Case Study #2 – Mammography

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1. **What types of data do we (as a health data analyst) need to capture in order to generate better evidence regarding mammograms? Provide examples and detail how it could be used to generate better evidence.**

   A. **Data with more information.**
   Mammography imaging is to generate cross-section image using X-ray (Mustra, Grgic, & Rangayyan, 2016) Generally, as other X-ray imaging methods, mammograms prefer higher resolution images, which provides the possibility of discovering abnormalities among the surrounding breast tissue. For the conventional transmission X-ray mammography, the detection of tumors tissue with time-resolved imaging relies essentially on blood absorption - the tumor tissue in general contains more vessels and thus tend to have higher absorption. Taroni et al. reasoned that, using shorter X-ray wavelengths than presently used (680–780 nm) could improve the resolution of the mammography. Their study further proves that the optical contrast increased when X-ray wavelengths decreases, thus gaining a higher mammography resolution (Taroni et al., 2004). Griffiths et al. have implemented an X-ray diffraction method, and noticed that using the said method, they can generate X-ray images with a higher resolution than the images generated using conventional transmission X-ray mammography (Griffiths et al., 2003).

   Other than purely image-based mammography, Sinkus et al. implemented a device to also measure the viscoelastic shear properties of breast lesions to improve the specificity of mammography. They reason that the shear modulus healthy breast tissue have a range of frequency range when measured by dynamic MR elastography. Exploiting this feature, and combining it with conventional X-ray image, they could shorten diagnosis time, and improve diagnosis specificity and sensitivity (Sinkus et al., 2007).

   B. **More organized and better analyzed data**.
   For some health data analyst, the resolution of the X-ray image is fixed. Thus, methods will need to be implemented to exploit the image, targeting to gain more, and more accurate information from data analysis. Conventionally, one method to obtain more accurate mammography is double-reading. That is, two independent health data analysts to analysis the exactly same X-ray image independently (Brown, Bryan, & Warren, 1996).

   Other than relying on human analysts, breast cancer screening has been widely adopted by the world, the increased need for mammography resulted the invention of computer-aided diagnosis (CAD) systems to help the health data analysts to generate better evidence, by labeling region of interest image segmentation and object detection algorithms (Mustra et al., 2016). Recently, machine learning has been applied in mammograms. The most utilized machine learning classifier (MLC) is support vector machine (SVM), which is used to distinguish muscle tissue from the rest of the breast using a

classification process, using mammography images (Cardoso et al., 2010; Domingues et al., 2010; Ramos-Pollán et al., 2012). Other MLC, including decision tree and artificial neuron networks are also used to generate better evidence regarding mammograms using available data (Ramos-Pollán et al., 2012).

2. **PCP's may recommend a screening based on USPTF guidelines, however patients are not obliged to heed such recommendations. What types of "decision support" could help patients decide if mammograms are right for them?**

   Mammography screening is a tradeoff of a continuum of benefits and harms. The decision supports should clarify both the benefits and harms.

   A. Benefits of mammogram:
      a. Studies show that woman receive mammography in a regular basis are more likely to have their cancers detected at smaller sizes and at earlier time (Kopans & Feig, 1993; Sickles & Kopans, 1993; Thurfjell & Lindgren, 1994).
      b. Statistics show that breast cancer mortality are reduced for women of all age groups from 39 to 69 years. Especially, mammography screening for women aged 39 to 49 years showed a statistically significant 15% breast cancer mortality reduction (Nelson et al., 2009).

   B. Harms of mammogram:
      a. Overdiagnosis is the main harm of mammogram. In the year 2007, in average 15 women for every 1000 women in mammography screening suffer from overdiagnosis, which lead to necessary treatment (Løberg, Lousdal, Bretthauer, & Kalager, 2015).
      b. Possibility of false-positive mammogram results lead to additional imaging, and thus additional X-ray radiation exposure, which may result in higher breast cancer rate. Studies show that 3 years after mammography, the breast cancer mortality of mammography-screened women is actually double than the women that has not been screened (Baines, 2003).
      c. False-positive may lead to necessary biopsies, which will create physical wound on the breast tissue (Baines, 2003).
      d. Extra radiation exposure. Although, the X-ray used are considered low-dose, low-energy radiation (Spelic, 2006)
      e. Breast compression is used in the mammography, which causes mild pain (Nelson et al., 2009)
      f. The mammography may cause anxiety, distress, and other Psychological Responses (Nelson et al., 2009)

3. **If patients who have received mammograms (like LS) wished to share their data for research, how could they do it?**

   The patients could sign the consent document for sharing their data for research with the healthcare givers who perform the mammography. For example, their mammograms data could be shared with a digital base for screening mammography. From the databased, digital images of the mammography from healthy and breast-cancer infected woman can be used to develop algorithms in the diagnosis of breast cancer (Heath, Bowyer, Kopans, Moore, & Kegelmeyer, 2000; Lee et al., 2017).

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