Contextual Differences in Cancer Care Provider Networks and the Adoption of Novel Innovations

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Introduction

Background

- Peer exposure is predictive of uptake of new treatments via relationships in patient-sharing networks, which have been shown to correspond to professional relationships in clinical practice.[1,2]
- The Oncotype DX (ODX) genomic assay became an American Society of Clinical Oncology (ASCO) guideline-recommended test in 2007, due to its ability to identify recurrence risk in patients with early-stage, estrogen receptor-positive, node-negative breast cancers. Patients with low risk tend to benefit from hormone therapy alone, thus avoiding adjuvant chemotherapy.[3]
- The effect of peer network exposure to ODX has been observed, but several network and geospatial factors remain unexamined.[4]

Gap in knowledge:

- Studies examining network effects on the adoption of ODX have been limited to regional registry data and have never been examined using complete nationwide claims data.[4,5]
- Nationwide data may reveal yet unidentified disparities in care when taking into account geospatial and care team characteristics that define patients' experiences within diverse health systems.
- Dynamic diffusion modeling is a yet unexplored space in physician network analysis that may be exploited to drive equitable access.

Objective:

- Examine peer network effects in national claims data and assess factors relevant to peer influence on ODX adoption over time.

Data Sources

Primary Data:

- Medicare Part A & B Claims 2007-2014 (CMS)

- Nationwide claims for women 65-100 years of age

Supporting Data:

- Coding Trends & Crosswalks (Dartmouth Atlas of Health Care)

- National Plan & Provider Enumeration System (NPPES)

- National provider identifier (NPI) number, location, and specialties for each provider

- Rural-Urban Commuting Area Codes (USDA/ERS)

- Small Area Income & Poverty Estimates (US Census Bureau)

- Wide-ranging Online Data for Epidemiologic Research (WONDER); US Cancer Statistics (USCS); Surveillance, Epidemiology, & End Results (SEER) Program (CDC/NCI)

Methods

Cohort Identification from Medicare Claims

- Incident breast cancer cases were identified via a modified set of algorithms, using 11 diagnosis (Dx) and 126 procedure codes for biopsy (Bx) and surgery (Sx).[6,7]
- Treatment with ODX was identified via additional algorithms.[8]

Construction of Physician Peer Network

- Providers having treated patients in common were assembled into networks, noting Dx and ODX dates.

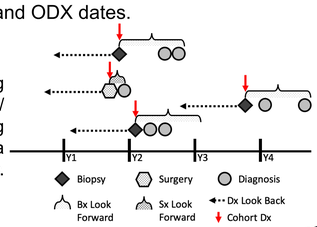

Fig. 1. Algorithm for identifying new diagnoses by procedures/ subsequent Dx and excluding prevalent or recurrent cases via lookback exclusion window.

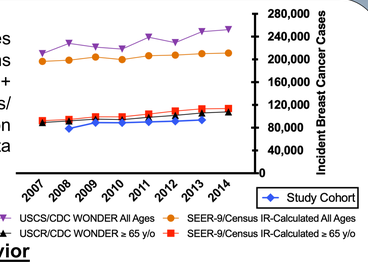

Fig. 2. Incident cases identified in Medicare claims mirrors incidence among 65+ women as seen in registries/ SEER surveillance region incidence rate (IR) data

ODX Prescribing Behavior

- 77% of prescribers were medical oncologists, 17.7% were surgeons, and 2% were radiation oncologists.
- Observing the initial prescribing period, adoption of ODX seemed to grow considerably around the time of ASCO and National Comprehensive Cancer Network (NCCN) guideline recommendations in 2007/2008.[9]

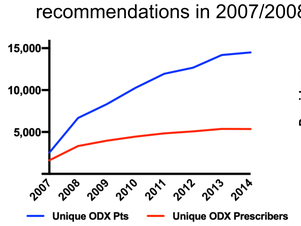

Fig. 3. The number of patients prescribed ODX continued to grow even as the number of new prescribers leveled off.

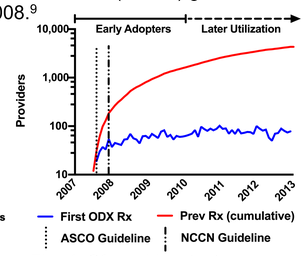

Fig. 4. Of providers that saw cohort patients in 2008-2009, we temporally separated prescribers into two adopter categories. [4]

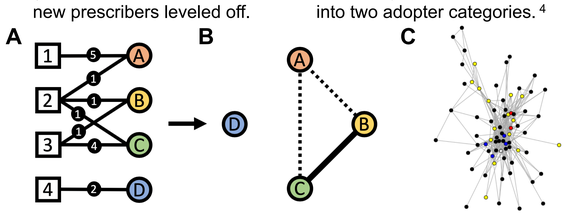

Fig. 5. A and B) Patient-sharing networks as bipartite (two-mode, A) and unipartite (one-mode, B and C) graphs. Patient (square) and physician (circle) nodes are connected by a tie (with number of encounters noted) if a patient was treated by a physician. This can also be represented in a projection (B), with the weight of ties between physicians determined by number of shared patients. C) Subgraph of oncologists caring for cohort patients in a single hospital referral region (HRR).

Patient Care Measures

Averaged for each provider's patients, which then attributed to each provider[10]:

- Continuity of Care (COC): sum of squares of visit counts to individual providers over number of total visits to all providers "Oncology team COC" - COC for GPs, oncologists, & surgeons

Patient-Sharing Network Attributes

- Degree Centrality: number of ties with other providers
- Bipartite Clustering Coefficient: for subnetworks (*e.g.*, HRRs), the ratio of patient-sharing ties with two or more patients over those with one or more patients shared[11]

ODX Prescriber Exposure/Influence

- Shares Patients with Early Adopter[2,4]
- Co-located with Early Adopter[12]

The full national network for 2008/9:	**157,520 nodes, 1.3M edges**
The oncologist network for 2008/9:	**9,144 nodes, 20,806 edges**

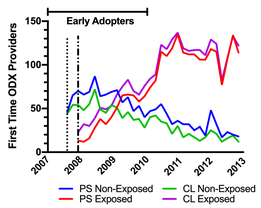

Fig. 5. New oncologist ODX prescribers by neighboring in the patient-sharing network (PS) or by ZIP code (ZCTA) co-location (CL) with previous ODX prescriber. Guideline releases are shown as represented in Figure 4.

	Early Adopter (n=1511)	Later Adopter (n=1879)	Non-Adopter (n=5753)	p-value
Patient Volume Divided by Tertile (%)				<0.001
1	169 (11.2)	284 (15.1)	2594 (45.1)	
2	630 (41.7)	732 (39.0)	1686 (29.3)	
3	712 (47.1)	863 (45.9)	1473 (25.6)	
Physician Gender = Male (%)	1096 (72.5)	1364 (72.6)	4210 (73.2)	0.816
Mean Patient Age * (%)	722 (47.8)	961 (51.1)	2887 (50.2)	0.133
% Pts in Rural Area * (%)	826 (54.7)	1124 (59.8)	2621 (45.6)	<0.001
Pt Area Poverty Rates * (%)	737 (48.8)	955 (50.8)	2879 (50.0)	0.491
% White Pts * (%)	637 (42.2)	842 (44.8)	3091 (53.7)	<0.001
% Pts Treated at Teaching Hospital * (%)	737 (48.8)	921 (49.0)	2914 (50.7)	0.271
% Pts Treated at NCI Cancer Center * (%)	783 (51.8)	962 (51.2)	2826 (49.1)	0.088
Total Continuity of Care § (mean (SD))	0.29 (0.09)	0.30 (0.10)	0.28 (0.13)	<0.001
Oncology Team Continuity of Care § (mean (SD))	0.69 (0.13)	0.70 (0.13)	0.65 (0.20)	<0.001
Physician Degree Centrality (mean (SD))	5.33 (4.66)	5.35 (4.65)	4.09 (4.84)	<0.001
HRR Bipartite Clustering Coefficient (%)	415 (27.5)	562 (29.9)	1260 (21.9)	<0.001
Shares Pts with Early Adopter (%)	838 (55.5)	1045 (55.6)	2385 (41.5)	<0.001
Co-Located with Early Adopter (%)	959 (63.5)	1160 (61.7)	2496 (43.4)	<0.001

Table 1. Descriptive statistics of oncologists seeing breast cancer cohort patients over 2008-2008 and network characteristics for early (2007-2009) and later (2010-2012) adoption as previously.[4] Pairwise-comparisons by ANOVA with Bonferroni correction are included.
* = above 50th percentile, § = aggregated from oncologist's patients

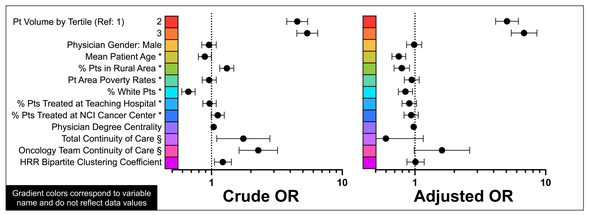

Figure 6. Multi-level logistic regression model of early adopter status with provider, geospatial, and sociodemographic characteristics.
A random effect for HRR was included.[13]
Odds ratios (ORs) with 95% confidence intervals are shown.
* = above top 50th percentile, § = aggregated by oncologist's patients

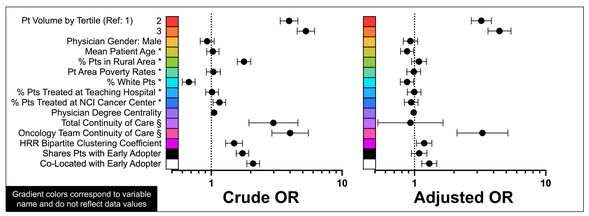

Figure 7. Multi-level logistic regression model of subsequent adopter status vs provider, geospatial, sociodemographic, and previous ODX prescriber provider exposure characteristics.
A random effect for HRR was included.
ORs with 95% confidence intervals are shown.
* = above top 50th percentile, § = aggregated by oncologist's patients

Conclusions

- Nationwide prescribing for the Medicare population increased markedly, as expected, over the period when ODX was recommended by ASCO and NCCN guidelines.
- Both early and later adoption were most strongly predicted by higher patient volume, likely indicating that providers specializing in breast cancer care were more likely to adopt.
- Oncology team continuity of care and HRR bipartite clustering coefficient were associated with subsequent adoption.
- Signaling a route of exposure exogenous to that suggested by patient-sharing networks, co-location with previous adopters was seen to have a larger association with adoption.
- Consistent with previous studies, providers with younger patients were more likely to prescribe ODX.[8]
- Contrary to other studies, providers serving larger proportions of minority patients were more likely to adopt.

Study limitations

- Results are based on Medicare beneficiaries and may not be generalizable to patients less than 65 years of age or in managed care.
- Due to the observational study design, our results cannot be interpreted as causal.

Future directions

- Further doctor, practice, and hospital characteristics, as well as oncologist availability by state, will be evaluated.[14]
- Application of multilayer network/coarsening approaches and diffusion centrality analysis[15] will be employed to ascertain the extent of network or other embedded features' impact on ODX dissemination.[16]
- Dynamic spreading and epidemic process analyses will also be explored to evaluate any radiative processes.

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Acknowledgments

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