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Radiation exposure and privacy concerns surrounding full-body scanners in airports

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ABSTRACT

Millions of people filter through airport security check points in the United States every year. These security checks, in response to the post 9/11 and 2009 "Underwear Bomber" terrorist threats, have become increasingly burdensome to the general public due to the wide spread deployment of "enhanced screening systems." The enhanced screening systems that have generated the most controversy are the passenger "full-body scanners." These systems enable airport security personnel to effectively detect contraband (often concealed under clothing) without the physical contact necessitated by a strip search. The two types of full-body scanners (also known as Advanced Imaging Technology systems), used in airports in the United States and around the world are referred to as backscatter technology units and millimeter-wave technology units. Although their respective radiation emissions vary, both scanners serve the same purpose; that is, the detection of concealed metallic and non-metallic threats in the form of liquids, gels, plastics, etc. Although enhanced screening systems were deployed to further public safety efforts, they have also generated wide spread public concern. Specifically, these concerns address the potential of adverse health and privacy issues that may result from continued public exposure to full-body scanner systems.

1. Backscatter systems

OSI Systems (Hawthorne, CA), American Science and Engineering (AS&E) (Billerica, MA), and Tek84 Engineering Group (San Diego, CA) are the leading manufacturers of the backscatter systems. These manufacturers supply the Transportation Security Administration (TSA), a subdivision of the Department of Homeland Security (DHS), with backscatter units to airports nationwide. The first full body scanner to use backscatter technology was produced by Steven W. Smith in 1992. Since then, Smith has sold the technology and rights to

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Rapiscan Systems (http://www.rapiscansystems.com) and continues to develop new generations of backscatter scanners among other weapon detection systems at Tek84 (http://www.tek84.com/index.html).

The backscatter systems work by generating small amounts of X-rays that reflect off the skin of an individual placed in the scanner. The scattered ionizing energy of the X-rays is then picked up by sensitive detectors and processed by a computer to produce a two-sided image. The resulting image is a revealing chalk-like outline that has been the cause of debate since its implementation. The backscatter scanners operate at 50 kVp producing X-rays with a tenth value layer (TVL) of about 8 cm in tissue (Moulder, 2012). Transportation Security Officers (in federal airports) or private contract screeners (in nonfederal airports) operate these units and it takes approximately 15 s to complete a scan. Traditional backscatter scanners require one operator to direct the passenger through the scanner while another operator is stationed in a private location to analyze the image that comes through to the computer. Rapiscan Secure 1000™, manufactured by Rapiscan Systems has an internal monitoring system that prevent over exposure of X-rays to passengers. These systems consist of sensors and detectors that enable the scanner to default to a power-down state if it is not operating within the set critical parameters (http://www.rapiscansystems.com).

1.1. *Privacy issues*

The public concern regarding privacy invasion from backscatter units has been an issue for years. In 2012 the Electronic Privacy Invasion Center (EPIC; Washington, DC) sued the Department of Homeland Security (DHS) with allegations that the new passenger screening program was unlawful, invasive, and ineffective (http://epic.org/privacy/airtravel/backscatter). EPIC argues that the implementation of the full body scanners is in violation of the Administrative Procedures Act, the Privacy Act, the Religious Freedom Restoration Act, and the Fourth Amendment. The court ruled that the backscatter units could be used in airports as long as passengers were offered alternative choices to the backscatter scan (http://epic.org/privacy/airtravel/backscatter). Measures have been taken by the manufacturing companies to assuage some of the privacy concerns. Implementation of technology to obscure the passenger's face on the image, technology that makes the images less graphic, and using separate rooms to analyze the images are a few of the measures taken by the TSA to reduce privacy concerns. The computer programs were modified so that the images could not be stored, printed, saved, or transmitted (http://www.tsa.gov). Despite these various measures to ensure the privacy of each passenger, passengers are still concerned about the detail and privacy of their images.

1.2. *Radiation safety*

X-rays used for medical imaging penetrate through the body whereas X-rays used in airport full body scanners have minimal interaction at the surface of the skin (Mehta & Smith-Bindman, 2011). Before the scanners were introduced to airports nationwide, radiation safety studies were conducted by the Food and Drug Administration's Center for Devices and Radiological Health (CDRH), Rapiscan's Third-Party Radiation Testing group, the National Institute of Standards and Technology's (NIST) Office of Law Enforcement Standards, and Johns Hopkins University Independent Assessment group. Each assessment proved the effective dose rate to be below the American National Standards Institute/Health Physics Society's standard annual dose limit of 250 μSv over a 12-month period. The effective dose estimates from a single scan range from 0.015 μSv to 0.88 μSv. To put these numbers into perspective, air travel can expose a passenger to 0.04 μSv per minute from cosmic radiation (Zanotti-Fregonara & Hindie, 2011). To look at this from another perspective, a passenger would have to pass through a backscatter scanner 1000–2000 times to equal the dose from a medical chest X-ray (Mahesh, 2010) which is also equivalent to the dose from 3 to 9 min of daily living (Mehta & Smith-Bindman, 2011). The TSA operators typically receive less than 100 μSv per year, which is well below the Occupational Safety and Health Administration's occupational safety health limit of 50,000 μSv per year (http://www.tsa.gov). Another reason why skepticism still surrounds backscatter units is because of studies that make the public question their safety. Marquette University's College of Engineering (Milwaukee, Wisconsin) conducted a study concluding that ionizing radiation emitted from backscatter scanning devices extends to organs deeper than the skin, but is still lower than the established health standards (http://www.marquette.edu/omc/newscenter/recent.php?subaction=showfull&id=1339424629&archive=).

2. Millimeter-wave systems

Millimeter-wave units do not expose passengers to ionizing radiation. They use a form of electromagnetic radiation called millimeter-waves that lie in the spectral region between radio waves and infrared to obtain images. The millimeter-wave scanners possess a unique property to pass transparently through lightweight materials such as clothing (Moulder, 2012). Despite the recent backscatter system ban in the UK, millimeter-wave systems are still being used. L3 Communications Holdings Inc. (New York, NY) and London based Smiths Group (http://www.smithsdetection.com) are the manufacturers of millimeter-wave systems. The millimeter-wave units beam low powered millimeter-waves over the surface of the body using two rotating antennas. The energy reflected back from the body is analyzed to create body images and to locate any objectionable items.

2.1. *Privacy issues*

In response to overwhelming complaint from human rights organizations and individual passengers about the exposing images that each scan creates, manufacturers are adding Automated Target Recognition (ATR) software to their scanners. This software allows for greater privacy and efficiency. A generic outline of the human body (same for both males and females) appears on the computer screen. If the scanner detects an irregularity, it will mark the location on the image and the TSA agent can further investigate. If the scanner does not

detect an irregularity, then the computer screen flashes a green screen with the word "OK" and the passenger is then free to pass. ATR eliminates the need for a second TSA agent to analyze images in a separate room.

2.2. *Radiation safety*

Although millimeter-wave scanners are becoming the primary full-body scanners used at airport security checks, there is still an alarmingly small amount of information about its potential health effects. The millimeter-wave safety standards are dose rate (power density) standards expressed in mW/m^2. The power density for a millimeter −wave scan is between 0.00001 and 0.0006 mW/cm^2 (Moulder, 2012). These scanners are believed to be less harmful to passengers because they emit nonionizing radiation and presumably do not have the potential for cancer causing DNA damage. The established health effects associated with non-ionizing radiation are limited to thermal effects. The long term effects of this type of radiation are still uncertain but it was reported that these scanners operate at outputs well below those required to produce tissue heating (http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_036.pdf).

3. Conclusion

This new technology is considered (by some people) as a more efficient security measure whereas others see it as an invasion of privacy and a public health issue. According to the widely accepted "As Low As Reasonably Achievable" (ALARA) principle, people should minimize their exposure to radiation sources to as minimal as possible. Due to background radiation, it is impossible to completely eliminate radiation exposure but ALARA helps to remind people and workers to try to avoid situations that could increase their risk.

Because the full body scanner units do subject every individual passing through the security check points (what some could argue to be unnecessary) with radiation exposure, it is understandable for people to be weary about their implementation at airports. Because the absorbed dose per scan is negligible, it is argued that there isn't much risk that an individual has to be concerned about. Concern naturally arises when taken into consideration the magnitude of people that are exposed over time and the frequent fliers that pass through security checks on a more regular basis. When the exposure risk is looked at on a grander scale, the public concern becomes clearer. As the number of people exposed to ionizing radiation increases the probability of health effects increases as well, especially in individuals who may be radiation sensitive. However, it would be very difficult to prove that the cause of cancer could have come from this specific radiation source. People are exposed to background radiation on a daily basis and the health effects can take years to appear. If a passenger is truly concerned about their radiation exposure then they should probably think twice before flying as a travel option because flying at high altitudes will expose an individual to much more radiation than from a backscatter unit.

Measures are being taken to remove backscatter units from U.S. airports because the manufacturers of these systems were unable to equip all of their units with ATR technology in the allotted time frame imposed by the TSA. As a result, more millimeter wave scanners will be implemented nationwide and this TSA decision could ultimately end the controversy over the use of full body scanners.

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