113] Frederick Banting, while developing a biological program in Canada, provided significant knowledge about airborne warfare to the UK program. He recognized the need for large factory-scale microorganism production capabilities and suggested that the UK focus on bacterial shell and bomb experimentation.[114] While it is unclear how much Ishii knew about Trillat's and Banting's ideas, Ishii was also enamored by the possibilities of airborne biological warfare.

As with the inoculation experiments, close analysis of the Khabarovsk trials reveals the presence of the three key features of the scientific method in the bacterial bomb experiments. Ishii postulated that conventional weapon design could not be applied to bacterial bombs. His observations with conventional warfare bombs led him to believe that the high temperature on explosion of the metal in arterial shells would kill the bacteria, thus rendering their dissemination useless.[115] Ishii's falsifiable hypothesis was that using porcelain as a delivery system would mitigate the high temperature on

112 Harold Fair, "Biological Warfare Specialized Files, 1941-1947" in Record Group 112: Records of the Surgeon General (Army), 1775-1994, 295a, Box 11, Folder 61-285, 12, Department of Defense, Department of the Army, Office of the Surgeon General and Preventative Medicine Division, National Archives and Records Administration.

113 Guillemin, *Biological Weapons*, 24.

114 Ibid., 47-48.

115 Khabarovsk Trials, 230.

explosion and avoid the problem of useless bacteria.[116] After devising this hypothesis and fulfilling the first step of the scientific method, Ishii was able to design experiments to verify or falsify his hypothesis.

To test the efficacy of the porcelain bacterial bombs, Ishii designed bombs that were packaged with different pathogens, including typhoid, paratyphoid, cholera, and plague.[117] The airborne trials took place at Anta railway station, also known as Unit 731's "proving grounds." Unit 731 chose Anta station for the airborne experiments because the geographical area closely mimicked battlefield conditions.[118] To emulate the biological warfare attacks, "Victims were left in an open space bound hand and food; or tightly tied to iron stakes driven into the ground."[119] After ten to fifteen prisoners were tied to stakes, multiple bombs were dropped from an airplane.[120] While the bacterial bomb experiments possessed small sample sizes, akin to the inoculation experiments, the experiments only served as a protocol in an attempt to master airborne biological warfare. Many more victims would be exposed to bacterial bombs over the years.[121]

The experimental results were disappointing to Ishii and his colleagues. Ishii concluded that despite his novel bomb design, strong air pressure and excessively high temperature still killed nearly 100% of the bacterial load prior to reaching the target.[122] The experiment demonstrated falsification of the hypothesis that porcelain bombs could effectively disseminate the bacterial pathogens. Unit 731 continued to modify their bacterial bomb hypotheses and experiments based on these conclusions, demonstrating the third key features of the scientific method. In order to combat the premature death of the bacteria, Unit 731 began dropping bombs from altitudes lower than 500 meters. However, the conclusions were once again disappointing. One of the major weaknesses associated with this low altitude method was that the bacteria did not scatter over large distances.[123] Overall, bacterial bombs were innovative in design but feeble in nature.

Notably, bacterial bombs were not the only attempt at mastering airborne biological warfare. Another method designed to disseminate microorganisms in the air involved spraying the bacteria from airplanes.[124] There are no extensive descriptions of spraying human experimentation in the Khabarovsk trial testimony, but the testimony does note that Unit 731 employed spraying of bacteria during real-world missions. The viability of spraying microorganisms will be discussed in the next section.

116 Ibid.
117 Ibid., 71.
118 Ibid., 7, 350.
119 Ibid.
120 Ibid., 40.
121 As per the inoculation experiments, the Khabarovsk trial testimony does not reveal the exact number of bacterial bomb victims. However, the experiments were continually adapted and tested on more victims over the course of the program's operation. Khabarovsk Trials, 11, 40, 44, 47, 72, 109, 194, 203, 222, 270, 277.
122 Ibid., 71.
123 Ibid.
124 Ibid., 67.

The inoculation and bacterial bomb experiments on humans were barbaric acts against humanity. The phrase barbaric acts may mistakenly suggest that Unit 731's experiments were only crude in nature. However, there were clear moments of application of the three features of the scientific method. The inoculation and bacterial bomb experiments provide further evidence that Unit 731 experiments were incorrectly described as lacking scientific rigor.

During the Unit's operation, hundreds of individuals were annually experimented on and ultimately killed.[125] Thousands of humans suffered greatly at the hands of Unit 731, but in the minds of Japanese scientists and military officials, human experimentation was a means to an end. Only through trial and error with human subjects could the Japanese eventually employ biological warfare in real world missions. Despite varied success with human experimentation, Unit 731 used the results of their work to conduct large-scale missions.

REAL WORLD MISSIONS

Although Unit 731 ran scientifically rigorous experiments, the data that was produced from the experiments was questioned regarding its utility.[126] To determine whether the Unit's data was useful, I first explore what American researchers were expecting to gain from the Japanese data. There were three major reasons that the Americans sought out Japanese biological warfare data. First, the Americans were limited to animal testing for their own biological warfare program and thus human experimental data would be much more applicable to the eventual use of biological agents on human targets. The Americans also lacked information regarding possible dissemination systems for the biological agents. Finally, the Americans sought "adequate" field-testing results to prove that biological warfare could be of good use in real world missions.[127] Analysis of the inoculation and airborne warfare experiments reveals that the first two American expectations of the data were met. The Japanese utilized humans as their research subjects in both experiments. While the bacterial bombs were an insufficient delivery system, inoculation of various foods proved to be successful.

However, to fulfill all three criteria of the American researchers' expectations, the Japanese also needed to possess data suggesting that adequate field trials were completed. The specific use of the word adequate implies that the Americans were not expecting all out success in terms of mortality and morbidity with the biological warfare field tests. Rather, the Americans sought evidence that biological warfare attacks could be carried out in the first place. While American scientists were motivated to gain biological warfare knowledge from the Japanese, the Americans also wanted to prevent the Soviets from gathering any data. During interviews with American investigators, Ishii was instructed to not divulge valuable information to the Soviets.[128] Given the perceived value of the data, the US government went so far as to create a

125 Khabavorsk Trials, 13.
126 Harris, *Factories of Death*, 306.
127 Ibid., 264.
128 Ibid., 273.

subcommittee to prevent the Soviets from gathering any biological warfare related information.[129]

The successes and failures of the inoculation and airborne trials, designed and carried out through the scientific method, were directly extrapolated to conduct three biological warfare missions from 1940-1942. Through my analysis of these missions, I also demonstrate that the Japanese did in fact produce adequate field trials, thus fulfilling all three American expectations regarding the data. These three missions were not considered additional experiments that utilized the scientific method. Rather, the missions were field tests conducted to produce artificial epidemics that inflicted death and injury towards enemies.

While the human experimentation trials used Russian, Chinese, and Manchurian POWs as research subjects, these three real world missions solely targeted Chinese civilian and military populations because the nations had been at war since 1937.[130] The already existing conflict with the Chinese proved an effective testing ground in which to stage the biological warfare field trials. While the Second Sino-Japanese war officially began in 1937, Japanese aggression toward the Chinese started as early as 1931 during the "Manchurian incident." Members of the Japanese Imperial Army detonated a bomb at a Japanese owned railway station and fabricated a story about Chinese aggression, thus paving the way for the seizure of Manchuria.[131]

Chinese civilian populations were especially susceptible to these real-world missions, as parts of China, such as Nanking, had already been conquered by the Japanese. Therefore, the Japanese biological warfare missions were not used to change the tide of the Second Sino-Japanese War, but rather were conducted to specifically determine the applicability of biological weapons in the field. The missions were essentially a prelude to the full-blown use of biological warfare in the future. The applicability of biological warfare, as demonstrated by the field tests, was exactly what the Americans were expecting to gather from the data. The three attacks progressively increased in size and inflicted more damage to civilian and military targets.

The first and second biological warfare attacks primarily adopted airborne methods of dissemination. These attacks took place in 1940 and 1941. Although the Japanese bacterial bombs were initially regarded as a failure, Unit 731 found value in their negative results in a way consistent with the third feature of the scientific method, whereby results are analyzed for further hypothesis and experimental testing. While bacterial bombs were not effective, researchers found other methods of dissemination. Indeed, spraying microorganisms from airplanes proved to be a successful method of airborne biological warfare. Notably, Unit 100 also researched aerial spraying techniques that were similar to those studied by Unit 731.[132] In contrast to the 1940 and 1941 missions

129 Ibid., 290.

130 Chang, *Rape of Nanking*, 33.

131 Emer O-Dwyer, "Japanese Empire in Manchuria," *Oxford Research Encyclopedia of Asian History*, November 2017, https://oxfordre.com/asianhistory/view/10.1093/acrefore/9780190277727.001.0001/acrefore-9780190277727-e-78; Chang, *Rape of Nanking*, 29.

132 Harris, *Factories of Death*, 123.

that relied on airborne biological warfare, the 1942 mission primarily employed bacterial inoculation as the major method of attack.

General Ishii led the 1940 attacks that took place in Nimpo (Ningpo), a region south of Shanghai.[133] The attack mostly targeted civilians in the region. Proof of the 1940 field test was not only ascertained by testimony during the Khabarovsk trials, but was also corroborated by documents captured by Soviet troops.[134] The captured documents included a waybill for train freight that described the transport of "officers and lower ranks totaling 40, with equipment (secret weapons and material)."[135] The secret weapons and material refer to the biological warfare materials that Unit 731 covertly transported into China, along with 40 men. The waybill for the train freight also mentioned a "Nara Unit" — a Unit name used as a disguise.[136] Unit 731 falsely created the Nara Unit to confuse individuals who came across the waybill. The details that went into keeping the 1940 expedition covert emphasizes the intricate planning and preparedness of Unit 731 in employing biological warfare in the battlefield. Multiple sources reported the success of the 1940 attacks.

Unit 731 was one obvious source that claimed success of the mission. Ishii was so elated with the success of the 1940 expedition that he personally ordered a documentary film to be created.[137] The documentary was shown to Japanese high command. According to Unit 731 officials, the documentary included video reels of "the way the special appliances for spraying plague-infested fleas was fixed to the aeroplane [and] the actual spraying of the plague-infested fleas from the airplane."[138] The documentary provides details about how the attack was conducted, but questions remain, including precise details about what microorganisms were used and how many individuals were harmed in the attacks.

A Chinese medical article referencing the attack describes the use of plague infected fleas mixed with rice and wheat to attract rodents, to accelerate the spread of the disease. The article notes, "On October 29th, 1940, bubonic plague for the first time occurred in Ningpo in Chekiang province. The epidemic lasted 34 days and claimed 99 victims."[139] Chuhsien, which is another region in Chekiang province, was also subject to an attack in 1940. The Chuhsien plague epidemic lasted 24 days while claiming 21 lives.[140] This second source provides details about the methodology in which plague was spread, including the use of plague infected fleas mixed with grains to attract rodents. Moreover, the length of the artificial epidemics as well as the reported number of causalities were revealed. As discussed earlier, Ishii heavily invested into the production of fleas. His commitment to produce 45kg of fleas every month proved to be a successful investment. The 1940 mission exceeded the American expectation of an

133 Khabarovsk Trials, 326.
134 Ibid., 153,156.
135 Ibid., 153, 155-156.
136 Ibid., 353.
137 Ibid., 355.
138 Ibid.
139 Interagency Working Group, "Select Documents on Unit 731," p 11 JWC 71.
140 Ibid.

adequate field trial, as Unit 731 induced artificial epidemics that lasted roughly a month and claimed over one hundred lives, despite no reports of Japanese causalities.

After reflecting on the success of the 1940 attack, Unit 731 prepared for another biological warfare mission in 1941. The target of the second mission was Changteh (Changde), located in Hunan, China. Unlike the first mission that solely targeted civilian populations, the second mission was specifically designed to "dislocate the communications of the Chinese forces."[141] Unit 731 shifted its objectives from targeting civilians to the more difficult task of targeting military forces. The shift to more difficult objectives demonstrates the Unit's increased confidence in employing biological warfare. The second mission also included roughly 60 more men than the first mission.[142] The willingness to involve more men on a covert mission again demonstrates Unit 731's increased confidence in the use of biological weapons. While the exact number of Chinese casualties was not reported, the Colonel who led the mission concluded that "a severe epidemic of plague was caused."[143] Ishii highly praised this attack as well.[144] Both the 1940 and 1941 field trials proved that Unit 731 could cause significant morbidity and mortality through methods such as spraying microorganisms. At the very least, two adequate field trials had taken place.

Unit 731's 1942 mission was the largest and most complicated biological warfare attack. Further, the 1942 attack tested direct inoculation as a means of biological warfare dissemination. Roughly 150-160 men, from Unit 731 and Unit Ei 1644, took part in the expedition.[145] The 1942 mission was more complicated than previous missions because deception played a major role in the attack. The Japanese employed a strategical retreat to cause the deception.[146] A deceptive attack, which would enhance the success of biological warfare, required increased preparation and coordination from Unit 731 Divisions.

One target of the deceptive attack was civilians' natural water sources in Nanking, China.[147] To prepare for the attack Manufacturing 4th Division employees, who produced the microorganisms, needed to effectively coordinate with Scientific Research 1st Division employees, who packaged the bacteria into metal flasks. The flasks were then thrown into wells, marshes, and villagers' homes.[148] As Japanese soldiers strategically retreated from the area, civilians unsuspectingly ingested the bacteria-containing water because metal flasks were commonplace and did not rouse any suspicion. The shift from pilots spraying bacteria from a far distance to ground-troops personally disseminating metal flasks shows the evolution of Unit 731's biological weapons development and employment over a couple of years. The benefit of using ground-troops for the mission was that the microorganisms more precisely reached civilian populations.

141 Khabarovsk Trials, 355.
142 Ibid.
143 Ibid., 355-356.
144 Ibid.
145 Ibid., 282-283.
146 Ibid., 356.
147 Ibid., 282-283.
148 Ibid., 283.

The second target of the deceptive 1942 biological warfare attack were Chinese POWs in Nanking, China. Unit 731 members of the Scientific Research 1st Division injected typhoid and paratyphoid into roughly 3000 bread rolls with the goal of causing widespread fever in the population.[149] Unit 731 had successfully identified multiple food media that could spread disease. While experimentation revealed that vegetables were ideal for pathogen spread, rolls were likely used due to the deceptive nature of this attack. As Japanese soldiers were strategically retreating, the inoculated bread rolls were delivered to Chinese POWs under the guise of a gift.[150] The "gifting" of items was meant to decrease suspicion of an attack, making the victims more susceptible to the pathogens.

To perpetuate the idea that the Japanese were engaging in a charitable act, Japanese photographers were on sight to take pictures. After prisoners ate the rolls, they were all released from the camp.[151] By framing the exchange of food as a charitable act and releasing prisoners after they ate the food, the Japanese soldiers consciously misrepresented themselves as a sympathetic military force. In reality, gifting the food to the Chinese POWs allowed for productive distribution of the poisoned rolls because starving Chinese prisoners would have hastily ingested the free food. Additionally, the release of prisoners into the surrounding civilian population accelerated the process of creating an artificial typhoid and paratyphoid epidemic.

While the Khabarovsk trial testimony depicted distinct details about the preparation and execution of this attack, much like the 1941 attack, there is little information regarding the number of causalities as well as the length of the artificial epidemic that was induced. Rather, Ishii made a statement to his personnel that the result of the attacks were "considerable and had caused several severe outbreaks of infectious disease."[152] When questioned during the Khabarovsk trials, multiple Unit 731 scientists also described the mission as successful. One investigator asked, "It follows, then, that as a result of the expedition, epidemics broke out and centres of epidemics were formed?" to which one Unit 731 scientist simply answered, "Yes."[153] Although the exact details that would constitute the level of success of this attack are missing, at least one more adequate field trial was employed.

Although results of some of the human experiments were directly extrapolated to real world missions, the failures of other human trials also provided the Japanese with valuable insight into biological warfare. The Japanese utilized an increasing number of troops and more complicated methods of biological warfare dissemination over the course of the three field tests. Even though the results of Unit 731's human experimentation ranged from failure to success, the Japanese described the three missions from 1940 to 1942 as successful. In some cases, nearly one hundred Chinese civilians were killed and epidemics were artificially introduced for month-long periods. In other cases,

149 Ibid.
150 Ibid., 283-284, 356.
151 Ibid.
152 Ibid., 357.
153 Ibid., 284.

Japanese scientists uniformly claimed success of the attack but did not reveal any further details. Given these results, it may be argued that the Japanese demonstrated adequate field tests with biological weapons. The Japanese program produced data that utilized humans as research subjects, provided information about various delivery systems, and showed adequate field tests, suggesting that the assertion in the historical literature that the Japanese data was of minor significance is incorrect. American scientists' need to secure the Japanese biological warfare data became imperative, and thus the stage was set for pursuit of an immunity deal.[154]

For years after the end of the war, the US research program sent numerous investigators to Japan to gather information regarding biological warfare. Through a coordinated effort, Japanese scientists initially presented the program as one solely focused on defensive efforts and denied human experimentation for biological weapons purposes.[155] Although years of investigation passed by and answers regarding human experimentation were still unclear, US investigators suspected that Unit 731 produced good science. During the early stages of interviews, and prior to the Immunity Agreement, Ishii claimed that the Unit employed a passive and unorthodox approach toward biological warfare. Ishii misrepresented the Unit's scientifically rigorous research process and deflected blame by stating "[I] used to think up a problem, assign experts to follow down on the defensive and offensive aspects and submit a report. For this reason, I do not know the details of experiments."[156] Given the lack of progression with the interviews, the American investigators ultimately assured Japanese scientists that the information collected would be used solely for scientific purposes, rather than prosecution for war crimes.[157]

Despite the US researchers' commitment to obtaining the Japanese data through the Immunity Deal, the use of the data in the post-war period remains controversial. By contrast, the Americans rapidly accepted and integrated the results of Nazi human experimentation research in the post-war period. For instance, cooling curves from the Dachau freezing experiments were compared to data from downed US military pilots.[158] However, one significant claim of the use of Unit 731's work surfaced a few years after the end of WWII. During the Korean War, forces from the North Korean and the People's Republic of China armies argued that the Americans were engaging in biological warfare attacks.[159] North Korean forces specifically claimed that the Americans were systematically scattering large quantities of bacteria-carrying insects by aircraft, a description that is similar to the field test discussed above.[160]

154 Harris, *Factories of Death*, 265.
155 Brody, Leonard, Nie, and Weindling, "United States Responses," 223.
156 Harris, *Factories of Death*, 273.
157 Ibid., 275.
158 Robert S Pozos, "Nazi Hypothermia Research: Should the Data be Used?" in *Military Medical Ethics*, Vol. II, ed. Dave E. Lounsbury, Ronald F. Bellamy, Thomas E. Beam, and Linette R. Sparacino (Washington, DC: Office of the Surgeon General at TMM Publications, 2003), 448-449.
159 Harris, *Factories of Death*, 325.
160 Gold, *Unit 731*, 122.

The US did admit to possessing biological weapons but denied using the weapons.[161] Although Japanese data on delivery systems and field tests may have been valuable to the US researchers for a potential biological warfare attack, no conclusive scientific evidence suggests that the Americans utilized biological weapons during the Korean war.[162]

CONCLUSION

Unit 731 was a highly organized biological warfare research unit that produced large quantities of lethal microorganisms. Unit researchers also ran a multitude of human experiments. In the past, only Unit 731's frostbite, tuberculosis, and mustard gas experiments were considered to be rigorous. This classification was based on the presence of reliable and valid data collection.[163] Drawing on the inoculation and airborne bacterial bomb trials as additional and significant examples of rigorous science, this paper demonstrated that the two experiments did satisfy the core tenants of the scientific method: falsifiable hypothesis generation, experimental testing, and extrapolation of results for further hypothesis generation and testing.

The Japanese went so far as to incorporate control versus treatment designs into their experiments, demonstrating that these experiments were conducted with specific research intent. The individual inoculation and bacterial bomb experiments possessed small sample sizes but were repeated numerous times over the course of the program's existence in order to master biological weapons. Ultimately, thousands of POWs, who were selected due to Japanese exceptionalism and other existing conflicts, died from experimentation. The novel framework of the hypothetico-deductive method, or the traditional scientific method, that was used to demonstrate the scientific rigor of Japanese human experiments can be utilized to further validate other instances of human experimentation.

By investigating the three American expectations for the data, including utilization of humans as research subjects, information about delivery systems, and the presence of adequate field tests, this paper demonstrated that the Japanese produced useful data. Three large scale missions that targeted Chinese military and civilian populations were conducted from 1940 to 1942. Data gathered directly from the inoculation and airborne experiments was extrapolated for use in these missions. While some missions revealed more precise data about causalities and length of artificial epidemics, the Japanese regarded all three missions as successful from their own perspective. The US agreed to an immunity deal and halted all further investigation into the research program in order to acquire "the data that could not be obtained in [their] own laboratories because of scruples attached to human experimentation."[164]

161 George W. Christopher, Daniel M. Gerstein, Edward M. Eitzen, and James W Martin, "Historical Overview: From Poisoned Darts to Pan-Hazard Preparedness," in *Medical Aspects of Biological Warfare*, ed. by Joel Bozue, Christopher K. Cote, and Pamela J. Glass (Fort Sam Houston, TX: Office of the Surgeon General, 2018), 6.

162 Ibid., 6-7.

163 Bärnighausen, "Data Generated in Japan's Biowarfare Experiments," 134, 142-149.

164 Brody, Leonard, Nie, and Weindling, "United States Responses," 225.

Although the Americans expected that the Japanese data was useful, it is difficult to ascertain if biological warfare was truly successful by Ishii's standards. Ishii stated that the real-world attacks were successful in their own regard.[165] However, Ishii's initial vision was that biological weapons would be "the weapon[s] of the future," replacing conventional warfare methods.[166] The biological weapons did cause significant harm but as the program was abandoned at the end of the war in 1945, there were no more real-world missions to demonstrate any further capacity of the weapons in offensive warfare settings.

Similar to Wernher von Braun, the German pioneer of rocket technology, the perpetrators of heinous Japanese war crimes survived unscathed and even flourished, unlike their victims. Ishii lived quietly on a retirement pension until his death. Other members of the Unit found employment in lucrative private businesses, particularly the drug industry. Some Japanese scientists even went on to be recognized for their "charitable contributions to humanitarian causes."[167]

The US investigators' intuition about good science being produced by the camp was not wrong. Unit 731 conducted multiple scientifically rigorous experiments and produced useful data within those narrow terms. Even though the Japanese program produced good science that fulfilled American scientists' expectations at the time, given the significant suffering of thousands of Chinese, Manchurian, and Russian POWs, the decision to halt war crimes investigations in exchange for the biological warfare data is still not justified. The Unit's heinous methods are a stern reminder echoing through the years that scientists should not unquestionably accept the results of scientific research. Rather, scientists have a moral duty to society to also consider its broader framework.

ACKNOWLEDGEMENTS

I am grateful to Dr. Shauna Devine for her dedicated guidance, mentorship and encouragement throughout the completion of this project. I would also like to thank Dr. Shelley McKellar and Dr. Paul Potter for their enthusiastic support of History of Medicine at the Schulich School of Medicine & Dentistry. Thank you also to Drs. Dale Smith, Susan Reverby, Paul Weindling and Neville Thompson for providing me with valuable feedback towards the manuscript. Finally, I am grateful to my family and friends who continue to encourage my scholarly pursuit within the field.

165 Khabarovsk Trials, 355, 357.
166 Harris, *Factories of Death*, 21.
167 Ibid., 337.