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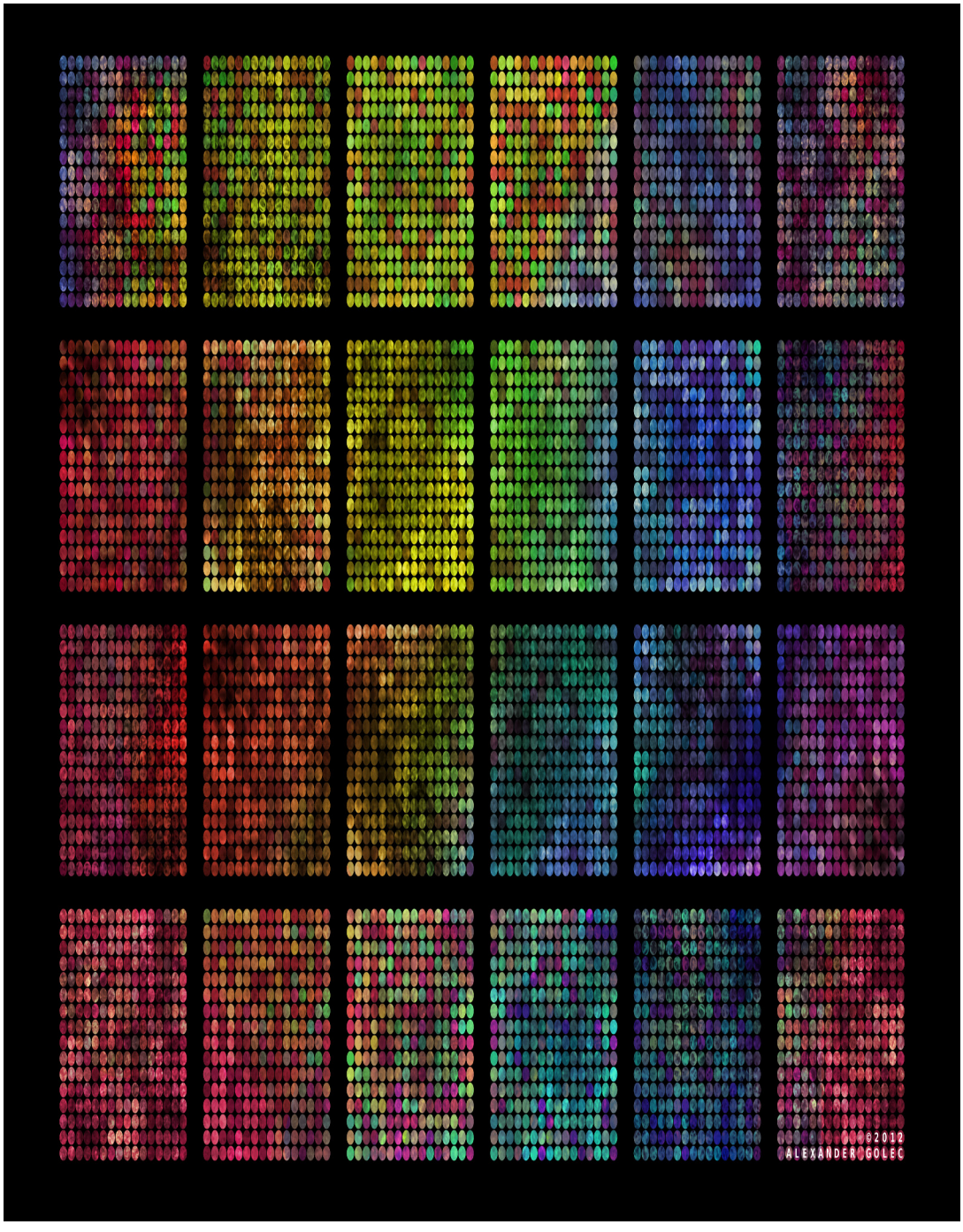
Fall, 2013



MICHIGAN STATE UNIVERSITY | College of Human Medicine

MSRJ

Michigan State University College of Human Medicine

Vol: 3, Issue: Fall, 2013

The Medical Student Research Journal (MSRJ) is the longest-running international academic journal in the United States authored, reviewed, edited, and published by medical students for medical students. It is dedicated to promoting the scientific achievements of medical students, teaching principles of peer and article review, and providing editorial, publishing and leadership learning experiences. Medical students worldwide are invited to submit manuscripts and serve as trained reviewers. The MSRJ publishes original research, case studies, editorials, research letters, reviews, and reflections that meet required standards, are authored by a medical student, and advance science. It is sponsored by the Michigan State University College of Human Medicine. Visit www.msrj.org and www.facebook.com/msrjchm for more information.

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In the third *MSRJ* issue of 2013 and the first of the 2013–2014 academic year, we are very excited to present enlightening and thought-provoking articles. We are publishing the work of students from Michigan State University's College of Human Medicine and Creighton University School of Medicine. This journal has seen large growth since the Spring 2013 issue, and we have bigger plans for the future.

The *MSRJ* has had more submissions and submission inquiries in the time period between the Spring 2013 and Fall 2013 issues than it has received since the very first call for submissions. We attribute this not only to an increased amount of public relations work in the past few months, but also to the hard work and diligence of our previous and current staff members setting the journal up for success. As we continue to receive interesting and novel manuscripts, we will continue to add to our staff of talented medical student reviewers to handle the growth; however, due to the demanding schedule of medical students, we can never have too many reviewers so please consider joining us in this capacity.

This year we implemented a new submission contest. Eligible authors had the chance to earn cash prizes in different categories including reflections, case reports, and original manuscripts. The contest came to a close with the publication of the Fall issue. The contest was a great success, bringing in many great submissions and generating more publicity for the journal. We hope to announce the winners by the end of the year, and because of the success of the contest, we may make this a recurring competition.

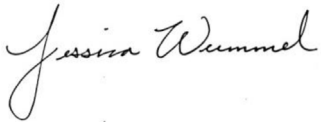
Our new staff is settling into their respective roles; reviewing manuscripts and serving on the editorial board. During our monthly meetings, they continually come up with great ideas that we expect to improve the *MSRJ* for years to come. One of the most rewarding parts of being an editor is being able to share our experience and insight with the *MSRJ* staff and inspire them to continue on the legacy.

Immediate plans for the future involve adding a greater focus to the educational aspects of the journal through an elective course at our college. This elective will continue to evolve and become a strong fixture in the student curriculum at MSU-CHM; enabling us to teach about the principles of peer-review, strong reviewing techniques, and the background behind academic publishing, as well as generating interest among first-year medical students to become future *MSRJ* staff members. We plan on adding to our website blog with featured postings by our editorial staff, covering important topics for understanding academic publishing, understanding and writing about statistics, and the proper writing and review of manuscripts. In addition, our Twitter account (@MSRJCHM) has become a resource not only for updates about the journal but also provides almost daily tips on writing and publishing. We hope to continue our public relation campaign to increase awareness of the journal and spread knowledge to those that follow us.

Again, we would like to thank the Michigan State University College of Human Medicine for their continued support. In addition, we would like to acknowledge the hard work of our talented staff in making this issue possible; without them the journal would not run smoothly and efficiently. We hope that our readers will continue to follow the progress of the *MSRJ*, both on Facebook and Twitter, and on our website at http://www.MSRJ.org. Please continue to send your wonderful manuscripts as we love learning and teaching, and hope to improve the academic skills of medical students from around the globe.

Sincerely,

Kevin Patterson
Executive Editor – MSRJ 2013–2014



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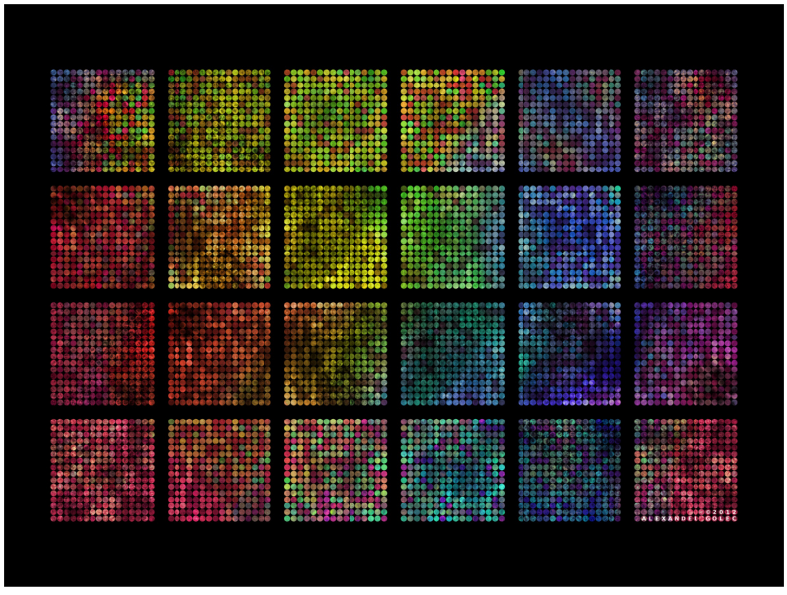

Incomplete Storytelling

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Our interviews, physical exams, and laboratory tests only uncover select words of a patient's story. Some days we may be lucky enough to stumble upon a phrase or complete sentence in their life's tome. We base our diagnoses on these incomplete discoveries and hope for the best. Some of us may act like we have the Rosetta Stone in our pocket, granting us the ability to translate everything into our noble medical language. Others may focus too much time on the details of the letters and completely miss the story behind them. Deciphering the story of each patient requires not only a stellar medical acumen but also an ability to comprehend stories in languages that may seem foreign to us.

The story of each patient never concludes. Each moment spent will reveal some new piece of history, emotional understanding, or bit of data. Unexpected findings may leave us awestruck or dumbfounded, changing the way we perceive the patient's story or causing us to investigate certain details further. A microarray can provide a wealth of information, but can also distort our understandings of each other. We have entered a world of curiosity, discomfort, joy, sadness, confusion, and enlightenment. We have agreed to the challenge of caring for our myriad of patients. We have begun to realize the art of knowing them through incomplete storytelling.

Public Stroke Knowledge: Those Most at Risk, Least Able to Identify Symptoms

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Background and purpose: *Fewer than 1 in 20 patients with acute ischemic stroke are treated with thrombolytic drugs, with three-quarters of otherwise eligible patients being excluded secondary to delay in seeking medical treatment. Lack of symptom recognition may contribute to low treatment rates and is an important focus of public health education. The purpose of this study was to determine if an individual's cumulative number of stroke risk factors correlated with their ability to identify stroke symptoms.*

Methods: *We surveyed adults about their stroke risk factors and knowledge of stroke symptoms at grocery stores and malls in a medium-sized university town in the Midwestern US.*

Results: *In total, 245 adults completed surveys. Self-reported risk factors included high blood pressure (25%), high cholesterol (22%), diabetes (12%), tobacco use (11%), alcohol use (7%), heart disease (7%), and prior stroke (3%). Cumulatively, 56% of respondents had no risk factors, 41% had 1–3 risk factors, and 4% had 4+ risk factors. When administered a six-point stroke symptom knowledge test, respondents with 4+ risk factors were significantly less knowledgeable, receiving a mean score of 3.2, compared to those with 1–3 risk factors, who scored a mean of 4.6. Those with four or more years of college were significantly more knowledgeable than those with only a high-school education, receiving mean scores of 4.6 and 3.9, respectively. There was no association between stroke knowledge and use of a primary care physician.*

Conclusions: *Although it is known that individuals with more risk factors are more likely to have a stroke, in our study these respondents were less able to recognize stroke symptoms compared to respondents with fewer risk factors. Future public stroke awareness campaigns should be targeted toward those most at risk so they learn to recognize stroke symptoms and thus seek treatment in a timely manner.*

Keywords: *stroke; CVA; risk factors; warning signs; patient education; public health.*

INTRODUCTION

Stroke is the third leading cause of death and the most common cause of severe, long-term adult disability in the United States.[1,2] The majority of strokes are ischemic in nature and have the potential to be treated with thrombolytic drugs, improving long-term outcomes when administered to eligible patients in a timely manner.[3] Despite the availability of this life-improving therapy, fewer than 1 in 20 patients with acute ischemic stroke receive thrombolytics, with three-quarters of otherwise eligible patients being excluded secondary to delay in seeking medical treatment.[4–6] Of patients delaying treatment, one-third reported that they were waiting to see if their symptoms would improve.[5] Previous studies have shown that one-quarter to one-third of the public cannot name a single risk factor or warning sign of a stroke.[7–9] Given these findings, increasing the public's awareness of stroke risk factors, warning signs, and the urgent need for treatment is a public health priority.

The primary purpose of this study is to determine if an individual's cumulative number of stroke risk factors correlates with their ability to identify stroke symptoms. We also examined the relationship between stroke symptom knowledge and age, gender, level of education, and use of a primary care physician. The findings of this study should be considered in developing future stroke awareness campaigns.

METHODS

Selection and description of participants

Members of the research team recruited respondents by randomly approaching customers at grocery stores and malls near East Lansing, Michigan. Each respondent was asked if they would be willing to complete a brief survey regarding their knowledge of stroke warning signs. Participants either completed the surveys on their own or gave verbal responses to items read by the research team. Following completion of

the survey, participants were provided the correct answers to the survey, as well as taught the FAST mnemonic, 'Face, Arm, Speech, Time', endorsed by the American Stroke Association.[10] Aside from receiving stroke education, respondents received no other compensation for their participation.

Technical information

This IRB-approved study used an in-person, closed-ended, 17-item multiple-choice survey. The survey included six knowledge items (stroke symptoms), screening for seven stroke risk factors, and four demographic questions (age, gender, level of education, and use of a primary care physician) (Fig. 1). Knowledge of stroke symptoms was assessed using a portion of the CDC's 2011 Behavioral Risk Factor Surveillance System Questionnaire,[11] which includes the five signs of stroke used by the National Institute of Neurological Disorders and Stroke.[12] To guard against patterned responses, we also included chest pain, a non-stroke symptom. Respondents were screened for: high blood pressure, high cholesterol, diabetes, tobacco use, alcohol use, heart disease, and prior stroke.

Statistics

Prior to analyses, symptoms for which respondents were 'unsure' were combined with 'incorrect' responses to assess for unambiguous symptom knowledge. Risk factors for which the respondent had 'maybe' been diagnosed were coded as being 'present' to include those with borderline risk factors. The cumulative number of risk factors for each respondent was calculated and categorized as 'none', '1–3', or '4 or more'. We analyzed the data using Stata v12 (College Station, TX) to estimate the prevalence of each risk factor within the sample population, as well as the frequency of the sample population to unambiguously identify whether each proposed symptom could be considered a warning sign of a stroke. We compared the mean number of correct stroke symptom responses and standard deviations for a number of subgroups including gender, level of education, number of self-reported stroke risk factors, and by use of a primary care physician.

STROKE KNOWLEDGE SURVEY

[Stroke Knowledge]
Please check only one column per symptom.

Which of the following do you think are symptoms of a stroke?	Yes	No	Don't know or not sure
Sudden confusion or trouble speaking			
Sudden numbness or weakness of face, arm, or leg, especially on one side			
Sudden trouble seeing in one or both eyes			
Sudden chest pain or discomfort			
Sudden trouble walking, dizziness, or loss of balance			
Severe headache with no known cause			

[Past Medical History]
Please check only one column per risk factor.

Have you ever been told by a health care professional that you currently have or have had one of the following?	Yes	No	Don't know or not sure
High blood pressure			
High cholesterol			
Diabetes			
Prior stroke			
Heart disease			
Need to cut down on alcohol use			
Need to cut down on tobacco use			

[Demographic Information]

Age	
Gender (please circle one)	Male or female
Highest Level of Education Completed (please circle one)	Never attended school or only attended kindergarten Grades 1 through 8 (Elementary) Grades 9 through 11 (Some high school) Grade 12 or GED (High school graduate) College 1 year to 3 years (Some college or technical school) College 4 years or more (College graduate)
Do you have one or more person you think of as your personal doctor or health care provider? (please circle one)	Yes, only one More than one No Don't know / not sure Refused
Thank you for your participation!	

Figure 1. Survey instrument.

Comparison of stroke knowledge by gender and use of primary care physician was performed using a *t*-test. Comparisons of stroke knowledge by level of education and cumulative number of risk factors were performed using ANOVA and Scheffé post-hoc analysis to determine pairwise differences between subgroups. Multivariate regression analysis was also performed to estimate the independent contribution of individual variables on stroke symptom knowledge.

RESULTS

In total, 245 respondents completed surveys, 58% of whom were female. The response rate to our survey was not collected; however, very few individuals who were approached refused to participate. The median age of respondents was 40 years, ranging from 18 to 88 years. Forty-nine percent of respondents completed a Bachelor's degree or more, 31% completed some college or attended technical school, 15% completed high school or General Educational Development® testing, while 5% had less than a high-school education.

The self-reported frequency of stroke risk factors in our study population is displayed in Table 1. More than one in five respondents reported having high blood pressure and/or high cholesterol while roughly 1 in 10 reported diabetes and/or tobacco use. Less than 10% of respondents reported alcohol use, having a history of heart disease, and/or a prior stroke. Cumulatively, 56% of respondents had no risk factors, 41% had 1–3 risk factors, and 4% had 4 or more risk factors.

Table 2 summarizes respondents' ability to identify stroke symptoms. The most easily identifiable stroke symptoms were sudden confusion or trouble speaking (93%); sudden numbness or weakness, especially on one side (92%); and sudden trouble walking, dizziness, or loss of balance (87%). Fewer respondents were able to recognize sudden headache (57%) or sudden trouble seeing in one or both eyes (68%) as potential stroke symptoms. To guard against patterned responses, our survey also included one symptom not related to stroke, sudden chest pain or discomfort, which only 44% of respondents were able to correctly reject with certainty. Most (85%) of the respondents reported having a primary care physician.

Table 1. Individual stroke risk factors present among survey respondents ($n = 245$).

Risk factors	Present, *n* (%)
High blood pressure	61 (25)
High cholesterol	55 (22)
Diabetes	30 (12)
Tobacco use	27 (11)
Alcohol use	16 (7)
Heart disease	16 (7)
Prior stroke	8 (3)

The subgroup analysis displayed in Table 3 demonstrates that gender and level of education were positively associated, and number of self-reported risk factors negatively associated, with knowledge of stroke warning signs, while use of a primary care physician was not.

Multivariate regression analysis, as seen in Table 4, again demonstrates that level of education was positively associated with stroke knowledge, while cumulative number of self-reported risk factors was negatively associated with stroke knowledge; however, gender was no longer a statistically significant association with stroke knowledge for this study population.

DISCUSSION/CONCLUSIONS

In this study, we were dismayed to find that respondents with an increased number of stroke risk factors were less able to correctly identify stroke symptoms. This is unfortunate given that this population is most likely to experience a stroke, yet may not understand their need to seek treatment in a timely manner.

We were also surprised to find that there was no association between stroke knowledge and use of a primary care physician; however, other studies have found that only 2% of patients viewed their physicians as their primary source of stroke knowledge,[9] so perhaps this is not to be unexpected. This information should however be alarming to primary care providers and efforts should be made to increase stroke education efforts in primary care settings, especially targeting those patients screening positive for four or more risk factors.

It is widely known that socioeconomic position (SEP) is one of the strongest and most consistent predictors of health outcomes. Multiple, often related indicators are commonly used to measure SEP in health research; however, there is no agreement on a single best indicator. While it may sometimes be necessary to capture multiple SEP indicators to avoid residual confounding effects, single indicators are sufficient to demonstrate that a socioeconomic gradient exists.[13] Income level, race, and level of education have previously been shown to be predictive of stroke knowledge.[7,8,14–17] For the sake of brevity, we designed our survey to use level of education as a single indicator of SEP. We did not intend to make comparisons between

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Table 2. Ability of survey respondents to identify symptoms of stroke ($n = 245$).

Symptom	Correct	Incorrect or unsure
Sudden confusion or trouble speaking	228 (93%)	17 (7%)
Sudden numbness or weakness of face, arm, or leg, especially on one side	225 (92%)	20 (8%)
Sudden trouble walking, dizziness, or loss of balance	213 (87%)	32 (13%)
Sudden trouble seeing in one or both eyes	167 (68%)	78 (32%)
Severe headache with no known cause	139 (57%)	106 (43%)
Sudden chest pain or discomfort*	108 (44%)	137 (56%)

*This symptom is suggestive of heart attack, not stroke.

racial or income groups in this study. Similar to the previous work, our results suggest that increased level of education is positively correlated with stroke knowledge.[7,8,14,15,18]

Table 3. Analysis of stroke symptom knowledge by gender, education, number of risk factors, and use of primary care physician.

	Mean correct responses (±SD)	*p*
By gender		
Female	4.6 (±1.2)	0.031
Male	4.2 (±1.3)	
By level of education*		
Less than high school	3.6 (±1.5)	0.003
High school or GED	3.9 (±1.5)	
Some college (1–3 years)	4.5 (±1.1)	
College graduate (4+ years)	4.6 (±1.2)	
By self-reported number of risk factors**		
None	4.3 (±1.3)	0.002
1–3	4.6 (±1.1)	
4 or more	3.2 (±1.6)	
By self-reported use of primary care physician		
Yes	4.5 (±1.2)	0.131
No	4.1 (±1.5)	

Note: Comparison of stroke knowledge by gender and use of primary care physician was performed using a *t*-test, while comparison by level of education and by number of self-reported risk factors were performed using ANOVA and Scheffé post-hoc analysis.
*Level of education was related to ability to correctly identify stroke warning signs ($F = 4.87$; $df = 3241$; $p = 0.003$); Scheffé post-hoc analysis revealed that mean knowledge score for category 'four or more years of college' was significantly different from the 'high school or GED' category ($p = 0.035$).
**Increased number of risk factors was also related to ability to correctly identify stroke warning signs ($F = 6.26$; $df = 2242$; $p = 0.002$); Scheffé post-hoc analysis revealed that mean knowledge score for category '4 or more' risk factors to be significantly different from '1–3' risk factors or 'none' categories ($p = 0.005$ and $p = 0.033$, respectively).
GED, General Education Development® testing.

Female gender has been previously shown to be predictive of increased stroke knowledge.[7,8,14,15,18] This finding was suggested by our univariate analysis ($p = 0.031$); however, multivariate analysis was not able to confirm this association with the same level of statistical significance ($p = 0.057$). This is likely a type II statistical error, which might have been overcome by increasing our sample size to boost the statistical power of our test.

Discordant with the previous work, our data suggest that there is an overall positive correlation between age and stroke knowledge. This is likely because other research groups have performed analysis using categorical age ranges rather than treating age as a continuous variable. Studies reporting data for multiple age categories have shown that stroke knowledge appears to be at its peak during the middle years of life,[17] while those using a single age cut-off of 65 to 75 years old have shown the elderly to have decreased stroke knowledge.[9,14,18]

Table 4. Regression analysis to predict stroke symptom knowledge.

Variable	Coefficient* (β)	*p*
Age	0.013	0.010
Gender[a]	−0.302	0.057
Education[b]		
High school	0.220	0.582
Some college	0.934	0.013
College graduate	0.958	0.008
Number of risk factors[c]		
1–3	0.206	0.254
4 or more	−0.843	0.045

*Estimated regression coefficients are adjusted for all other variables in the table. Adjusted $R^2 = 0.1204$.
[a]Reference category is 'Females'.
[b]Reference category is 'Less than high school'.
[c]Reference category is 'Zero risk factors'.

Our results suggest that some stroke symptoms are more easily recognizable to the public than others. This is consistent with statewide telephone-based surveys of the Michigan population.[8] Sudden confusion or trouble speaking and weakness or numbness are the most easily recognizable symptoms of a stroke, while respondents have more difficulty identifying severe headaches, trouble seeing, trouble walking, dizziness, or loss of balance as potentially being warning signs of a stroke. These differences may be related to the symptoms that have been most heavily emphasized in public stroke awareness campaigns such as FAST.[10]

Limitations of this study include the reliance upon respondents to self-report their risk factors, since some patients may have denied risk factors for which they had not actually been screened; responding 'no' rather than 'unsure'. While administering the surveys, a number of respondents stated they were users of tobacco and/or alcohol, however denied this as a risk factor; potentially as an artifact of how the question was framed (Fig. 1). In future studies, it would be helpful to quantify amounts of tobacco and alcohol consumption to eliminate any reporting bias. While cumulative number of self-reported risk factors likely correlated with magnitude of stroke risk, a stroke prediction score such as the Framingham stroke risk profile may have alternatively been used;[19] however, calculating such a score would require more quantitative data collection than was possible using a brief, public survey format. Given that this survey was administered in grocery stores and malls in a single university town in the Midwest, our results may have limited external validity as a result of selection bias. Indeed many other studies have shown that there are regional differences in public knowledge of stroke warning signs and symptoms.[8] Additionally, our use of a six-point test to measure symptom knowledge may not necessarily represent clinically meaningful differences in stroke knowledge or predict an individual's response to seek treatment. Individuals with severe symptoms such as the sudden onset of unilateral weakness might seek emergent medical attention regardless of whether or not they knew this was indicative of a stroke. Conversely, individuals with milder stroke symptoms may wait for improvement before seeking treatment.

Compared to previous studies showing that one-quarter to one-third of the public cannot name a single stroke symptom,[7–9] respondents to our survey appeared to have much greater levels of knowledge. This is likely related to the fact that our survey required respondents to accept or reject symptoms from a closed-ended list rather than asking for open-ended responses. Aside from the fact that stroke symptoms may be easier to identify with closed-ended questioning, there may also be an effect of patterned responses. We were surprised to find that more than half of respondents were unable to definitively exclude chest pain as a stroke symptom. Further complicating the use of chest pain to evaluate for the effect of patterned responses is that even with open-ended questioning, the public has difficulty distinguishing between the symptoms heart attack and stroke.[15] A study of hospitalized patients who had experienced strokes found that only half were able to identify stroke as an injury to the brain.[9] Despite public confusion in distinguishing between symptoms of stroke and heart attack, it is debatable whether this leads to significant differences in recognizing the need for emergent medical treatment. In future studies using closed-ended questioning, it may be beneficial to increase the number of non-stroke symptoms in order to better evaluate the effect of patterned responses.

Given our findings, future studies should be conducted to better understand why those with the most risk factors may have the least knowledge of stroke symptoms. The lack of association between use of a primary care physician and stroke knowledge should also be further investigated in terms of the quality of primary care received, specifically, but not limited to, the frequency of follow-up visits, continuity with a single provider, and emphasis on patient education. Future public stroke awareness campaigns should be targeted toward those most at risk so that they can seek treatment in a timely manner should they develop any symptoms of stroke onset.

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Conflict of interest and funding: The authors have no conflicts of interest to report.

REFERENCES

1. Roger VL, Go AS, Lloyd-Jones DM, et al. 2011. Heart disease and stroke statistics—2011 update a report from the American Heart Association. Circulation 123:e18–e209. http://dx.doi.org/10.1161/CIR.0b013e3182009701.

2. Wechsler LR. 2011. Intravenous thrombolytic therapy for acute ischemic stroke. N Engl J Med 364:2138–46. http://dx.doi.org/10.1056/NEJMct1007370.
3. Hacke W, Kaste M, Bluhmki E, et al. 2008. Thrombolysis with alteplase 3 to 4.5 hours after acute ischemic stroke. N Engl J Med 359:1317–29. http://dx.doi.org/10.1056/NEJMoa0804656.
4. California Acute Stroke Pilot Registry (CASPR) Investigators. Prioritizing interventions to improve rates of thrombolysis for ischemic stroke. Neurology 2005; 64(4):654–9. http://dx.doi.org/10.1212/01.WNL.0000151850.39648.51.
5. Barber PAM, Zhang J, Demchuk AM, Hill MD, Buchan AM. 2001. Why are stroke patients excluded from TPA therapy? An analysis of patient eligibility. Neurology 56(8):1015–20. http://dx.doi.org/10.1212/WNL.56.8.1015.
6. Katzan IL, Hammer MD, Hixson ED, et al. 2004. Utilization of intravenous tissue plasminogen activator for acute ischemic stroke. Arch Neurol 61(3):346–50. http://dx.doi.org/10.1001/archneur.61.3.346.
7. Kleindorfer D, Khoury J, Broderick JP, et al. 2009. Temporal trends in public awareness of stroke warning signs, risk factors, and treatment. Stroke 40:2502–6. http://dx.doi.org/10.1161/STROKEAHA.109.551861.
8. Reeves MJ, Rafferty AP, Aranha AAR, Theisen V. 2008. Changes in knowledge of stroke risk factors and warning signs among Michigan adults. Cerebrovasc Dis 25:385–91. http://dx.doi.org/10.1159/000121338.
9. Kothari R, Sauerbeck L, Jauch E, et al. 1997. Patients' awareness of stroke signs, symptoms, and risk factors. Stroke 28:1871–5. http://dx.doi.org/10.1161/01.STR.28.10.1871.
10. American Stroke Association. Stroke warning signs and symptoms. 2013. Available from: http://strokeassociation.org [cited 10 August 2013].
11. Centers for Disease Control and Prevention. 2011 behavioral risk factor surveillance system questionnaire. 2011. Available from: http://www.cdc.gov/brfss/questionnaires.htm [cited 10 August 2013].
12. National Institute of Neurological Disorders and Stroke (NINDS). Stroke information page. 2013. Available from: http://www.ninds.nih.gov/disorders/stroke/stroke.htm [cited 10 August 2013].
13. Galobardes B, Shaw M, Lawlor DA, Lynch JW, Smith GD. 2006. Indicators of socioeconomic position (part 1). J Epidemiol Community Health 60:7–12. http://dx.doi.org/10.1136/jech.2004.023531.
14. Schneider AT, Pancioli AM, Khoury JC, et al. 2003. Trends in community knowledge of the warning signs and risk factors for stroke. JAMA 289(3):343–6. http://dx.doi.org/10.1001/jama.289.3.343.
15. Reeves MJ, Hogan JG, Rafferty AP. 2002. Knowledge of stroke risk factors and warning signs among Michigan adults. Neurology 59(10):1547–52. http://dx.doi.org/10.1212/01.WNL.0000031796.52748.A5.
16. Yoon SS, Heller RF, Levi C, Wiggers J, Fitzgerald PE. 2001. Knowledge of stroke risk factors, warning symptoms, and treatment among an Australian urban population. Stroke 32:1926–30. http://dx.doi.org/10.1161/01.STR.32.8.1926.
17. Greenlund KJ, Neff LJ, Zheng ZJ, et al. 2003. Low public recognition of major stroke symptoms. Am J Prev Med 25(4):315–19. http://dx.doi.org/10.1016/S0749-3797(03)00206-X.
18. Pancioli AM, Broderick J, Kothari R, et al. 1998. Public perception of stroke warning signs and knowledge of potential risk factors. JAMA 279(16):1288–92. http://dx.doi.org/10.1001/jama.279.16.1288.
19. Wolf P, D'Agostino R, Belanger A, Kannel W. 1991. Probability of stroke: a risk profile from the Framingham study. Stroke 22:312–18. http://dx.doi.org/10.1161/01.STR.22.3.312.

A Rare Case of Breast Carcinosarcoma with Lymphatic Metastasis

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Introduction and Patient Profile: *Carcinosarcoma of the breast is a rare malignancy composed of two cell lines described as a ductal-type carcinoma with a sarcoma-like component. It is an aggressive neoplasm that is usually larger in size than epithelial breast cancers and characterized by a rapid increase in size. A 32-year-old woman presented with a palpable lump in the left upper outer breast. Imaging findings and an ultrasound-guided biopsy demonstrated a malignant neoplasm with chondroid differentiation.*

Interventions and Outcomes: *The patient underwent a modified radical left breast mastectomy with sentinel node biopsy. Pathology report from the mastectomy demonstrated an infiltrating metaplastic carcinoma (MPC) with positive lymph nodes.*

Discussion: *The most unusual feature of this case is the lymph node positivity, as lymphatic spread is uncommonly associated with carcinosarcoma or any subtype of metaplastic carcinoma of the breast. This case is important because it illustrates the potential future need for treatment guidelines for this uncommon tumor.*

Keywords: *breast cancer; carcinosarcoma; clinical protocols; treatment protocols; lymphatic metastasis.*

INTRODUCTION AND PATIENT PROFILE

Carcinosarcoma of the breast, one of five subtypes of metaplastic carcinoma (MPC), is an aggressive neoplasm composed of two cell lines described as a ductal-type carcinoma with a sarcoma-like component. It is an aggressive neoplasm that is usually larger in size than epithelial breast cancers and characterized by a rapid increase in size.[1] It has been reported to account for 0.08–0.2% of all breast malignancies.[2] Breast malignancies affect 12.3% of women at some point during their lifetime, with an estimated incidence of 232,340 new cases diagnosed in 2013.[3] MPC of the breast most often presents in women more than 50 years of age as a unilateral, well-defined, large, and painless mass within the breast. Typically, MPCs of the breast do not express the estrogen or progesterone receptors and do not over-express the HER2/neu oncogene.[4] This 'triple-negative' phenotype tends toward more aggressive tumors that are unlikely to respond to targeted therapy with drugs such as trastuzumab (Herceptin) or estrogen/progesterone receptor antagonists. Prognosis for MPC is less favorable compared with invasive ductal or invasive lobular carcinoma.[1] Predictors of poor outcome include age younger than 39 years at presentation, skin invasion, and size greater than 5 cm, while the subtype of MPC has not been shown to affect outcome.[5] Five-year overall survival for carcinosarcoma of the breast is 49–68%.[2]

A 32-year-old woman with a medical history of congenital heart disease with double outlet right ventricle status post-repair presented with a palpable lump in the left upper outer breast. The patient had been breastfeeding for the past 2 years and presumed that the lump was related to lactation. No palpable lymphadenopathy was noted on clinical exam.

The patient was sent to radiology by a breast surgeon for initial imaging, which included a bilateral mammogram and a left breast ultrasound examination. An approximately 6 cm mildly lobulated mass was present in the upper outer quadrant left breast posterior depth (Fig. 1). No additional abnormalities were noted on the mammogram. A focused ultrasound examination was performed at the area of concern. On the ultrasound examination, a large lobulated cystic and solid mass was visualized with associated vascularity, corresponding to the patient's palpable concern. Imaging findings were reported as suspicious for carcinoma and an ultrasound-guided biopsy was recommended.

Left breast core biopsy was obtained, which demonstrated a malignant neoplasm with chondroid differentiation (Fig. 2). The differential diagnosis was reported as phyllodes tumor, MPC, and chondrosarcoma.

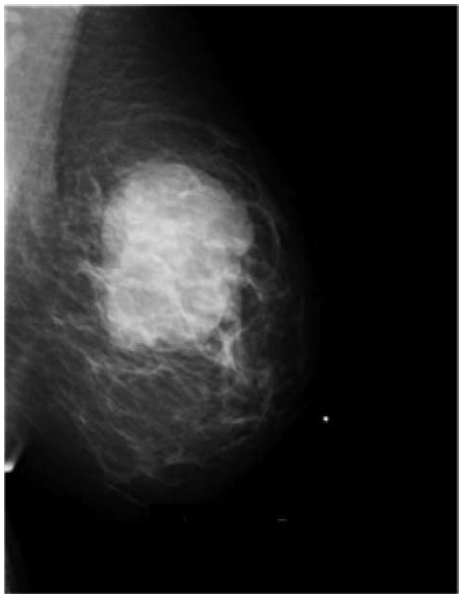

Figure 1. Left mediolateral oblique (MLO) mammogram image: 6-cm mildly lobulated mass in the upper outer quadrant left breast posterior depth.

A bilateral breast MRI examination was performed for treatment planning. The MRI exam demonstrated a large predominantly cystic complex mass with thick enhancing septations and a thick enhancing peripheral rim corresponding to the patient's known carcinoma (Fig. 3). The mass was noted to involve a large portion of the lateral aspect of the left breast. Edema and inflammatory changes associated with this mass were noted to extend to the chest wall with no definite chest wall involvement. No additional abnormally enhancing lesions were noted in either breast that would be suggestive of malignancy. No abnormally enlarged lymph nodes were noted on the MRI exam.

A PET CT was performed for staging. A large irregularly contoured mass was noted with intense fluorodeoxyglucose (FDG) avidity peripherally with a standard uptake value (SUV) of 13.7 in the left breast. Additionally, an FDG avid left internal mammary lymph node was noted measuring 13 × 7 mm with an SUV of 4.2. No additional foci of FDG avidity were noted to suggest metastasis.

INTERVENTIONS AND OUTCOMES

The patient underwent a modified radical left breast mastectomy with sentinel lymph node biopsy. Pathology report from the mastectomy demonstrated an infiltrating MPC with predominant cartilaginous differentiation. Foci of high-grade ductal carcinoma *in*

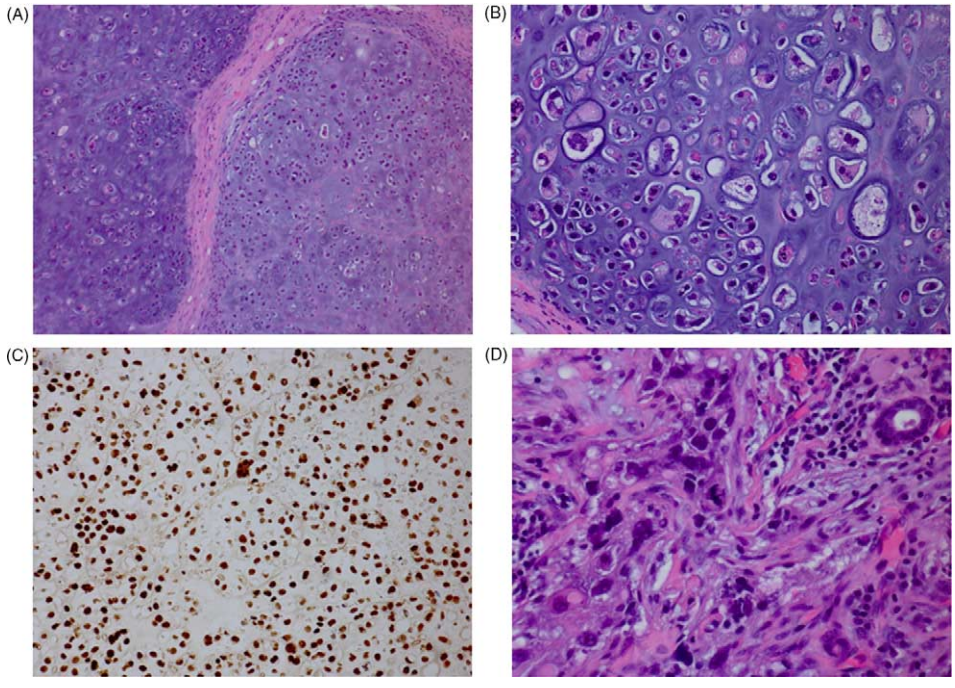

Figure 2. (A) Cartilaginous differentiation in the tumor (hematoxylin and eosin (HE) × 100x). (B) Markedly atypical neoplastic cells lying in lacunae (HE × 200x). (C) The atypical cells express S100, consistent with cartilaginous differentiation (3,3'-diaminobenzidine × 100x). (D) Background neoplastic cells with severe atypia are identified infiltrating the stroma as individual cells (HE × 200x).

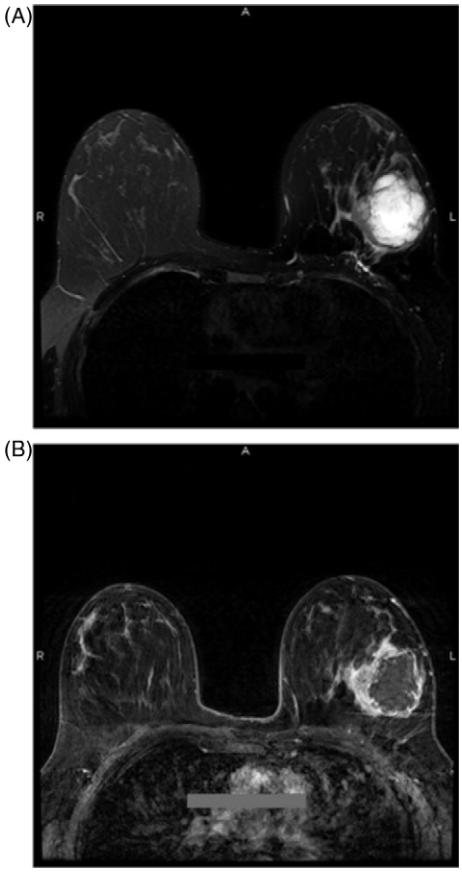

Figure 3. (A) MRI T2-weighted image shows a large circumscribed mass with internal high-signal intensity and edema and inflammatory changes noted to extend to the chest wall. (B) MRI post contrast T1-weighted image shows a large predominantly cystic complex mass with thick enhancing septations and thick enhancing peripheral rim.

situ with comedonecrosis and dense chronic inflammation were seen surrounding the tumor. Tumor size was noted to be 10.5 cm in maximum gross dimension on pathology. The tumor was described as a mixed epithelial and mesenchymal MPC with 70% chondrosarcoma and 30% ductal carcinoma. Overall Scarf Bloom Richardson histologic grade was 9/9 with a grade of 3 in tubule formation, nuclear grade, and mitotic count. No lymphatic, vascular or perineural invasion was identified. The tumor was weakly estrogen receptor positive and progesterone receptor negative. Expression of the HER2/neu oncogene was negative.

A sentinel lymph node biopsy was done which showed two out of five lymph nodes positive for metastatic carcinoma with metastatic foci measuring 1.2 and 2.6 mm. A completion axillary dissection revealed 12 additional lymph nodes, which did not harbor any metastatic carcinoma. The tumor was staged as p T3, p N1, M0, stage IIIA.

The patient received chemotherapy for 6 months after diagnosis and did not receive radiation therapy. A subsequent PET scan demonstrated no evidence of FDG avid malignancy.

DISCUSSION

Metaplastic breast cancer is characterized as an unusual, uncommon tumor that is comprised of malignant epithelial tissue (carcinoma) mixed with malignant mesenchymal cells (sarcoma). Most metaplastic tumors of the breast are poorly differentiated, high grade, and of triple-negative receptor status.[2] The patient presented with a large, rapidly-dividing tumor that was found to be of high histologic grade as well as weakly estrogen receptor positive, in contrast to the triple-negative phenotype of most MPCs. The most unusual feature of this case is the lymph node positivity, as lymphatic spread is uncommonly associated with carcinosarcoma or any subtype of MPC of the breast. However, there is a high hematogenous metastatic potential to extranodal sites such as lung and bone.[4]

Clinical features of metaplastic breast cancer and carcinosarcoma are similar to those seen in patients with invasive ductal carcinoma. Obtaining an accurate diagnosis is imperative in order to optimally tailor adjuvant therapy and improve survival and patient outcomes.[4]

Imaging features of MPC have been reported as benign on mammograms with round or oval shapes and circumscribed margins. The lesions are often noncalcified with a high rate of architectural distortion.[4] Our patient presented with an oval-shaped 6 cm mildly lobulated mass in the upper outer quadrant left breast posterior depth, consistent with a poor prognosis based on size greater than 5 cm. On sonogram, MPCs are generally described as a heterogenous or hypoechoic solid mass. They may also be described as a mixed cystic and solid mass with a round, oval or lobular shape, and most frequently demonstrate posterior acoustic enhancement (compared with posterior shadowing).[6] The patient's mass was described as a large lobulated cystic and solid mass with associated vascularity, also consistent with known imaging features of MPC. The MRI exam findings were also found to be characteristic of typical MPC findings, which include T2 hyperintensity and lesions containing ring-like, homogenous, heterogeneous, or nonenhancing internal components.[4]

These nonenhancing T2 high-signal-intensity internal components correlate with necrosis, cyst, and chondroid matrix on pathology exam findings.[6]

Evaluation of MPC includes analysis of receptor expression on the primary tumor, as well as close interval follow-up after resection for metastasis due to a high rate of extranodal spread. Currently, there are no standard guidelines for the treatment of MPC. The recommended treatment has followed the NCCN guidelines for patients with invasive breast cancer. Most patients undergo modified radical or radical mastectomy followed by adjuvant chemotherapy and/or radiation therapy.[5] Mastectomy without axillary lymph node dissection is considered standard treatment for women with breast carcinosarcoma because lymphatic spread is uncommon in this type of malignancy.[7] This case is important because it identifies the potential for lymphatic spread of MPC in a young patient and illustrates the potential future need for treatment guidelines for this uncommon tumor.

LEARNING POINTS

1. Most metaplastic tumors of the breast are poorly differentiated, high grade, and of triple-negative receptor status.
2. Clinical features of metaplastic breast cancer and carcinosarcoma are similar to those seen in patients with invasive ductal carcinoma.
3. The most unusual feature of this case is the lymph node positivity, as lymphatic spread is uncommonly associated with carcinosarcoma or any subtype of MPC of the breast.
4. Mastectomy without axillary lymph node dissection is considered a standard treatment for women with breast carcinosarcoma because lymphatic spread is uncommon.

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REFERENCES

1. Beatty JD, Atwood M, Tickman R, Reiner M. 2006. Metaplastic breast cancer: clinical significance. Am J Surg 191(5):657–64. http://dx.doi.org/10.1016/j.amjsurg.2006.01.038.
2. Esses KM, Hagmaier RM, Blanchard SA, Lazarchick JJ, Riker AI. 2009. Carcinosarcoma of the breast: two case reports and review of the literature. Cases J 2:15. http://dx.doi.org/10.1186/1757-1626-2-15.
3. SEER Cancer Statistics Factsheets: Breast Cancer. National Cancer Institute. Bethesda, MD, Available from: http://seer.cancer.gov/statfacts/html/breast.html [cited 8 September 2013].
4. Leddy R, Irshad A, Rumboldt T, Cluver A, Campbell A, Ackerman S. 2012. Review of metaplastic carcinoma of the breast: imaging findings and pathologic features. J Clin Imaging Sci 2:21. http://dx.doi.org/10.4103/2156-7514.95435.
5. Al Sayed AD, El Weshi AN, Tulbah AM, Rahal MM, Ezzat AA. 2006. Metaplastic carcinoma of the breast clinical presentation, treatment results and prognostic factors. Acta Oncol 45(2):188–95. http://dx.doi.org/10.1080/02841860500513235.
6. Shin HJ, Kim HH, Kim SM, Kim DB, Kim MJ, Gong G, et al. 2007. Imaging features of metaplastic carcinoma with chondroid differentiation of the breast. AJR Am J Roentgenol 188(3):691–6. http://dx.doi.org/10.2214/AJR.05.0831.
7. Smith TB, Gilcrease MZ, Santiago L, Hunt KK, Yang WT. 2012. Imaging features of primary breast sarcoma. AJR Am J Roentgenol 198(4):W386–93. http://dx.doi.org/10.2214/AJR.11.7341.

Direct Access to Physical Therapy in Michigan is Overdue

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Direct access to physical therapists (PTs), the ability for a patient to seek care from a PT without physician referral, has been contested for many years. The traditional gatekeeper model of access to physical therapy has changed throughout the nation and only two states remain without direct access. Michigan is one of those states, and the state legislature has not advanced direct access legislation despite numerous opportunities over the past 12 years. However, no evidence exists to show that direct access causes harm to patients and the healthcare system and, on the contrary, easy and early access to physical therapy by patients has been shown to improve outcomes and decrease costs of care. Direct access to physical therapy is long overdue in Michigan and should be reconsidered in order to better serve our patients and the healthcare system.

Keywords: *direct access; physical therapy; primary care; healthcare; utilization.*

Physical therapy includes the treatment of musculoskeletal disorders by qualified and specially trained physical therapists (PTs). PTs are experts in the field of rehabilitation, and in part 178 of the Michigan Public Health Code Act 368 of 1978, PTs are defined as engaging in the practice of physical therapy involving '... evaluation of, education of, consultation with, or treatment of an individual by the employment of effective properties of physical measures and the use of therapeutic exercises and rehabilitative procedures, with or without assistive devices, for the purpose of preventing, correcting, or alleviating a physical or mental disability'. However, as the act continues, 'Practice of physical therapy does not include the identification of underlying medical problems or etiologies, establishment of medical diagnoses, or the prescribing of treatment'.

In the state of Michigan, patients can be referred from MDs, DOs, DDSs, or DPMs for rehabilitation of different disease states after being evaluated by the physicians or physician assistants/nurse practitioners. PTs in Michigan can evaluate, consult, and educate, but cannot treat patients without a prescription for physical therapy from the aforementioned professionals. A prescription for physical therapy can include the diagnosis, mode, frequency, duration, and intensity of treatment. Despite the prescription, professional standards established by the American Physical Therapy Association obligate the PT to also examine the patient, determine the nature or cause of the problem to be treated, and develop or modify an appropriate treatment plan. Open referrals or prescriptions are used frequently for problems like lower back pain. In this case, the referral or prescription does not specify the direct problem or the care to be provided, but instead states 'evaluate and treat'. This obligates the PTs to independently determine a diagnosis and develop a treatment plan and recognizes that they are experts in the field.[1] The restriction on direct access is present in two states in the United States; Oklahoma is the only other state besides Michigan that requires patients to have a prescription for physical therapy before a PT can provide any treatment. Over the past few years, the number of states that had exclusive physician referral requirements has dwindled.

Prior to the current 2012–2013 legislative session, four bills have been introduced to the Michigan legislature since 2000 that failed to receive a vote at various stages in the legislative process. The language in previously proposed legislation has ranged from unrestricted direct access to direct access under very limited circumstances. Currently, Senate Bill 0690 (2013) is designed to allow evaluation and treatment by PTs without a physician prescription for 21 days or 10 visits, whichever first occurs. It also adds specific clauses to require a PT to refer a patient to a physician for cases that present with a problem outside the scope of physical therapy practice or that fail to demonstrate reasonable progress. Thirty-two other states have clauses that require physician referral in a situation similar

to either of the two clauses included in SB 0690.[2] Furthermore, under the current prescription requirement, it is already stated in part 17,284 of the Michigan Public Health Code Act 368 of 1978 that:

> (1) A physical therapist shall refer a patient back to the health care professional who issued the prescription for treatment if the physical therapist has reasonable cause to believe that symptoms or conditions are present that require services beyond the scope of practice of physical therapy. (2) A physical therapist shall consult with the health care professional who issued the prescription for treatment if a patient does not show reasonable response to treatment in a time period consistent with the standards of practice as determined by the board.

Therefore, the passage of direct consumer access would not change the manner in which a PT would provide treatment or make decisions about the appropriateness of physical therapy for a given patient. A PT must continually evaluate whether a prescription for PT is appropriate based on the presenting signs and symptoms or whether a referral back to a physician is needed. The current Michigan law promotes collaboration between healthcare professionals, and SB 0690 would preserve this collaboration.

The education of a PT has adapted in order to provide more comprehensive care and, more importantly, to recognize the symptoms of an underlying disease process that is outside the scope of physical therapy. Currently, of the 212 accredited physical therapy programs in the United States, 96% are offered as a Doctor of Physical Therapy (DPT).[3] The remaining programs are offered at the Master's level, but will be required to transition to a DPT program to remain accredited. Students receive training in disease processes of musculoskeletal, cardiopulmonary, neuromuscular, integumentary, metabolic/endocrine, gastrointestinal, and genitourinary systems with a commitment to learning evidence-based practices for improving their patient's health. PTs even have subspecialties that delve into specific regions of the body, patient populations, or disease states. PTs have been taught the process of physical diagnosis and history-taking skills, acting in the patient's best interests, leading to better health outcomes.[4] The training eventually leads to board certification and licensure in the state they choose to practice in (MI Public Health Code 368 of 1978, 333.17820). Licensure for all students also includes passing the National Physical Therapy Exam (NPTE). Because 48 states have some form of direct access, students must possess the knowledge necessary to practice in a state with direct access to pass the NPTE. Therefore, students who receive an education in Michigan are trained to practice with direct access, yet do not have the right to do so.

Published case reports have demonstrated that PTs consider a broad differential and are able to recognize non-musculoskeletal disorders, leading to referral for medical evaluation and proper management.[5] In addition, PTs take detailed histories and have excellent physical exam skills.[4,6] There are multiple published reports of PTs referring patients to physicians through history and physical exam or through inconsistent referral diagnoses which has led to proper evaluation and management.[7] Both DPTs and physical therapy students scored higher than physicians of multiple specialty types and medical students on exams designed to assess intern physician knowledge of musculoskeletal medicine, and were only outscored by orthopedic specialist physicians,[8] demonstrating that on a standardized examination, PT students and DPTs have similar if not better musculoskeletal disorder management knowledge than most physician types and medical students. A study of patients being referred to physical therapy by a sample of general practitioners and specialists showed that less than one third of referrals included a specific diagnosis.[9] Therefore, PTs must use clinical judgment to determine the etiology of the symptoms in order to provide treatment more than may be commonly recognized.[10] Zero adverse events were seen in a large retrospective study of open access to patient care in a multi-center military setting. Even during the analysis of data, a great number of medical diseases were diagnosed by PTs, such as Ewing sarcoma, compartment syndrome, and pelvic masses, leading to proper evaluation and treatment of patients.[11]

Quick access to PTs was shown to have positive results and was well received among patients. The patients were satisfied and physicians generally preferred quick access.[12] Having a PT consult for patients in an office led to a change in management and even to a decrease in referral to physician specialists. Primary care providers were often satisfied with a very large majority of the consults, demonstrating that PTs can determine physical therapy requirements and favorably change patient management, leading to better health outcomes.[13] Early access to physical therapy has led to a greater reduction in pain perception.[14] For patients with lower back pain, early referral had decreased likelihood of advanced imaging, additional physician visits, major surgery, spine injections, and opioid prescriptions.[15] Early referral was also shown to decrease cost

of care as did close proximity of physicians to PTs.[15] Although the study did not take into account whether later referrals were a consequence of negative imaging or failed techniques prior to referral, the study only considered outcomes after primary care provider referral and not under direct access.

Opponents of direct access express concern about the loss of physician oversight and control of physical therapy utilization. As reviewed in Donato et al., PT provided under direct access has been shown to be cost effective, and there is often high patient and physician satisfaction with functional improvement with PT management.[16] Empirical data regarding the cost effectiveness of direct access comes from two studies. A 1997 study by Mitchell and deLissovoy studied over 600 Blue Cross Blue Shield of Maryland claims, and found that costs of physical therapy care under direct access resulted in fewer visits and over half of the cost of those episodes that occurred as a result of physician referral.[17] Most recently, a 2011 analysis of over 62,000 Iowa and South Dakota non-Medicare claims data similarly revealed that episodes of physical therapy care under direct access cost less and had fewer visits than those that were referred by a physician.[18] The study was not designed to allow comparison of disease severity or outcomes, so this cannot be inferred, however it gives a general sense of decreased healthcare burden by self-referral. An opponent to direct access may argue that it will increase the costs because patients will have to be referred back to physicians since patients may not know what problems can be fixed by physical therapy. However, in Scotland, Holdsworth et al. studied the costs of self-referral vs. physician-suggested referral vs. physician-referred physical therapy, showing that self-referred patients had less costs associated with the injury/disease state and decreased referrals to specialists, analgesics, and general practitioner visits, all while having similar disease severity.[19] In addition, a study showed that self-referral to physical therapy led to significantly shorter visits to their primary care providers, allowing physicians to focus their attention on other cases.[20] Even though direct access has not been shown to increase the cost of healthcare, opponents of direct access continue to express concern about increased costs. During the 2011–2012 legislative session, companion bills were introduced that would have permitted third party payers to continue to require a physician referral despite a regulatory change allowing direct access. Despite these provisions, third party payer groups continued to oppose direct access legislation. Currently, similar companion legislation (Senate Bills 0691-0694) has been introduced to allow for insurance agencies, corporations/businesses paying for worker's compensation, and others to require a physician prescription as a condition of payment for physical therapy.

In considering the peer-reviewed, published research about direct access to physical therapy, Michiganders should advocate for a change in state law by urging the legislators to pass Senate Bills 0690-0694. The benefits of direct access to physical therapy outweigh the potential harms and unsubstantiated fears associated with it. PTs are very well educated healthcare professionals, with nearly all entry-level PTs obtaining doctorate level degrees. These providers are well qualified and able to take on more patients than primary care physicians can handle. This would not only free up the time that primary care providers may desperately need for other complex issues, but would allow for shortened time to treatment and lower costs of care for many patients.

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REFERENCES

1. Brooks G, Dripchak S, Vanbeveren P, Allaben S. 2008. Is a prescriptive or an open referral related to physical therapy outcomes in patients with lumbar spine-related problems? J Orthop Sports Phys Ther 38(3):109–15. http://dx.doi.org/10.2519/jospt.2008.2591.

2. American Physical Therapy Association (2013). Direct access at the state level. Available from: http://www.apta.org/StateIssues/DirectAccess [cited 20 September 2013].

3. American Physical Therapy Association (2013). Who are physical therapists? Available from: http://www.apta.org/AboutPTs [cited 20 September 2013].

4. Rose SJ. 1989. Physical therapy diagnosis: role and function. Phys Ther 69:535–7.

5. Shah N, Nakamura Y. 2010. Case report: schizophrenia discovered during the patient interview in a man with shoulder pain referred for physical therapy. Physiother Can 62:308–15.

6. Stowell T, Cioffredi W, Greiner A, Cleland J. 2005. Abdominal differential diagnosis in a patient referred to a physical therapy clinic for low back pain. J Orthop Sports Phys Ther 35(11):755–64. http://dx.doi.org/10.2519/jospt.2005.35.11.755.
7. Boissonnault WG, Ross MD. 2012. Physical therapists referring patients to physicians: a review of case reports and series. J Orthop Sports Phys Ther 42(5):446–54. http://dx.doi.org/10.2519/jospt.2012.3890.
8. Childs JD, Whitman JM, Sizer PS, Pugia ML, Flynn TW, Delitto A. 2005. A description of physical therapists' knowledge in managing musculoskeletal conditions. BMC Musculoskelet Disord 6:7. http://dx.doi.org/10.1186/1471-2474-6-32.
9. Davenport TE, Watts HG, Kulig K, Resnik C. 2005. Current status and correlates of physicians' referral diagnoses for physical therapy. J Orthop Sports Phys Ther 35(9):572–9. http://dx.doi.org/10.2519/jospt.2005.35.9.572.
10. Davenport TE, Sebelski CA. 2011. The physical therapist as a diagnostician: how do we, should we, and could we use information about pathology in our practice? Phys Ther 91(11):1694–5. http://dx.doi.org/10.2522/ptj.2011.91.11.1694.
11. Moore JH, McMillian DJ, Rosenthal MD, Weishaar MD. 2005. Risk determination for patients with direct access to physical therapy in military health care facilities. J Orthop Sports Phys Ther 35(10):674–8. http://dx.doi.org/10.2519/jospt.2005.35.10.674.
12. Pinnington MA, Miller J, Stanley I. 2004. An evaluation of prompt access to physiotherapy in the management of low back pain in primary care. Fam Pract 21(4):372–80. http://dx.doi.org/10.1093/fampra/cmh406.
13. Hendriks EJM, Kerssens JJ, Dekker J, Nelson RM, Oostendorp RAB, van der Zee J. 2003. One-time physical therapist consultation in primary health care. Phys Ther 83(10):918–31.
14. Nordeman L, Nilsson B, Moller M, Gunnarsson R. 2006. Early access to physical therapy treatment for subacute low back pain in primary health care: a prospective randomized clinical trial. Clin J Pain 22(6):505–11. http://dx.doi.org/10.1097/01.ajp.0000210696.46250.0d.
15. Fritz JM, Childs JD, Wainner RS, Flynn TW. 2012. Primary care referral of patients with low back pain to physical therapy impact on future health care utilization and costs. Spine 37(25):2114–121. http://dx.doi.org/10.1097/BRS.0b013e31825d32f5.
16. Donato EB, DuVall RE, Godges JJ, Zimmerman GJ, Greathouse DG. 2004. Practice analysis: defining the clinical practice of primary contact physical therapy. J Orthop Sports Phys Ther 34(6):284–304. http://dx.doi.org/10.2519/jospt.2004.34.6.284.
17. Mitchell JM, deLissovoy G. 1997. A comparison of resource use and cost in direct access versus physician referral episodes of physical therapy. Phys Ther 77(1):10–18.
18. Pendergast J, Kliethermes SA, Freburger JK, Duffy PA. 2012. A comparison of health care use for physician-referred and self-referred episodes of outpatient physical therapy. Health Serv Res 47(2):633–54. http://dx.doi.org/10.1111/j.1475-6773.2011.01324.x.
19. Holdsworth LK, Webster VS, McFadyen AK, Scottish Physiotherapy Self R. 2007. What are the costs to NHS Scotland of self-referral to physiotherapy? Results of a national trial. Physiotherapy 93(1):3–11. http://dx.doi.org/10.1016/j.physio.2006.05.005.
20. Holdsworth LK, Webster VS. 2004. Direct access to physiotherapy in primary care: now and into the future? Physiotherapy 90(2):64–72. http://dx.doi.org/10.1016/j.physio.2004.01.005.