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13. Abstract ***(Maximum 200 Words)*** *(abstract should contain no proprietary or confidential information)*
Treatment of many military-relevant diseases depends on knowledge of body surface area (BSA). BSA is typically estimated using predictive formulae that were developed using a variety of measurement techniques. These techniques range from applying paper to the surface of the body and measuring the contact area to measuring the reflectance area of the skin with bright light. More recently, a technology, the 3-D laser scanner, has been developed which allows precise measurement of BSA. The objectives of this study are to accomplish the following: (1) collect measurements of BSA from whole-body laser scans, (2) determine the accuracy of currently used BSA estimation formulae based on stature and weight, (3) determine the impact of additional body dimensions on the accuracy of BSA estimation, (4) determine the reliability of BSA prediction from laser scans, (5) determine differences between two scanner types, and (6) develop new models that include use of body circumferences and segment lengths as predictor variables. After 14 months of effort, all contracts were let, and an international assurance was obtained. The data for this study have been collected and analysis is due to begin soon. The study should be completed by March 2005.

14. SUBJECT TERMS
whole body scans, 3-dimensional laser scanning, body surface area, anthropometry, girths, limb lengths

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INTRODUCTION:

Treatment of many military-relevant diseases depends on knowledge of body surface area (BSA). In the chemical industry, models are used to estimate the toxicity of materials that penetrate the skin. The exposed skin area is crucial for the accuracy of the model predictions. Such calculations are important in the determination of the effects of exposure to chemical agents. In chemotherapy, BSA is needed to calculate drug dosage. In thermal physiology, BSA values are necessary to calculate heat transfer. BSA is critical to the functioning of heat response models, and thus prediction of risk of heat illness. Serious over- or underestimation may occur when the surface area is incorrectly determined. For military clothing applications, surface area is important for design and manufacture of clothing that fits comfortably and allows adequate air circulation for proper temperature maintenance. Finally, determination of surface area in burn victims is essential to estimate the clinical outcome. Accuracy of body surface area measurements in all of these areas is very important.

BSA is typically estimated using predictive formulae that were developed using a variety of measurement techniques. These techniques range from applying paper to the surface of the body and measuring the contact area to measuring the reflectance area of the skin with bright light. More recently, a new technology was developed which allows precise measurement of BSA, namely the 3-D laser scanner. The Netherlands Organization for Applied Scientific Research (TNO) currently has a Vitronic Viro 3D-pro scanner. With this scanner, TNO is participating as the European member in the Civilian American and European Surface Anthropometry Resource (CAESAR) project begun by the U.S. Air Force. The objective of the CAESAR program is to build a new database of descriptive measurements of human dimensions. The database will be used to improve the fit of military and civilian clothing and the design of military and commercial vehicles (including aircraft) and military weapon systems to accommodate the human form.

This study will use laser scans to measure the BSA of human subjects and to determine whether or not formulas for the prediction of body surface area need to be revised. Better calculation of BSA will improve the treatment of diseases and models of chemical and thermal exposure.

The objectives of this study are to accomplish the following: (1) collect measurements of BSA from whole-body laser scans, (2) determine the accuracy of currently used BSA estimation formulae based on stature and weight, (3) determine the impact of additional body dimensions on the accuracy of BSA estimation, (4) determine the reliability of BSA prediction from laser scans, (5) determine differences between two scanner types, and (6) develop new models that include use of body circumferences and segment lengths as predictor variables.

The study is a correlational study. Subjects to be measured on the Vitronic Viro scanner will be stratified into five ranges according to their estimated BSA. Anthropometric measurements will be made on these subjects, and a 3-dimensional body scan will be obtained. Four subjects in each BSA range will be randomly selected and asked to return later in the day for a second scan to provide the basis for a system reliability determination. Extant data from CEASAR database will be used to compare two different scanner types.

Subjects to be scanned with the Vitronic Viro scanner in this study will be fifty (approximately 25 men and 25 women) healthy Dutch citizens 18 – 55 years of age. The subjects will be selected to provide equal representation within BSA quintiles based on

estimations from the application of an equation that uses height and weight to a U.S. Navy population sample (unpublished data, N = 86,641). Quintiles for BSA are BSA < 1.81, 1.81 ≤ BSA < 1.92, 1.92 ≤ BSA < 2.01, 2.01 ≤ BSA < 2.12, and BSA ≥ 2.12. Because men and women differ in body surface area on average, it is not anticipated that the number of men and number of women will be equal in each quintile. Particular attention will be paid to choosing subjects representing a range of segment proportionalities (e.g. leg length/stature). It is intended that the results of this study generalize to U.S. military populations. The sample size is based on unpublished data from a pilot study and a power of 0.80 and $P < 0.05$.

Existing scans for 32 additional subjects will be analyzed as follows:

(1) An extant set of 12 subjects who were measured using both a Vitronic Viro and Cyberware scanner will have BSA determined from scans recorded on each machine. These BSA values will be analyzed to compute an inter-machine reliability.

(2) Scan data for ten male and ten female subjects will be selected from the U.S. CAESAR database and processed to determine BSA. A comparable set based on stature, weight, ethnicity, and limb length proportion will be selected from the current study database. The US and NL data will be compared to determine whether or not the choice of NL subjects will affect the accuracy of models applied to US personnel.

BODY:

Accomplishments

Funding was received by the TRUE Foundation to support this work 01 March 2003.

The TNO Human Factors TCPE (Institute of Ethics Committee) approved the study on 4 November 2002. A DOD international assurance was needed for the TCPE.

The NHRC IRB reviewed and approved this protocol on 22 May 2003.

A contract with TNO Human Factors was let to support collection of the scans in July of 2003. The completion date of this contract was extended one time to 30 June 2004.

On 25 March 2004, a no-cost extension for the project was granted, with a new completion date of 25 March 2005.

An assurance number was issued 04 May 2004.

NHRC completed its continuing review for this study on 21 May 2004.

The laser scans were completed 30 June 2004.

The data analysis computer has been set up and software installed. Data analysis will begin in August 2004.

KEY RESEARCH ACCOMPLISHMENTS:

- Raw data are collected

REPORTABLE OUTCOMES:

None

CONCLUSIONS:

N/A

REFERENCES:

None

APPENDICES: