

Talking Points on Chiarelli et al. - Digital Compared with Screen- Film Mammography: Performance Measures in Concurrent Cohorts within an Organized Breast Screening Program

1. It is important to focus on the study results that were reported to have statistical significance:
 - a. Among women 50-74, CR was less effective at cancer detection than SFM, while DR and SFM had comparable cancer detection rates.
 - b. CR also was less effective at cancer detection than SFM in certain subgroups: detection of invasive breast cancers, women getting rescreened (not first-time screening), women with breast densities less than 75%, women with no family history of breast cancer, and women not currently using estrogen.
 - c. DR had higher cancer detection rates than SFM for in-situ cancers.
2. The cancer detection rate findings for CR are at odds with the two previous studies that compared CR to SFM:
 - a. A Finnish study (Lipasti et al, ref 24 in the Chiarelli paper) compared the performance of CR in 30,153 women screened in 2007–2008 with SFM in 32,939 women screened in 1999–2000. The study found significantly higher cancer detection rates with CR than SFM (6.2 per 1,000 vs. 4.1 per 1,000) and higher screening PPVs for CR than SFM (36% vs. 26%), with similar specificities. The Finnish study had the limitation of comparing screening performance over different time periods; the Chiarelli study does not.
 - b. A Swedish study (Heddson et al, ref 17 in Chiarelli) compared the performance of screening with SFM (Jan 2000-May 2002), CR (Fuji, May 2002-Feb 2005), and DR (direct photon-counting, formerly Sectra, now Philips, Sept 2004-Feb 2005). Cancer detection rates were 3.1 per 1,000 for SFM, 3.8 per 1,000 for CR, and 4.9 per 1,000 for DR. The detection rate difference between SFM and CR was not statistically significant. PPV was significantly lower for SFM (22%) than for either CR (39%; $P < 0.001$) or DR (47%; $P < 0.001$). Recall rates were significantly higher for SFM than for CR or DR: 1.4% for SFM, 1.0% for both CR and DR.

While, unlike these two previous studies of CR, the Chiarelli study included more women and was a concurrent comparison of 3 modalities, care should be taken in concluding that CR is inferior to SFM in cancer detection in light of the prior two reported studies. The Chiarelli study raises concern that CR performance cannot be assumed to be as good as SFM or DM, and indicates that further investigation is needed to determine the reasons that CR had inferior cancer detection in the Chiarelli study. One possible difference is a different study population in the CR group, which had nearly double the rate of women with $\geq 75\%$ breast density, compared to the SFM and DR groups. Other possible differences include the distribution of digital manufacturers included in the Chiarelli study compared to prior studies of CR, and the radiation doses at which CR was operating at the Chiarelli study sites, compared to CR in other studies. CR is known to be a somewhat less efficient detector (has a lower DQE) than DR (see Siebert JA, http://www.appliedradiology.org/courses/1394/HTML/idm_experience.html) and is not capable of the flat-field corrections that DR uses to eliminate some structured noise in mammography images.

3. The Chiarelli study is consistent with ACRIN DMIST findings in terms of the comparison of SFM and DR for the age group 50 years and over. Differences between the two studies are:

a. DMIST included all women seeking screening mammography (33.5% were under age 50) and performed paired SFM and digital exams, while Chiarelli et al. included women 50-74 and women received either SFM, CR, or DR. Because Chiarelli et al. excluded women under age 50, it either entirely or largely excluded the subgroups for which DMIST showed digital to be significantly more accurate than SFM: women under age 50, pre- and peri-menopausal women, and women with dense breasts.

b. DMIST based its primary findings on ROC analysis, which examines accuracy, while Chiarelli et al. based their primary findings on cancer detection rates.

c. DMIST was not designed to compare CR to SFM separately. DMIST included CR in its “digital mammography” arm (22.3% of DMIST digital exams were CR, all Fuji CR). Subgroup analyses of DMIST data by manufacturer found that CR did not miss any larger fraction of cancers than SFM or other (DR) digital machine types (Pisano ED, Hendrick RE, Yaffe MJ, et.al. Diagnostic accuracy of digital versus film mammography: exploratory analysis of selected population subgroups in DMIST. *Radiology* 2008; 246: 376-383).

4. The poorer performance of CR has implications for only a small fraction of the sites providing mammography services in the U.S., where the great majority (79.4%) are DR, 12% are SFM, and only 8.6% are CR.

5. The lead statement in the press release from RSNA is misleading: “Digital direct radiography (DR) is significantly more effective than computed radiography (CR) at detecting breast cancer, according to a new study published online in the journal *Radiology*.” The study never compared the performance of DR and CR, but instead compared both CR and DR to SFM. The study design avoided comparing DR and CR directly, because to do so would have required adjustment in the statistical methods to allow for multiple comparisons (Bonferroni corrections) and would have reduced the power to make any statistically significant conclusions. I am letting Martin Yaffe, one of the co-authors, know about this misleading statement in hopes that he can convince RSNA to revise it.