SINI 2017 — 27th Summer Institute in Nursing Informatics

Clinical Practice, Health, and the Internet of Things

July 11-14, 2017
University of Maryland School of Nursing, Baltimore, MD

The Characteristics of Pressure Injury Photographs from Electronic Health Record in Clinical Settings

Dan Li, Ph.D, RN
Assistant Professor
University of Pittsburgh
School of Nursing
dal144@pitt.edu

University of Pittsburgh

Pressure Injury ---The Facts

- Pressure is exerted on the skin, soft tissue, muscle and bone by the weight of an individual against a surface beneath.

- The incidence in ICUs between 1–56% and in Non-ICU units between 1--11%.

- Costly to the health care system, total cost to the U.S.=$11 billion/year.

- Require consistent objective assessments and documentation in order for proper treatment to occur.

University of Pittsburgh

What Anatomical Locations are at Risk?

University of Pittsburgh

European Pressure Ulcer Advisory Panel and National Pressure Ulcer Advisory Panel (2016) Classification System

Stage* (2016)	Sign and symptoms
Stage I	Intact skin with a localized area of non -blanchable erythema, which may appear differently in darkly pigmented skin. Presence of blanchable erythema or changes in sensation, temperature, or firmness may precede visual changes. Color changes do not include purple or maroon discoloration; these may indicate deep tissue pressure injury.
Stage II	Partial-thickness loss of skin with exposed dermis. The wound bed is viable, pink or red, moist, and may also present as an intact or ruptured serum-filled blister. Adipose (fat) is not visible and deeper tissues are not visible. Granulation tissue, slough and eschar are not present. Full-thickness loss of skin, in which adipose (fat) is visible in the ulcer and granulation tissue and epibole (rolled wound edges) are often present.
Stage III	Slough and/or eschar may be visible. The depth of tissue damage varies by anatomical location; areas of significant adiposity can develop deep wounds. Undermining and tunneling may occur. Fascia, muscle, tendon, ligament, cartilage and/or bone are not exposed. If slough or eschar obscures the extent of tissue loss this is an Unstageable Pressure Injury.
Stage IV	Full-thickness skin and tissue loss with exposed or directly palpable fascia, muscle, tendon, ligament, cartilage or bone in the ulcer. Slough and/or eschar may be visible. Epibole (rolled edges), undermining and/or tunneling often occur. Depth varies by anatomical location. If slough or eschar obscures the extent of tissue loss this is an Unstageable Pressure Injury.
Unstageable	Full-thickness skin and tissue loss in which the extent of tissue damage within the ulcer cannot be confirmed because it is obscured by slough or eschar. If slough or eschar is removed, a Stage 3 or Stage 4 pressure injury will be revealed. Stable eschar (i.e. dry, adherent, intact without erythema or fluctuance) on the heel or ischemic limb should not be softened or removed.

University of Pittsburgh

Future Pressure Injury Documentation

Image processing Technology (granulation, color, size and stage)

Nursing knowledge (location, dressing, and odor)

Completed Pressure Injury Documentation

A picture can be worth a thousand words!

University of Pittsburgh

Image Processing: Applications

- Medical Imaging

Tumor detection, wound assessment

- Monitoring

Traffic, surveillance, defects detection

- Automation

Robotics, factory, driving

*Google and UBER autonomous car

Applications: Digital Wound Assessment (DWA)

University of Pittsburgh

- Digital Wound Assessment

- Can be done locally or remotely

- Can be 2D or 3D

University of Pittsburgh

Wound Assessment by Image Processing

Four Steps:

(1) Preprocessing
(2) Segmentation
(3) Image Analysis
(4) Healing Projection

University of Pittsburgh

Image Processing Technology on Pressure Injury Analysis

University of Pittsburgh

Why is Wound Photography Important?

- 1. Allows for a formal record of pressure injury upon admission
- 2. Education for nursing and medical teams
- 3. Objective reproducible documentation
- 4. Assessment of pressure Injury overtime

University of Pittsburgh

How Should Photos be taken?
--Wound Photography Protocol

- Step 1: Prepare a digital camera with industry-standard resolution for high image quality
- Step 2: Undress the wound and thoroughly cleanse the wound
- Step 3: Position the camera perpendicularly to the wound
- Step 4: Hold a small measurement grid flat along edge of the wound but not cover any part of wound
- Step 5: Take the photographs under adequate light
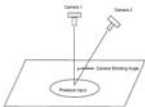- Step 6: Upload the photos into the EHR

University of Pittsburgh

How Should Photos be taken?

University of Pittsburgh

Photography Characteristics Affecting Image Processing Wound Analysis

- **Clinical background objects**

  Image processing wound assessment: Preprocessing

- **Relative position of the PI in the photographs**

  Image processing wound assessment: Segmentation

- **Camera shooting angle**

  Image processing wound assessment: Image Analysis

University of Pittsburgh

Method

- A 520-bed hospital in western Pennsylvania
- 360 Pressure Injury Photographs from EHR
- An experienced WOCN nurse and a nurse researcher reviewed all the PI photographs
- An image processing algorithm was used to calculate camera shooting angle.

University of Pittsburgh

Result: Quality of Pressure Injury Photographs

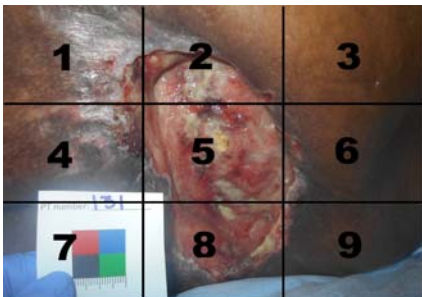| Variables	Number	Percentage
Total collected photographs	360	100%
Blurred photographs	14	3.9%
Un-integrated PI	9	2.5%
Total qualified photographs	337	93.6%

University of Pittsburgh

Result: Statistics of Clinical Background Objects

Clinical Background Objects	Number	Percentage
Bed linens	113	33.5%
Gowns	155	46.0%
Other body parts	98	29.1%
Glove	56	16.6%
Ceiling and walls	47	13.9%
Floor	69	20.5%
Others	86	26.4%

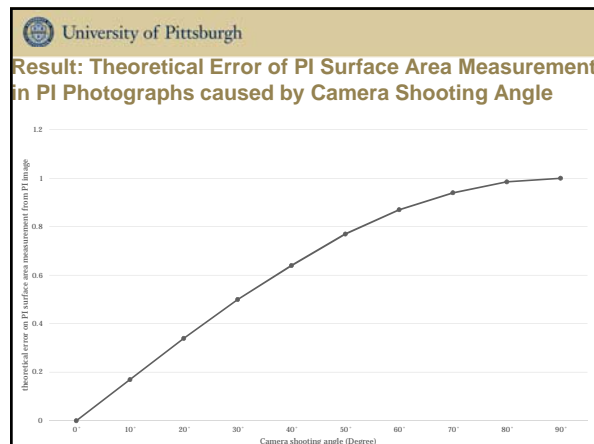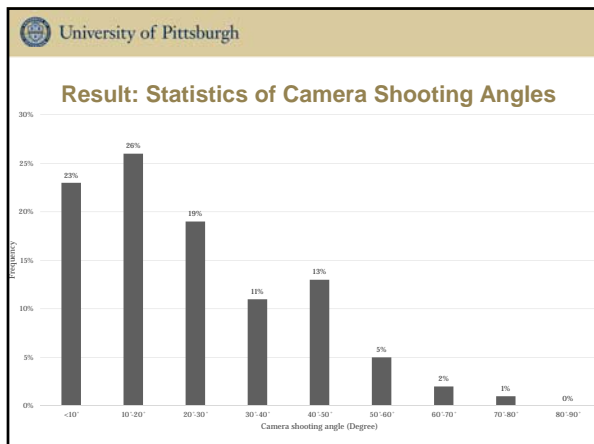## University of Pittsburgh

Result: Statistics of pressure Injury relative position in the images

University of Pittsburgh

Result: Statistics of pressure Injury relative position in the images

3.3% (11/337)	3.0% (10/337)	2.4% (8/337)
3.0% (10/337)	80.1% (270/337)	1.8% (6/337)
2.1% (7/337)	3.6% (12/337)	0.9% (3/337)

University of Pittsburgh

Result: Statistics of Camera Shooting Angles

University of Pittsburgh

Result: Theoretical Error of PI Surface Area Measurement in PI Photographs caused by Camera Shooting Angle

University of Pittsburgh

Discussions

- Photograph characteristics such as clinical background objects, camera angle, and the relative position of the PI in the images do not affect wound assessment when assessment from photographs by clinicians.
- Image processing experts must consider clinical background objects when developing image processing technologies for wound analysis.
- Any method that is designed to retrieve wound dimension from wound photographs must incorporate a correction for suboptimal camera shooting angle.

University of Pittsburgh

Conclusion

- The characteristics of pressure injury photos provide preliminary evidence of how they affect image processing and wound analysis.
- Certain standards and techniques must be followed when photographing the PIs—or other chronic wounds in order to further utilize the PI photographs.

University of Pittsburgh

Thank you!