Original Study

A Better Pathway? Building Consensus and Engaging Providers with Feedback to Improve and Standardize Cancer Care

Sarah Colonna,[1] John Sweetenham,[1] Trever B. Burgon,[2] Saundra S. Buys,[1] Ray Lynch,[1] Trang Au,[1] Eric Johnson,[1] Timothy Kubal,[5] David Paculdo,[2] Maria Czarina Acelajado,[2] John W. Peabody[2,3,4]

Abstract

To reduce unwanted clinical variation in a multidisciplinary breast cancer team, we utilized patient simulations with feedback and the in-house development of breast cancer pathways. At baseline, we found high variation in care decisions across the team. After introduction of clinical pathways and serial measurement and feedback of patient simulations, we saw significantly reduced variation.

Introduction: Unwanted clinical variation is common across the United States health care system and is particularly vexing in oncology owing to the complexity, morbidity, and high cost of the disease. Efforts to standardize care including guidelines and continuing medical education have had only limited impact. Disease-specific oncology clinical pathways hold the promise of reducing variation but have been hampered by a lack of ownership and accountability among oncology providers. **Materials and Methods:** We describe the utility of combining a patient simulation-based clinical variation measurement with the in-house development of multidisciplinary breast cancer pathways at a National Cancer Institute-designated cancer center. **Results:** At baseline, we found high variation in care decisions across the multidisciplinary team and within individual specialties in the management of simulated patients. Development and introduction of breast cancer clinical pathways combined with individual and group feedback on pathway adherence led to significant increases in pathway-aligned care decisions and decreases in measured variation. Overall quality scores increased from 47.5% to 61.1% ($P < .001$), with the largest improvement in diagnostic accuracy (+22.1%). Providers also ordered fewer unnecessary tests, saving an estimated $305 per patient case. Adherence to preferred chemotherapy regimens increased for both medical oncologists (+16%) and other members of the multidisciplinary team (+19%). **Conclusion:** Our work shows that a structured process to measure clinical variation and provide personalized feedback to an oncology multidisciplinary team drives adoption of evidence-based pathways, less unneeded spending, and higher quality care for patients.

Clinical Breast Cancer, Vol. 19, No. 2, e376-84

Keywords: Clinical pathways, Evidence-based medicine, Practice improvement, Standardization of care, Variation reduction

Introduction

A growing array of efficacious cancer therapies has contributed to a 21% decline in cancer mortality since 1991.[1] However, these advances have also driven up the cost of cancer care, which is estimated to reach $173 billion dollars in the United States by 2020, a 39% increase from 2010.[2] Conscious of the increasingly unsustainable rise in health care costs, policy makers, payers, and providers have looked for opportunities to control spending while improving care quality. One of the most attractive approaches is to reduce unwanted clinical variation, defined as variation from evidence-based recommendations that is not driven by the unique medical needs of an individual patient, which leads to misutilization, poor quality, and unneeded costs.[3] Variation, however, is widespread, for example, in the workup for

[1]Huntsman Cancer Institute, University of Utah, Salt Lake City, UT
[2]QURE Healthcare, San Francisco, CA
[3]Department of Epidemiology and Biostatistics, University of California, San Francisco, CA
[4]Department of Health Policy and Management, University of California, Los Angeles, CA
[5]H. Lee Moffitt Cancer Center, Tampa, FL

Submitted: May 18, 2018; Revised: Nov 12, 2018; Accepted: Dec 7, 2018; Epub: Dec 21, 2018

Address for correspondence: John W. Peabody, MD, PhD, 450 Pacific Ave, Ste 200, San Francisco, CA 94133
E-mail contact: jpeabody@qurehealthcare.com

1526-8209/$ - see frontmatter
https://doi.org/10.1016/j.clbc.2018.12.010

patients with metastatic breast cancer.[4] In fact, recent reports suggest that 35% to 50% of health care spending may be wasted on unnecessary and inefficient care.[5-7]

Different approaches to care standardization have been taken, with only limited success.[8,9] The American Society for Clinical Oncology, in 2012, released a list of avoidable low-value tests and procedures that had little evidence of benefit. Unfortunately, a recent impact study showed persistent use of these tests and procedures.[10] Professional guidelines, such as those developed by the National Comprehensive Cancer Network (NCCN), are another approach. Guidelines, however, often have multiple regimens that are considered "on guideline." The recent NCCN guideline for metastatic breast cancer, for example, has 8 "preferred" single-agent regimens and 8 "recommended" regimens for human epidermal growth factor receptor 2 (HER2)-negative recurrent or metastatic disease.[11] Although each of these evidence-based regimens may be appropriate, the adoption of a more standardized and uniform approach would lead to cost savings and improved safety.[6]

Clinical pathways are a potential way to circumvent these limitations because they are specific, make 1 or 2 targeted clinical recommendations, and can be used at the point of care. In oncology, the use of pathways has grown dramatically.[12] Notwithstanding, pathway use has been poor, with adherence across multiple conditions hovering around 53%.[13] Low pathway adherence may be owing to 3 factors. First, most pathways are purchased from outside vendors or developed by a small cohort of internal providers, contributing to physicians' lack of "ownership." Second, little accountability for pathway implementation exists because providers may not get feedback on their adherence and how they compare with their colleagues. Last, the match between pathways and the patient is never exact, making it difficult to distinguish between unneeded pathway deviations and "patient fit."

In 2013, the Huntsman Cancer Institute (HCI) engaged QURE Healthcare, LLC, to provide logistical support and practical guidance to develop and introduce "home-grown" clinical pathways. We hypothesized that collaborative development of these pathways combined with regular measurement of pathway adherence would lead to more standardized, evidence-based care among a multidisciplinary group of breast cancer providers. Herein we describe how we evaluated an approach that used simulated patients to serially measure adherence to Huntsman oncology pathways across the clinical continuum (workup, diagnosis, treatment, follow-up) among physicians, pharmacists, and advanced practice clinicians.

Materials and Methods

Setting

The HCI at the University of Utah is a National Cancer Institute-designated comprehensive cancer center. Huntsman Cancer Hospital, part of the HCI, is a dedicated 100-bed cancer hospital providing cancer care to the large, multi-state Mountain West region of the United States.

Participants

Between June 2014 and October 2016, 36 HCI multidisciplinary breast cancer specialists participated in the project. The specialist team consisted of medical oncologists, surgeons, radiation oncologists, pharmacists, nurse practitioners, physician assistants, pathologists, and radiologists. Participation in the project was voluntary. Of these 36 total participants, 27 (75%) participated both before and after the introduction of clinical pathways and were included in the pre-post analysis. There were no statistical differences in the characteristics and the baseline scores of the 9 providers who did not participate after the introduction of the pathways, except that all participants who dropped out were male ($P = .039$). As part of HCI's standard monitoring, the data gathered for this study were collected for clinical quality and safety purposes and contained no patient information.

Clinical Performance and Value Data

We used Clinical Performance and Value (CPV) vignettes for patients with breast cancer to measure engagement with and adherence to cancer pathways. CPV patient simulations have been validated against standardized patients and chart abstraction to verify decisions made in the simulations are consistent with actual clinical decisions.[14-17] CPV simulations have been used across a wide range of diseases and conditions, with extensive applications in oncology.[13] In addition to validating CPV data against other measures of practice, improvements in CPV care translated into improvements in patient-level outcomes,[18,19] with a 3% to 5% improvement in the CPVs sufficient to discern meaningful clinical change at the provider level.[16,20]

CPV simulations are online, interactive patient vignettes wherein participant-providers specify the important components of the history and physical exam of a given case, describe what laboratory and imaging tests they would order, and, based on the results of their evaluation, make a diagnosis and outline a treatment plan. To replicate practice, the simulations are open-ended, not multiple-choice.

The authors and other members of the HCI team created 12 CPV patients with breast cancer, each presenting with different types and stages of breast cancer (See Supplemental Table 1 in the online version for a brief summary of the cases). Cases ranged from early stage to metastatic disease and included hormone receptor- and HER2-positive and -negative patients with varying common comorbidities. Prior to gathering any data, a select group of Huntsman clinicians reviewed each case and agreed upon the evidence-based scoring criteria (based on the evidence base, local expert knowledge, and clinical guidelines) used to evaluate care decisions before they were released to the full multidisciplinary group. Over the course of this 2-year project, participating Huntsman breast cancer providers completed 2 CPV cases about every 4 months over 6 total rounds. Providers received the 12 cases in random order to allow for analysis of group performance trends. As the providers went through the cases, the patient simulation platform returned information to the providers based on their responses in the cases. All open-ended responses were recorded and scored against the previously outlined scoring criteria by trained physician abstractors at QURE Healthcare, LLC, who were blinded to participant identities. Providers received points for responses that matched the scoring criteria. CPV scores are reported as a percentage of total correct items.

The first 2 rounds of CPV cases (4 total cases) measured baseline variation across the group and provided direction for pathway development. The final 4 rounds of CPV cases (8 total cases),

measured clinical practice and pathway adherence after development and release of the breast cancer pathways and, using feedback and repeat measurement, reinforced key pathway-based decisions.

Feedback

After each round, the participants received personalized individual feedback on their clinical decisions and were given specific recommendations to improve pathway-based care. Their scores were also benchmarked to other members of the group after every round. Group feedback, consisting of a 60-minute QURE-facilitated discussion, reviewed the top 6 areas of clinical variation or economic opportunities among the group in that round. The group sessions were aimed at developing consensus in areas of pathway divergence.

Pathway Development

After the first 2 rounds of CPV (baseline) measurement, we formed multiple small working groups to develop HCI-specific breast cancer clinical pathways. The intent was to build pathways using evidence-based guidelines while simultaneously reflecting local context. The evidence base was gleaned from a review of relevant clinical literature including guidelines from the American Society for Clinical Oncology and NCCN. The pathways sought to explicitly standardize practice and, as a principle, set out a limited number of clinical options. Where one option was shown to be more efficacious, that option was preferred. Where no option was shown to lead to better outcomes, options with less severe side effects were prioritized. If options were equal on those measures, then the lowest cost option was preferred.

Based on the working groups' input, QURE generated the first draft of each pathway as a flow chart. The HCI working group provided edits and updates on the flow charts themselves and in short conference call discussions, incorporating Huntsman-specific preferences. This process was iterated 4 to 5 times. After finalization of each, the breast cancer leadership team took the pathways to the full team for review during the weekly multidisciplinary treatment planning conference. In all, we developed 13 unique pathways covering all elements of care ranging from evaluation of a palpable mass to initial diagnostic testing through treatment (including surgery, chemotherapy, radiation treatment), and follow-up care (including maintenance therapy and palliative care) (see Figure 1 for an example). Once finalized by the full multidisciplinary team, the pathway elements were reviewed by another group of HCI providers to ensure that the criteria were included in the CPV case scoring criteria. The pathways were presented as visual flow charts and disseminated in 2 ways: published on-line where the team could easily access them when caring for patients and printed as a set of laminated pocket cards given to all members of the team. At weekly multidisciplinary treatment planning conferences, the pathways were reviewed to ensure that care plans were aligned with real-life patient management. Care plans were further modified as appropriate.

Following development, review, and release of HCI-developed breast cancer pathways, we administered 4 more rounds of CPV measurement with individual and group feedback. The purpose of the measurement and feedback was to create a system of objective accountability for pathway adherence and feedback-supported improvement in adherence over time.

Patient-level Data

A crucial question is whether the improvements in CPV care translate into improvements in actual care. Other studies, including large-scale validation studies, indicate this is so.[16,17,21] However, every institution, including HCI, aspires to confirm improvement in management of real-world patients, as distinct from improvements observed in the validated virtual ones. In specific areas where we were able to obtain data, 2 of the authors at HCI (T.A., E.J.) performed a retrospective manual abstraction of chart data on cardiac monitoring of patients on cardiotoxic chemotherapies to see if pathway introduction had an impact at the patient level. These data were contemporaneous and abstracted pre/post around the introduction of the pathways, which included cardiac monitoring in the new pathways.

Analyses

We analyzed 2 main outcomes in the group's multidisciplinary care: (1) baseline variation in CPV scores (overall and domain), as determined by percentage of items correctly addressed by participants according to evidence-based scoring criteria, before the pathways were put in place; (2) the change in pathway-based care decisions after development of detailed, homegrown breast cancer pathways. In the analyses comparing pre-pathways versus post-pathways data, we used the Fisher exact test for all binary outcome data and the Student t test for continuous outcomes. All statistical analyses were performed using Stata 14.2.

Results

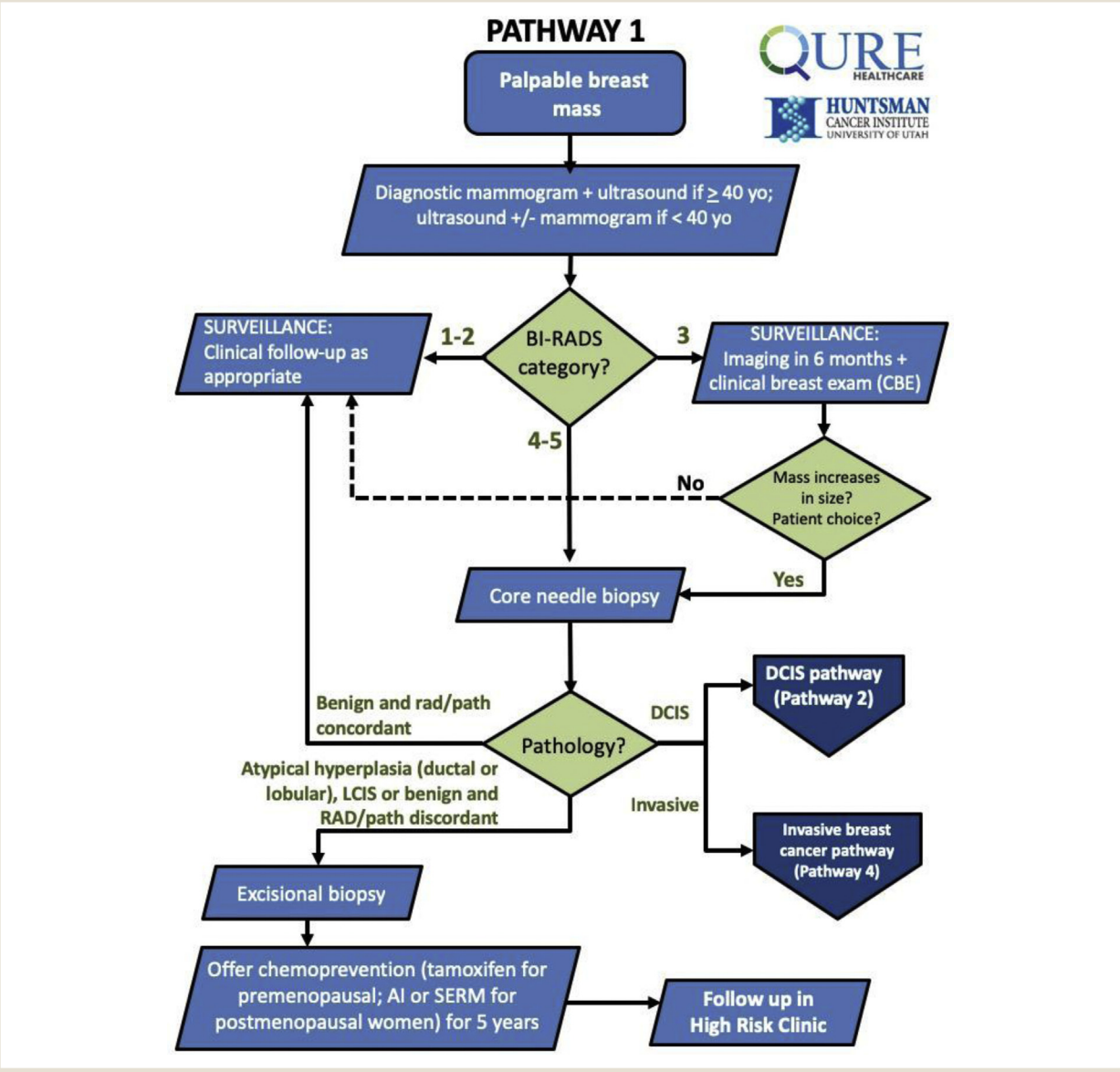
Participant Characteristics

Among the HCI breast cancer providers who participated before and after the introduction of pathways, 74% (n = 20) were physicians, most commonly medical oncologists (22%; n = 6) or surgeons (22%; n = 6); 15% (n = 4) were advanced practice clinicians and 11% (n = 3) were pharmacists. The average age of participants was 47.5 years (range, 27-67 years), and participants reported an average of 11.3 years caring for patients with breast cancer (SD, 10.4 years). The group was 63% (n = 17) female and reported that just over 50% of the patients they cared for were seen for breast cancer. On average, 12% of participants' time was spent on research (SD, 10.8%) and over one-half (n = 14) reported having worked as a principal investigator (Table 1).

Baseline CPV Variation Assessment

Before introducing pathways, we used 2 rounds of CPV simulation (2 cases each round) to measure baseline practice variation in breast cancer care across the group and exclude a possible learning effect. From the first to the second round, overall scores improved by only 1.2%, a difference that was not significant ($P = .343$). Data from the 2 rounds of baseline measurement revealed wide variations in care, with an average CPV total quality score of 47.5% (SD, 17.3%), meaning that just under one-half of the necessary care items were addressed across the workup, diagnosis, and treatment care domains (Table 2). Workup scores, which included laboratory and imaging diagnostics, were highest (60.3%) but also displayed the greatest variation (SD, 25.0%). Treatment scores, which evaluated providers' comprehensive pathway-based

Figure 1 Sample Huntsman Breast Cancer Pathway



Abbreviations: AI = aromatase inhibitor; BI-RADS = Breast Imaging Reporting and Data System; CBE = clinical breast exam; DCIS = ductal carcinoma in situ; LCIS = lobular carcinoma in situ; SERM = selective estrogen receptor modulator.

treatment plan for the patients, including pharmacologic and nonpharmacologic care options, showed the lowest scores (43.2%; SD, 22.1%). By specialty, pharmacists showed the highest performance (67.0%), followed by medical oncologists (53.6%), and surgeons (45.7%).

Pathway Impact: Changes in CPV Scores Overall and by Domain

Overall CPV quality scores improved significantly after pathways introduction. CPV scores increased from 47.5% at baseline to an average of 61.1% post-pathways ($P < .001$) (Table 2). The standard deviation in overall scores also decreased from 17.3 to 15.6, reflecting standardization in practice around pathway-based care.

We disaggregated the overall scores to evaluate changes in the individual care domains (workup, diagnosis, and treatment). Diagnostic accuracy, as measured by providers noting the correct diagnosis and staging for the virtual patients they cared for, showed the largest improvement of 22.1 percentage points (to 74.1%). With better diagnostic accuracy, we looked for related improvements in workup and treatment decisions. We found a 10.7 percentage point increase in workup scores (to 71.0%) and a 9.9 percentage point increase in treatment scores (to 53.1%). All increases in CPV quality scores by care domain were statistically significant ($P < .001$). Post-pathways, pharmacists (82.0%) and medical oncologists (66.6%) continued to perform the best, followed by radiation oncologists (60.2%).

Table 1 Participant Characteristics

Characteristic	N (%)
Total	27
Mean age, y (range)	47.5 (27-67)
Male	10 (37)
Provider subgroup	
Advance practice clinician	4 (15)
Pharmacist	3 (11)
Physician	20 (74)
Medical oncology	6 (22)
Radiation oncology	3 (11)
Surgery	6 (22)
Other (pathology and radiology)	5 (19)
Years of training (physicians only)	6.6 ± 1.9
Years treating patients with breast cancer	11.3 ± 10.4
Patients with breast cancer seen/week	24.4 ± 32.6
Percentage of patients seen with breast cancer	50.3 ± 28.6
Time spent as part of multidisciplinary team, %	58.5 ± 36.8
Work as principal investigator, %	53.9
Time spent teaching/mentoring, %	19.3 ± 13.8
Time spent in research, %	12.4 ± 10.8

Based on earlier studies showing high levels of variation in the evaluation of the patients with metastatic disease, we investigated the pre-post impact of introducing pathways on the workup.[20] At baseline, we found wide variations in the workup for metastatic breast cancer: only 41% of participants outlined an appropriate patient workup compared with the pathways (Table 2). Examples of appropriate workup included items such as chest and abdominal computed tomography for suspected patients with metastatic disease, genetic counseling for at-risk patients, and baseline cardiac assessment for patients who are candidates for cardiotoxic regimens. Insufficient (as opposed to excessive) workup was the most common deviation from guidelines at baseline and was found in 44% of the cases. To improve these findings, the pathways specifically included patient selection criteria and laboratory testing or imaging studies for patients at risk for metastatic disease. Following pathway introduction and CPV pre-post measurement and feedback, scores for appropriate metastatic workup increased from 41% to 69% ($P < .01$).

Similarly, staging accuracy in the primary diagnosis was only correct 78% of the time at baseline for stage 0 to 2 disease and 59% in the more complex stage 3 to 4 disease. Secondary diagnoses (comorbidities) were correct or partially correct 51% of the time for stage 0 to 2 and 35% for stage 3 to 4, raising clinical concerns as well as missed coding opportunities. With measurement and feedback, staging accuracy improved by 5% for stage 0 to 2 disease ($P = .616$) and 29% for stage 3 to 4 ($P < .001$). Documentation of the secondary diagnoses improved by 27% for stage 0 to 2 ($P = .020$) and by 30% for stage 3 to 4 ($P = .003$).

Three additional clinical areas were of interest to the multidisciplinary team: potential savings from reducing unneeded testing, inconsistency of chemotherapy prescribing, and a desire to increase use of palliative care services.

Table 2 Pre- Versus Post-pathways Changes

	Pre-pathways, %	Post-pathways, %	*P* Value
No. cases	113	174	
CPV score			
Overall	47.5 ± 17.3	61.1 ± 15.6	< .001
Workup	60.3 ± 25.0	71.0 ± 20.1	< .001
Diagnosis	52.0 ± 25.0	74.1 ± 18.7	< .001
Treatment	43.2 ± 22.1	53.1 ± 22.2	< .001
Diagnosis and staging			
Stage 0-2			
Primary diagnosis	80	97	.008
Secondary diagnosis	49	76	.020
Staging	78	83	.616
Stage 3-4			
Primary diagnosis	82	98	.001
Secondary diagnosis	65	95	.003
Staging	59	88	< .001
Diagnostic mammogram	74	86	.100
Metastatic workup			
Appropriate	41	69	
Excessive	15	14	.001
Insufficient	44	17	
Unneeded testing			
Cases with unneeded test	80	55	< .001
Average unneeded tests/case, n	1.6	1.0	< .001
Average unneeded cost/case, $	782	477	.008
Unneeded biopsies	18	9	.018
Chemotherapy pathway adherence			
Overall	54	73	.007
Medical oncology/ pharmacy	71	87	.029
Other specialty	46	65	.004
Palliative care referrals	6	42	.014

Abbreviation: CPV = Clinical Performance and Value.

Unneeded Testing

We wanted to understand practice variation to maximize high-value tests and reduce unneeded tests. At baseline, unneeded testing was common: 80% of all cases had at least 1 unneeded test ordered, with an average of 1.6 unneeded tests per case (Table 2). After pathways development, only 55% of the cases had any unnecessary tests, with only one (1.0) unneeded test per case (both results, $P < .001$). The most commonly avoided tests over the course

of the project were unneeded biopsies and imaging studies such as ultrasounds or repeat mammograms. To give a specific example, ordering of unnecessary biopsies decreased from 18% pre-pathways to 9% post-pathways ($P = .018$). We estimated the financial impact of these reductions using national Medicare reimbursement rates, which is likely appreciably conservative when compared with commercial payment rates. After pathway introduction, the average spending per case on unneeded testing fell 39% from $782 to $477 per case ($P < .01$), saving $305 on average per patient case.

Chemotherapy

At baseline, we confirmed the group's intuition of large variation in the identification of guideline-based chemotherapy regimens. This included adjuvant, neoadjuvant, and maintenance therapy. Initially, only 54% of the regimens were identified as guideline-based. As expected, medical oncologists and pharmacists scored higher than other clinical specialties ($P < .01$). After pathway introduction, which narrowed preferred chemotherapy regimens down to 1 or 2 options, CPV chemotherapy scores increased to 73% for the whole group, a 19% increase from the pre-pathway score ($P < .01$). All groups improved their post-pathway chemotherapy scores, with medical oncologists and pharmacists improving by 16% and other specialists improving by 19% ($P < .05$ for both).

Palliative Care

The baseline measurement revealed vast underuse of palliative care resources. Only 6% of CPV cases included a palliative care plan for candidate patients. In response to these findings, we developed a specific palliative care pathway that identified specific disease course, and physical, emotional, and practical concerns that should trigger palliative interventions. With the introduction of this pathway, palliative care plans were included in 42% of appropriate cases ($P = .01$). In concrete terms, this means that an additional 10 members of the multidisciplinary team recognized the need for palliative care for appropriate patients.

Patient-level Outcomes

Finally, we compared the results of the CPV data, which revealed improvements in choice of chemotherapy regimens and declines in inadequate workups, against the chart abstractions. Analysis of the patient-level data indicated that pathways had a measurably large impact on the appropriate evaluation and regular cardiac monitoring of patients with breast cancer placed on trastuzumab or pertuzumab. From January 2010 until introduction of the pathways (ie, CPV baseline data collection), 73% of HCI patients receiving trastuzumab or pertuzumab had a documented baseline echo/multigated acquisition scan within 30 days of first treatment, and 21% had documented follow-up monitoring scans at the recommended 90-day intervals throughout active treatment. After the pathways were introduced in the summer of 2015, cardiac pretreatment assessments rose to 93% (+20% increase; $P < .001$), and surveillance testing increased to 32% (+11% increase; $P = .036$).

Discussion

Standardizing clinical practice in oncology is challenging. In this study-project at HCI, we introduced clinical pathways, which were developed internally by the multi-disciplinary breast cancer team, with the explicit intention of evaluating whether pathway-based practice could be improved with measurement and feedback using simulated patients. We used a common quality improvement tool, CPVs, to eliminate the challenges of case-mix variation and small sample sizes, to measure care decisions, and to provide feedback on pathway adherence opportunities.

Although others have found pathway use and adherence wanting,[22] this study shows that CPV measurement and feedback can accelerate pathways awareness and enhance pathway use in a group. At baseline, using 2 rounds of measurement, we found gaps in quality and widespread variation in clinical practice. After the introduction of the locally developed breast cancer pathways, not only did overall scores increase from 47.5% to 61.1%, but CPV scores on diagnostic accuracy, workup, and treatment improved. Of equal importance is that practice variation between Huntsman providers decreased significantly.

CPV simulations are uniquely able to measure diagnostic accuracy because, ex ante, we know what the patient has and what their diagnosis is. Other studies have shown that diagnostic inaccuracy is a serious problem, with an overall incident rate of 10% to 20% of all diagnoses.[23] Although studies of diagnostic accuracy are difficult in traditional studies, the ease of studying diagnostic accuracy using simulations allowed us to answer a more important question: "Can diagnostic accuracy be improved?" As was the case for the studies cited above, we found that the accuracy of the primary diagnosis was incorrect or incomplete 1 of 5 times at baseline; for example, not appropriately identifying BRCA positivity or hormone receptor status. With CPV measurement and feedback, the primary diagnostic accuracy rose to 97%. This 17% improvement was one of the largest improvements in any of the domains in this project. Better diagnostic accuracy should be linked to more accurate workups and better treatment plans. Indeed, workup improved 11% and pathway-based treatment improved 10% in our study. Reducing unnecessary testing, providing pathway-based chemotherapy, and increasing palliative care referrals also improved substantially after pathway introduction, with unneeded tests per case falling by 38% (from 1.6 to 1.0), on-pathway chemotherapy decisions increasing by 19%, and palliative care planning increasing by 36 percentage points. The ability to improve palliative care has proved challenging elsewhere, and inclusion of palliative care in pathways with CPV accountability appears particularly effective in this study.[24]

We believe that there are 3 major reasons we were able to see so much improvement in pathway adherence in this study. The first is the use of CPV cases. Pathway adherence measurement is usually complicated by patient-level variability, which makes feedback and the identification of group patterns of care difficult. We overcame this using the simulated CPV cases that removed patient-level variation, which would otherwise confound measures of clinical practice standardization. In our pre-post analysis, serial measurement and feedback on pathway adherence proved very effective. The second reason is that providers knew that their results would be compared with their colleagues' results. This caused angst in some participants and contributed to the 25% dropout, but it also motivated adoption and improvement. The benchmarking of scores, when providers were all caring for the same patients, has face validity. The third reason is that the HCI providers felt that they "owned" the pathways rather than having them imposed upon them. We obviated the ownership

problem by building the pathways locally and involving users in a review process that was engaging but not burdensome. Future studies may help to define the relative contributions of CPV accountability versus home-grown development.

The Huntsman project is important in one other way. Pathways and accountability to using pathways was done by the entire multidisciplinary team of Huntsman health care professionals. To underscore the multidisciplinary nature of HCI care, the pathway introduction and the CPV feedback accounted for and accommodated the expertise of every member of the team, ranging from the radiologists to the pathologists to the experts in the 3 treatment modalities (surgery, systemic therapy, and radiation). Our observation is that this inclusion improved care coordination, although we did not explicitly measure this in the study.

There are important limitations to consider when looking at our findings. We did not have a control group, and thus we cannot rule out secular effects also improving breast cancer care at the same time. Working with the whole multidisciplinary team, although it had advantages, also brought up differences in perspectives that had to be overcome; for example, reluctance on the part of the surgeons to learn about chemotherapy regimens. Although there were no differences in those that completed or did not complete the cases, there is the possibility that their care was materially different from those that continued. Additionally, it took providers time to review and finalize the pathways even though these were created by the QURE partners. At HCI, this required leadership to step forward to either do the reviews or see that they were carried out—always a challenge for busy clinicians. The vignettes themselves do not measure the coordination or the logistics of therapy such as same-day visits and patient preferences for a particular treatment such as hypofractionation. Obviously, there are costs involved in preparing pathways and measuring adherence to the pathways once they were introduced. Institutions have to calculate the investment versus the returns.

Ideally, more patient-level data would have been abstracted for comparison to CPV performance. We were able to obtain some specific patient-level analysis (cardiac monitoring) through manual abstraction that we could link to the CPVs, validating the impact of the pathways when used with CPV measurement and feedback. These patient-level findings and findings from other studies using simulated patients support the hypothesis that there were meaningful practice improvements and cost savings at HCI.[16,17] In the future, measurement and intervention studies using simulations, where possible, should contain pre/post patient-level data and a reference group.

Conclusion

In summary, measurement and feedback that relied on simulated cases improved adherence to institutionally developed clinical pathways. The use of simulations greatly simplified the evaluation of pathways. The most important improvements were in the costliest elements of cancer care: misdiagnosis, workup, and treatment. Specific details of these improvements were found in palliative care referrals, pathway-based chemotherapy, and wasteful testing and translated into at least one specific clinical area: cardiac functional testing and monitoring. Building pathways institutionally was time-consuming, but in this setting, appears to have successfully standardized breast cancer care.

Clinical Practice Points

- Unwarranted variation in cancer care is common and costly. With the cost of cancer in the US having risen dramatically in the past 10 years, new approaches to ensure all patients receive evidence-based, cost-effective treatment options are needed.
- Clinical pathways are gaining increasing interest as a tool to help providers identify and apply the best available care for cancer patients. However, hurdles to pathway adoption include lack of physician ownership in pathway content and accountability to pathway recommendations.
- This study implemented a new collaborative approach to develop "home-grown" breast cancer clinical pathways across a multidisciplinary group of oncology providers at an NCI-designated comprehensive cancer center.
- The approach was bolstered with validated patient with breast cancer simulations, which were used to measure care decisions made by the group. The researchers used care decisions made by providers in the simulations to (1) identify common areas of variation before pathway development and (2) provide education and feedback on pathway adherence after pathway introduction.
- Combining breast cancer clinical pathway development with individual and group feedback on pathway adherence led to significant increases in pathway-aligned care decisions, including reductions in unnecessary testing, increases in diagnostic accuracy, and improved adherence to pathway preferred chemotherapy regimens.
- These results show that a structured process to measure clinical variation and provide personalized feedback to an oncology multidisciplinary team drives adoption of evidence-based pathways, less unneeded spending, and higher quality care for patients. Acknowledgment This work was funded by a contract between Huntsman Cancer Institute and QURE Healthcare, LLC. QURE, LLC, whose intellectual property was used to prepare the cases and collect the data, was contracted by Huntsman Cancer Institute.

Acknowledgment

This work was funded by a contract between Huntsman Cancer Institute and QURE Healthcare, LLC. QURE, LLC, whose intellectual property was used to prepare the cases and collect the data, was contracted by Huntsman Cancer Institute.

Disclosure

The authors have stated that they have no conflicts of interest.

Supplemental Data

Supplemental table accompanying this article can be found in the online version at https://doi.org/10.1016/j.clbc.2018.12.010.

References

1. Seigel RL, Miller KD, Jemal A. Cancer statistics, 2016. *CA Cancer J Clin* 2016; 66: 7-30.
2. Mariotto AB, Robin Yabroff K, Shao Y, Feuer EJ, Brown ML. Projections of the cost of cancer care in the United States: 2010-2020. *J Natl Cancer Inst* 2011; 103: 117-28.
3. Wade JC. Unwanted variation in cancer care: it is time to innovate and change. *J Oncol Pract* 2017; 13:6-8.

4. Chagpar A, Babiera G, Aguirre J, Caropreso P, Hughes T; American College of Surgeons Communities. Variation in metastatic workup for patients with invasive breast cancer. *Am J Surg* 2015; 210:1147-54.e2.
5. IOM (Institute of Medicine). *The healthcare imperative: lowering costs and improving outcomes: workshop series summary*. Washington, DC: The National Academies Press; 2010.
6. IOM (Institute of Medicine). *Best care at lower cost: The path to continuously learning health care in America*. Washington, DC: The National Academies Press; 2013.
7. James BC, Poulsen GP. The case for capitation. Available at: https://hbr.org/2016/07/the-case-for-capitation. Accessed: May 9, 2018.
8. Davis D, Thomson O'Brien MA, Freemantle N. Impact of formal Continuing Medical Education: do conferences, workshops, rounds, and other traditional continuing education activities change physician behavior or health care outcomes? *JAMA* 1999; 282:867074.
9. Mansouri M, Lockyer J. A meta-analysis of Continuing Medical Education effectiveness. *J Contin Educ Health Prof* 2007; 27:6-15.
10. Rocque G, Blayney DW, Jahanzeb M, et al. Choosing wisely in oncology: are we ready for value-based care? *J Oncol Pract* 2017; 13:e935-43.
11. National Comprehensive Cancer Network. NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines): Breast Cancer. Version 1.2018. 2018. Available at: https://www.nccn.org/professionals/physician_gls/pdf/breast.pdf. Accessed: May 9, 2018.
12. Daly B, Zon RT, Page RD, et al. Oncology clinical pathways: charting the landscape of pathway providers. *J Onc Pract* 2018; 14:e194-200.
13. Kubal T, Letson DG, Ciappori AA, et al. Longitudinal cohort study to determine effectiveness of a novel simulated case and feedback system to improve clinical pathway adherence in breast, lung and GI cancers. *BMJ Open* 2016; 6:e012312.
14. Peabody J, Luck J, Glassman P, Dresselhaus TR, Lee M. Comparison of vignettes, standardized patients, and chart abstraction: a prospective validation study of 3 methods for measuring quality. *JAMA* 2000; 283:1715-22.
15. Peabody J, Luck J, Glassman P, et al. Measuring the quality of physician practice by using clinical vignettes: a prospective validation study. *Ann Intern Med* 2004; 141:771-80.
16. Burgon TB, Cox-Chapman J, Czarnecki C, et al. Engaging primary care providers to reduce unwanted clinical variation and support ACO cost and quality goals: a unique provider-payer collaboration. *Popul Health Manag* 2018. https://doi.org/10.1089/pop.2018.0111.
17. Weems L, Strong J, Plummer D, et al. A quality collaboration in heart failure and pneumonia inpatient care at Novant Health: standardizing hospitalist practices to improve patient care and system performance. *Jt Comm J Qual Patient Saf* 2018. https://doi.org/10.1016/j.jcjq.2018.09.005.
18. Quimbo S, Peabody JW, Javier X, Shimkhada R, Solon O. Pushing on a string: how policy might encourage private doctors to compete with the public sector on the basis of quality. *Econ Lett* 2011; 110:101-3.
19. Peabody J, Shimkhada R, Quimbo S, Solon O, Javier X, McCulloch C. The impact of performance incentives on health outcomes: results from a cluster randomized controlled trial in the Philippines. *Health Policy Plan* 2014; 29:615-21.
20. Peabody JW, Paculdo DR, Tamondong-Lachica D, et al. Improving clinical practice using a novel engagement approach: measurement, benchmarking and feedback: a longitudinal study. *J Clin Med Res* 2016; 8:633-40.
21. Quimbo S, Wagner N, Florentino J, Solon O, Peabody J. Do health reforms to improve quality have long-term effects? Results of a follow-up on a randomized policy experiment in the Philippines. *Health Econ* 2016; 25:165-77.
22. Van de Klundert J, Gorissen P, Zeemering S. Measuring clinical pathway adherence. *J Biomed Inform* 2010; 43:861-72.
23. Graber ML. The incidence of diagnostic error in medicine. *JAMA* 2012; 308:1211-2.
24. Parikh K, Yandrapalli S, Kumar A, Frankenthaler M, Liu D. A nationwide analysis of palliative care service utilization in hospitalized metastatic cancer patients. *J Clin Oncol* 2018; 36:6602.

Supplemental Table 1 Case Summaries of All 12 CPV Vignettes

- Case 1: 33-year-old woman with a 2-cm mass in the right breast, family history of breast CA and ER^+/PR^+ high-grade DCIS.
- Case 2: 52-year-old woman with an abnormal screening mammogram which is ultimately diagnosed as atypical ductal hyperplasia.
- Case 3: 63-year old woman presenting with a palpable, non-tender firm mass in her left breast diagnosed with bilateral infiltrating lobular carcinoma.
- Case 4: 55-year-old woman with abnormal screening mammogram diagnosed with early stage $ER^+/PR^+/HER2^-$ invasive ductal carcinoma in the right breast.
- Case 5: 46-year-old premenopausal woman with BRCA2 mutation and a right breast mass that diagnosed as stage II invasive lobular carcinoma that is $ER^+/PR^+/HER2^-$.
- Case 6: 65-year-old woman with CHF and an incidental finding of a mass in her left breast, which turned out to be stage III $ER^-/PR^-/HER2^+$ invasive ductal carcinoma.
- Case 7: 28-year-old woman with breast pain found to be BRCA1 positive and diagnosed with triple-negative, stage III inflammatory breast CA.
- Case 8: 81-year-old woman with significant debilitating comorbidities and recurrent $ER^+/PR^+/HER2^-$ IDC in the right breast.
- Case 9: 31-year-old pregnant woman with an indurated left breast mass found to be stage IIB triple negative IDC.
- Case 10: 67-year-old woman with palpable axillary mass found to be an isolated axillary recurrence of an $ER^-/PR^-/HER2^+$ invasive ductal CA.
- Case 11: 77-year-old woman with bone pain, and right breast mass diagnosed with $ER^+/PR^+/Her2^-$ IDC metastatic to the vertebrae, hip, and ribs.
- Case 12: 65-year-old woman with a seizure episode found to have a solitary brain metastasis from recurrent stage IIIC $ER^-/PR^-/Her2^-$ invasive ductal carcinoma.

Abbreviations: CA = cancer; CHF = congestive heart failure; CPV = Clinical Performance and Value; DCIS = ductal carcinoma in situ; ER^- = estrogen receptor-negative; ER^+ = estrogen receptor-positive; $HER2^-$ = human epidermal growth factor receptor 2-negative; $HER2^+$ = human epidermal growth factor receptor 2-positive; IDC = invasive ductal carcinoma; PR^- = progesterone receptor-negative; PR^+ = progesterone receptor-positive.

For readers interested in seeing an interactive demonstration of a CPV vignette, please reach out to the authors at jpeabody@qurehealthcare.com.