

## Observational Study

# Hospitals' Web Site Lists of Their Interventional Pain Procedures Inadequately Reflect the Diversity of Their Actual Pain Medicine Practices

Tyler L. Abarca, MD<sup>1</sup>, Franklin Dexter, MD, PhD<sup>1</sup>, Richard H. Epstein, MD<sup>2</sup>, and Amy CS. Pearson, MD<sup>1</sup>

From: <sup>1</sup>University of Iowa, Iowa City, IA; <sup>2</sup>University of Miami, Miami, FL

Address Correspondence:  
Franklin Dexter, MD, PhD  
University of Iowa, Division of  
Management Consulting  
200 Hawkins Drive  
Iowa City, IA 52242  
E-mail:  
franklin-dexter@uiowa.edu

Disclaimer: There was no external funding in the preparation of this manuscript.

Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript. Support was provided solely from institutional and/or departmental sources

Manuscript received:  
03-16-2020  
Revised manuscript received:  
04-09-2020  
Accepted for publication:  
05-08-2020

Free full manuscript:  
www.painphysicianjournal.com

**Background:** Multidisciplinary chronic pain management includes many types of interventional pain procedures. However, navigating the landscape of providers offering such services is challenging.

**Objective:** We investigated whether stakeholders (e.g., patients, referring physicians, hospital administrators, nurses working for insurance companies, and state officials) could accurately judge the diversity of interventional services actually provided based on information gathered from hospital Web sites.

**Design:** This was an observational cohort study.

**Setting:** All 119 nonfederal hospitals in Iowa were included in the study.

**Methods:** We recorded the publicly available data presented on all hospital Web pages related to interventional pain procedures. We counted the listed types of procedures and numbers of pain medicine physicians portrayed. We compared those results with actual performed interventional pain procedures calculated using contemporaneous data from the Iowa Hospital Association. The diversity of types of procedures performed was quantified using the inverse of the Herfindahl index.

**Results:** No pain medicine physician was identified on the Web site for 87.4% of hospitals. Such hospitals accounted for 61.4% of the interventional pain procedures performed statewide. The partial Kendall correlation between the count of types of procedures listed on Web sites and the number of pain medicine physicians, controlling for the performed procedures during the year, was too small to be informative: 0.22 (95% Confidence Interval [CI], 0.07 to 0.38;  $P = .005$ ). The one-sided upper confidence limit that included 0.50 (i.e., moderate) was the 99.98% limit. The partial correlation between the count of types of procedures listed on Web sites and the actual diversity of types of procedures performed, controlling for the performed procedures during the year, was not statistically significant: 0.12 (95% CI, -0.03 to 0.28;  $P = .12$ ). The partial Kendall correlation between the number of pain medicine physicians listed on the Web sites and the diversity of types of procedures performed was not significant: 0.03 (95% CI, -0.13 to 0.19;  $P = .73$ ).

**Limitations:** This study was limited to the state of Iowa, where we found that 38.6% of interventional pain procedures were performed at hospitals with at least one pain medicine physician. The 38.6% is substantively less than the corresponding estimate of 54.2% for the state of Florida. The estimate of 38.6% exceeds the estimate of 30.4% for critical access hospitals in the United States nationwide. Although the heterogeneity is as expected, it shows that findings are likely to be heterogeneous across regions.

**Conclusions:** Stakeholders could not have accurate awareness of the spectrum of services provided by multidisciplinary pain medicine clinics and physicians based on currently reported data, even if they sought it out from publicly available information. Transparency will need to come from pain medicine physicians, at facilities providing the full diversity of services, releasing quantitative data about the services that they provide (e.g., counts by procedure).

**Key words:** Data transparency, diversity, Herfindahl index, interventional pain procedures, managerial epidemiology, pain medicine physicians, partial Kendall correlation, State Ambulatory Surgery and Services Databases

**Pain Physician 2020; 23:E723-E730**

**M**ultidisciplinary chronic pain management includes many types of interventional pain procedures intended to treat pain and reduce opioid use (1). However, navigating the landscape of providers offering such services is challenging. Many physicians offering interventional pain services lack fellowship training and/or board certification in pain management (2,3). Whether or not the clinics where they work offer comprehensive pain management services is difficult to discern.

Stakeholders (e.g., patients, referring physicians, insurance carriers) make inferences about the diversity of medical services provided by organizations using surrogate measures such as the overall numbers of performed procedures (“volume”). However, inferences based on such surrogates are inaccurate for interventional pain management (4). Although hospitals performing more interventional pain procedures tend to have greater diversity in the types of such procedures ( $P < 0.001$ ), there is such low correlation (Kendall’s  $\tau_b = 0.332$  [standard error (SE) 0.09]) that volume is an inaccurate surrogate for the comprehensiveness of procedural care (4). In addition, although larger hospitals (based on staffed beds) may offer greater diversity of types of procedures ( $P = .05$ ), there is reliably such low correlation (Kendall’s  $\tau_b = 0.205$  [SE 0.109]) that hospital size cannot be used to infer comprehensiveness of care of patients with chronic pain (4).

Potentially useful sources of information about the comprehensiveness of care offered by pain clinics are hospital Web sites. For the current study, we recorded the data presented on all Web pages related to interventional pain procedures for the 119 nonfederal hospitals in Iowa. One objective was to quantify the extent to which hospitals with Web sites listing more types of procedures were the hospitals with more pain medicine physicians. Another objective was to examine the extent to which hospitals with Web sites listing more types of procedures were those hospitals performing a greater diversity of types of procedures. Finally, we quantified the extent to which hospitals with more listed pain medicine physicians provided a greater diversity of types of procedures. These objectives are important because they address how potential referring physicians, administrators, insurers, local (state/provincial) policy analysts, and patients could know which hospitals provide many services for patients with chronic pain, specifically interventional pain procedures. If Web sites are uninformative or provide misleading information, then without publication of analyses such as that pre-

sented in the current study, there cannot be quality population-based decision-making.

## **METHODS**

The University of Iowa Institutional Review Board determined on April 10, 2019, that this study does not constitute human subjects research.

### **Iowa Hospital Association Data**

Outpatient procedure data were obtained from the Iowa Hospital Association for the fourth quarter of 2018 (i.e., October 1 through December 31) and the first through third quarters of 2019 (i.e., January 1 through September 30) (5). For convenience, when referring to the Iowa Hospital Association data, procedures performed during this 12-month period are referred to as having occurred in 2019. The data included all facilities owned by one of the 119 nonfederal hospitals statewide; the 2 Veterans Affairs hospitals were excluded because they do not contribute data to the Iowa Hospital Association. The data were not limited to one health network or payer (i.e., not restricted to patients with US Medicare fee for service insurance). The Iowa Hospital Association data attributed each procedure to the hospital owning the facility where the procedure was performed (6); practically, most facilities are close to the hospital (7). The hospital data included procedures performed at facilities owned by hospitals (e.g., the medical office building used by the 5 pain medicine physicians of the state’s only accredited pain medicine program) (8). We henceforth refer to all the studied facilities as “hospitals.” Thus, when we refer to the count of interventional pain procedures performed at each hospital, that does not mean that the procedure was literally performed in a hospital building; often, it would have been in a nearby clinic (9).

Procedures were chosen from among those in the American Society of Interventional Pain Physicians’ list of 2019 physician payment rates (10). Our list of included procedures is in the Excel file with our study results at <https://FDshort.com/IowaPain2019>.

Among the 64,209 interventional pain procedures performed at an Iowa hospital in 2019, 4.4% were performed on the same date as an “invasive surgical procedure” that was not itself a pain procedure (11). These 4.4% of procedures (i.e., 2829 of 64,209) likely were peripheral nerve or neuraxial anesthetic blocks for management of acute pain related to surgical care (e.g., caudal blocks performed for pediatric urological and orthopedic procedures), not procedures performed

for the treatment of chronic pain. Therefore, they were excluded, leaving 61,380 interventional pain procedures to study. The exclusion did not influence the results because all analyses performed involved relative relationships, not raw counts.

The diversity of types of procedures performed at the hospitals was quantified using the relative proportions of procedures of such codes at each hospital (12-15). The sum of the squares of the proportions was each hospital's Herfindahl index (12). The Herfindahl index equals the probability that any 2 procedures selected at random, with replacement, from a list of all procedures performed at the hospital are of the same type of procedure. The inverse of the Herfindahl is the "number of procedures of each type of procedure performed commonly" (12). This quantity is also referred to as the "effective number of types of procedures" (16). Each increase in the number of different types of procedures commonly performed is associated with an increase in the inverse of the Herfindahl (12,17-19). There are several online tutorials of using  $1/\text{Herfindahl}$  as a measure of diversity (16,20-22). The inverse of the Herfindahl has been used in managerial epidemiology studies of the diversity of surgical procedures among hospitals (12-14).

### Review of Hospital Web Sites

The 119 hospitals' Web sites were reviewed to obtain listings of the types of procedures performed. A uniform random number was used to randomize the sequence in which the hospitals were reviewed. This approach assured that hospitals with similar names (e.g., the 15 "Mercy" hospitals of Iowa and the 15 "UnityPoint Health" hospitals) and with branded Web sites were reviewed independently.

Between July and September 2019, for each of the 119 hospitals, a Google search using the hospital's name and address provided a hospital Web site, visited in the random order. Each of the hospital's Web site pages were screened for interventional pain procedures by entering the following text into the Google search box: pain (interventional OR fluoroscopy OR fluoroscopic OR steroid OR injection) site:{hospital default Web site} (9). We used this protocol to screen hospital Web sites because of its success in our earlier study of critical access hospitals (9). Specification of the site (e.g., "site:https://uihc.org" for University of Iowa public health care Web site) limits the search to the organization's domain, updated regularly in the Google database. The results were reviewed by the first author for keywords related

to interventional pain procedures performed at the hospital or its owned facilities (9). No restriction was placed on the theme of the page (e.g., Web pages for radiology that include one or more interventional pain procedures were included). The address of each hospital was verified to confirm concordance with the original list of the hospitals. For each hospital, once all physicians or nonphysicians listed as performing one or more of the interventional pain procedures had been identified, the hospital Web site was searched for all pages including the name of that physician or nonphysician to find additional listed types of procedures.

All Web pages listing at least one interventional pain procedure being offered were saved as a PDF file, available at: <https://FDshort.com/IowaPain2019>. One variable obtained was the count of the types of interventional pain procedures offered. The other variable was the number of physicians with any medical degree (e.g., MD, DO, MBBS) listed as performing interventional pain procedures at that facility and with completion of subspecialty board certification in either American Board of Medical Specialties pain medicine or American Board of Interventional Pain Physicians ("pain medicine physician"). Confirmation of board certification was made for each physician. The American Board of Medical Specialties provided a list of all physicians with active board certification (2). The American Board of Interventional Pain Physicians has a publicly available list of diplomates (23). There were no physicians listed who indicated that they held an American Osteopathic Association Pain Management Subspecialty Certification; there were 3 physicians with osteopathic medical degrees who were pain medicine-certified from the American Board of Medical Specialties.

Hospital Web sites change over time. Therefore, on October 10-11, 2019, the Web sites of the 119 hospitals were revisited by an author. PDF files were updated and reviewed by 2 other authors. Repeating this search during a 2-day window provided a cross-sectional survey of data with complete PDF files for all 119 facilities. These reports (i.e., our results) are available at: <https://FDshort.com/IowaPain2019>. All counts (i.e., the data analyzed) from the recorded Web sites were performed independently by 3 authors and were concordant.

The number of pain medicine physicians listed at hospital web sites was 23 statewide. We used this count rather than the value of 26 obtained in September 2018 by combining American Board of Medical Specialties pain medicine with Iowa Board of Medicine licenses linked by National Provider ID (4). The latter

includes physicians working in their primary specialty (e.g., as anesthesiologists) and physicians who left, but maintained an active Iowa medical license.

### Statistical Methods

The partial Kendall  $\tau$  correlation between the number of pain medicine physicians and the count of types of procedures listed on Web sites was calculated, controlling for the performed procedures during the year. The STATA Version 16.1 (College Station, TX) part-tau module was used (24). The 95% 2-sided confidence intervals (CI) are jackknife estimates (24). We refer to partial correlations less than 0.30 as small, and those at least 0.30 but less than 0.50 as moderate (25).

Partial correlations were also calculated between the variables and the inverse of the Herfindahl index (i.e., diversity of performed procedures at the hospital). Quantification of the diversity of performed procedures needs larger sample sizes than observed at some hospitals, making the standard errors and, consequently confidence intervals, wide. Therefore, we calculated the Herfindahl index for each of the 82 hospitals with  $\geq 100$  interventional pain procedures performed during the studied year (4).

### RESULTS

The estimated correlations among the 119 hospitals showed evidence of convergent validity. Specifically, the counts of types of procedures listed on the Web sites were positively associated with the numbers of pain medicine physicians (Kendall's  $\tau_b = 0.30$ ,  $P < .001$ ) and with the numbers of interventional pain procedures performed in 2019 (Kendall's  $\tau_b = 0.31$ ,  $P < .001$ ). The numbers of pain medicine physicians were positively associated with the numbers of interventional pain procedures performed in 2019 (Kendall's  $\tau_b = 0.34$ ,  $P < .001$ ). The estimated correlations also showed evidence of divergent validity; none of the 3 variables was associated with the random sequence in which the hospitals' Web sites were reviewed (all  $P \geq 0.12$ ).

Among the 112 of 119 hospitals with at least one performed procedure, 87.4% of the Web sites did not identify a pain medicine physician (i.e., the interventional pain procedures were performed by nonphysicians or by physicians without board certification). Statewide, 38.6% of the 61,380 interventional pain procedures performed in 2019 were performed at the facilities of hospitals with at least one of the 23 pain medicine physicians. There were 22 physicians with

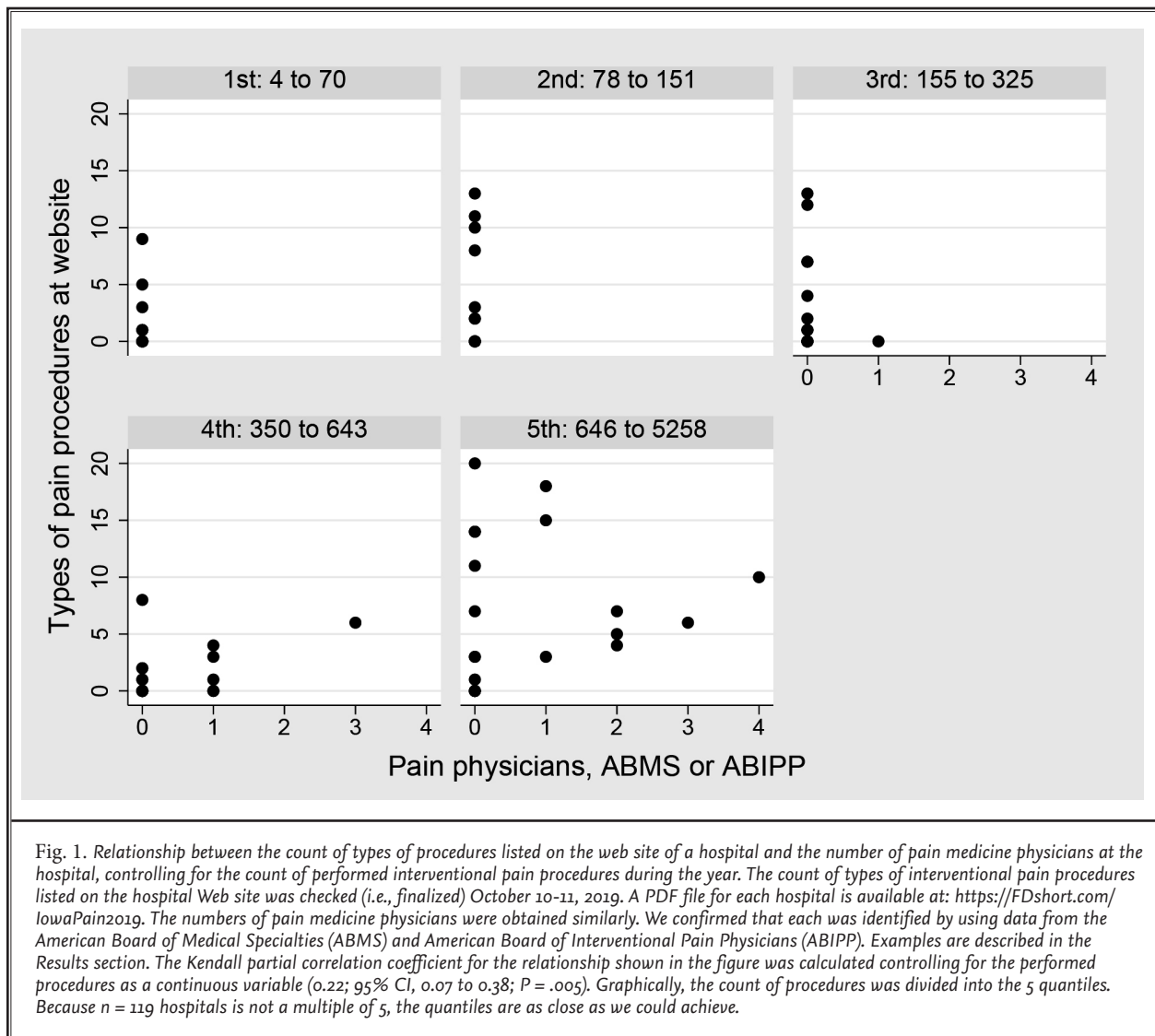
American Board of Medical Specialties certification, and one from the American Board of Interventional Pain Physicians; none had both certifications.

The partial Kendall correlation between the count of types of procedures listed on Web sites and the number of pain medicine physicians, controlling for the performed procedures during the year, was small: 0.22 (95% CI, 0.07 to 0.38;  $P = .005$ ; Fig. 1;  $n = 119$  hospitals). Repeating the calculation while limiting to the hospitals with at least one performed procedure, the partial correlation was small: 0.22 (95% CI, 0.06 to 0.38;  $P = .006$ ;  $n = 112$  hospitals). Repeating the calculation while limiting to the hospitals with at least 100 performed procedures, the partial correlation was small: 0.22 (95% CI, 0.05 to 0.39;  $P = .013$ ;  $n = 82$  hospitals). Repeating the calculation with all hospitals, the one-sided upper confidence limit that included 0.50 (i.e., moderate) was the 99.98% limit.

For example, the second row, second column of the figure shows the hospital (and its facilities) with the largest count of types of procedures performed listed on the Web site, 20 types, and with no pain medicine physician. There were 3 Certified Registered Nurse Anesthetists, each with the Nonsurgical Pain Management Subspecialty Credential (26).

For example, among the 3 hospitals with no types of interventional pain procedures performed listed on the Web site but at least one pain medicine physician, the hospital with the most performed procedures explained on the Web site that "the care plan developed by the pain clinic staff utilizes the latest interventional pain management techniques plus interdisciplinary services," but no specifics were included. This hospital is shown in the second row, first column of the figure.

Using the Iowa Hospital Association data, we calculated the diversity of types of procedures performed among the 82 hospitals with at least 100 performed procedures. As previously reported (4), there was a statistically significant but small positive correlation between diversity and number of interventional pain procedures performed (Kendall's  $\tau_b = 0.22$ ,  $P = .004$ ). The partial Kendall correlation between the count of types of procedures listed on Web sites and the actual diversity of types of procedures performed, controlling for the performed procedures during the year, was not significant: 0.12 (95% CI, -0.03 to 0.28;  $P = .12$ ). The partial Kendall correlation between the number of pain medicine physicians and the diversity of types of procedures performed also was not significant: 0.03 (95% CI, -0.13 to 0.19;  $P = .73$ ).



## DISCUSSION

In Iowa, most (87.4%) hospitals and hospital-owned facilities with interventional pain procedures performed have no pain medicine physician (see below). Those hospitals accounted for more than half (61.4%) of the performed procedures. Our objective was to determine whether referring physicians, hospital administrators, states, or nurses working for insurance companies could use public information to inform patients about a wide spectrum of appropriate types of procedures performed by fellowship-trained pain medicine physicians. They cannot.

Our results show that although hospitals with

more types of procedures listed on their Web sites tended to perform a greater diversity of procedures, the relationship was so small as to be uninformative. Although hospitals with more types of procedures listed were those hospitals with more pain medicine physicians, the relationship was also too small to be important quantitatively. Finally, the hospitals without pain medicine physicians were commonly performing as many types of procedures as those hospitals with pain medicine physicians. The implication is that neither patients, administrators, state officials, etc., could have awareness of the spectrum of services provided by multidisciplinary pain medicine clinics and physicians based on currently reported data, even if they sought

it out from the public information. Because the Web sites are not informative, poor decision-making in the choices and recommendations of hospitals' facilities should be expected. Pain medicine physicians at hospitals providing the full diversity of services would need to use their facility's administrative data to educate stakeholders about the uniqueness of their services. In other words, quality decisions and recommendations at a policy level will depend on pain medicine physicians and investigators performing similar analyses of their data, just like we did for all hospitals in a state, making their results public, and educating stakeholders (e.g., health administrators) about the importance of the results.

### **Comparison with Previous Studies of Iowa, Florida, and Rural Hospitals**

Our results complement a previous managerial epidemiology study using data from the state of Iowa (4). Hospitals differed substantively in the diversity of types of interventional pain procedures (4). However, there was too weak of an association between hospital size and diversity to use hospital size as a surrogate; diversity of procedures needs to be measured and reported (4). There was also too weak of an association between numbers of procedures performed and diversity to use volume as a surrogate (4). The implication is that pain medicine physicians at hospitals offering a complete spectrum of tools to treat chronic pain patients need to measure their diversity as we have done (i.e., not just provide a list including types of procedures rarely performed) and educate the community.

Matching findings for the state of Florida (2), clinicians who have not completed a pain medicine fellowship and board certification are performing many types of procedures. While Iowa has 23 pain medicine physicians, from our previous study, there were 224 proceduralists each performing an average of at least one interventional pain procedure every 3 weeks (4). Consequently, although board certification is an important message for communication, it is not a suitable surrogate for patient access to a substantive diversity of types of interventional pain procedures at the hospital.

Only 38.6% of the interventional pain procedures were performed at hospitals with at least one pain medicine physician. We used Web sites because ours was a study of marketing. Nevertheless, the 38.6% result from Iowa differed substantively from the corresponding 54.2% figure for the state of Florida (2). The 38.6% also differed from the estimate obtained by taking a

random sample of critical access hospitals nationwide (9). Specifically, among the 110 randomly selected critical access hospitals nationwide, pain medicine physicians were reported to be at 30.4% of the 23 hospitals with interventional pain procedures (9). All but one of the anesthesiologists and physical medicine and rehabilitation physicians were pain medicine-certified (9). The value for Iowa (38.6%) being between the estimates of 30.4% and 54.2% makes sense because Iowa has multiple critical access hospitals and some metropolitan areas, all vastly smaller than those in Florida. In addition, Iowa has many hospitals with Certified Registered Nurse Anesthetists and no anesthesiologists, reflecting policies of the Centers for Medicare and Medicaid Services, both for payment to critical access hospitals and for the "opt out" option selected by Iowa that nurse anesthetists need not be supervised by a physician to receive payment for anesthetics and interventional pain procedures. As in our example presented in the Results, at the critical access hospitals, Certified Registered Nurse Anesthetists were the clinicians, other than pain medicine physicians, performing the interventional pain procedures at the largest numbers of hospitals and with the most clinicians (9). Extension of "opt out" to all US states in March 2020 may result in greater generalizability of our findings to other states if this temporary waiver due to the Coronavirus Disease 2019 crisis were to remain in effect longer-term (27).

A limitation of our study is that none of the preceding studies is directly comparable to the current study comparing information publicly marketed with actual workload for interventional pain procedures; this also highlights the novelty of our study. Furthermore, Iowa is a rural state, with a land area comparable to that of Florida but a population smaller than Miami. Results might differ in large metropolitan areas. The sole pain medicine fellowship in Iowa with the most pain medicine physicians had the largest observed diversity of types of interventional pain procedures. The cost in terms of patients' time traveling 5 hours by car (e.g., Sioux City to Iowa City) may be different than that of the < 1 hour that is considered "lengthy" within metropolitan areas (30). That is, Iowa is a largely rural state in which patients may have greater tolerance for traveling for advanced medical care. We recommend that other investigators perform comparable studies in other geographic areas to assess the generalizability of our findings. We think that our methodology and analyses provide information necessary to plan future studies with testable hypotheses.

### Limitations of Types of Facilities Studied

Although we refer to studying “hospitals,” we studied Web sites (i.e., corporate entities), not literally hospital buildings. Another related limitation is that, for each hospital, the physical location where the procedure was performed was unknown (e.g., hospital building, ambulatory surgery center, or office) (6). Again, our study was of facilities owned by the hospital, not hospitals per se. Because most hospital-owned procedure centers are physically close to the hospital (7), especially relative to the substantial distances patients travel in a rural state, this limitation probably would not affect future studies of patient access to care.

We studied hospital-owned facilities. Interventional pain procedures performed at clinics or ambulatory surgery centers with separate US Medicare certification were not included. This limitation is extremely unlikely to have influenced results, based on the robustness of our results. The partial correlations between the count of types of procedures listed on Web sites and the number of pain medicine physicians were the same whether we considered all hospitals or those with at least 100 performed procedures, and it was only the 99.98% confidence limit that even included a partial correlation of 0.50.

Finally, our study could not address the quality of care because there were limited data that were publicly available. One such quality metric is the percentage of lumbosacral epidural steroid injections administered at a frequency greater than clinically shown to improve outcomes, a factor that differentiates among hospitals (30). Among the steroid injections, overall, 1.91% represent the 5th or greater steroid injection. Among the 39 hospitals in Iowa that performed overall at least one steroid injection every 4 days, there were 6 hospitals at which the percentages of injections that were the fifth or greater significantly exceeded the overall prevalence of 1.91% (range, 3.0%-6.4%). There were 14 of the 39 hospitals with a prevalence significantly less than the overall prevalence. We checked, and there was no association between this quality measure and procedures performed (Kendall's  $\tau_b = 0.182$  [SE

0.114],  $P = .11$ ). There also was no association between this quality measure and diversity among the 39 hospitals (Kendall's  $\tau_b = -0.151$  [SE 0.111],  $P = .19$ ). Thus, a limitation is that our consideration of the diversity of procedures (i.e., comprehensiveness of services) differs from the quality of care being provided.

### CONCLUSIONS

We recorded all Web pages related to interventional pain procedures for the 119 nonfederal hospitals in Iowa and compared that information to the administrative patient care data from the hospitals. Although hospitals with more types of procedures listed on their Web sites tended to perform a greater diversity of procedures, the correlations were so small as to be irrelevant. Although hospitals with more types of procedures listed were those hospitals with more pain medicine physicians, the correlation was also unimportantly small. Hospitals with more fellowship-trained pain medicine physicians only had slightly more types of procedures than other hospitals. The implication is that neither patients, hospital administrators, nurses working for insurance companies, or state officials, etc., could have accurate awareness of the spectrum of services provided by multidisciplinary pain medicine clinics and physicians based on currently reported data, even if they sought it out from publicly available information. Transparency will need to come from pain medicine physicians, at hospitals providing the full diversity of services, releasing quantitative data about the services that they provide.

### Acknowledgments

Assistance: Brandon Johnson, Director of Strategic Planning at the University of Iowa Hospitals and Clinics, manages the Iowa Hospital Association data at the University of Iowa and prepared the data fields for us.

Data availability: Summary counts in Excel file and recorded web pages as PDF are provided at <https://FDshort.com/IowaPain2019>. The Iowa Hospital Association data used are available publicly with appropriate data use agreement (5).

## REFERENCES

- Patwardhan A, Matika R, Gordon J, Singer B, Salloum M, Ibrahim M. Exploring the role of chronic pain clinics: Potential for opioid reduction. *Pain Physician* 2018; 21:E603-E610.
- Epstein RH, Dexter F, Pearson ACS. Pain medicine board certification status among physicians performing interventional pain procedures in the State of Florida between 2010 and 2016. *Pain Physician* 2020; 23:E7-E18.
- Epstein RH, Dexter F, Podgorski E III, Pearson A. Annual number of spinal cord neuromodulation procedures performed in the State of Florida during 2018: Implications for establishing neuromodulation centers of excellence. *Neuromodulation*. In press.
- Pearson ACS, Dexter F. Observational study of the distribution and diversity of interventional pain procedures among hospitals in the State of Iowa. *Pain Physician* 2019; 22:e157-e170.
- Iowa Hospital Association. Inpatient/Outpatient Database. Iowa Hospital Association Web site. [www.ihaonline.org/Information/Inpatient-Outpatient-Database/Data-Request](http://www.ihaonline.org/Information/Inpatient-Outpatient-Database/Data-Request). Date Accessed 11/11/2019.
- Iowa Hospital Association. Outpatient & Additional Outpatient Database. Data dictionary for use with the IHA outpatient database, Appendix I. Hospitals. Iowa Hospital Association Web site. [www.ihaonline.org/Portals/0/webdocs/information/OP%20Data%20Dictionary%202Q%202015.pdf#page=6](http://www.ihaonline.org/Portals/0/webdocs/information/OP%20Data%20Dictionary%202Q%202015.pdf#page=6). Date Accessed 02/09/2020.
- Elhag D, Dexter F, Elhakim M, Epstein RH. Many US hospital-affiliated freestanding ambulatory surgery centers are located on hospital campuses, relevant to interpretation of studies involving ambulatory surgery. *J Clin Anesth* 2018; 49:88-91.
- Carver College of Medicine, Department of Anesthesia, Chronic Pain Medicine, Division Listing. Department of Anesthesia Web site. <https://medicine.uiowa.edu/anesthesia/people/division/chronic-pain-medicine>. Date Accessed 11/11/2019.
- Elhakim M, Dexter F, Pearson ACS. US critical access hospitals' listings of pain medicine physicians and other clinicians performing interventional pain procedures. *J Clin Anesth* 2019; 58:52-54.
- American Society of Interventional Pain Physicians. 2019 - Physician Payment Rates. <http://files.constantcontact.com/be15115b001/a3355a8d-7658-4248-b7b5-046be703f640.pdf>. Date Updated 11/01/2018. Date Accessed 11/11/2019.
- Healthcare Cost and Utilization Project. Surgery flags software for services and procedures. Agency for Healthcare Research and Quality Web site. [www.hcup-us.ahrq.gov/toolssoftware/surgeryflags\\_svcproc/surgeryflags\\_svcproc.jsp](http://www.hcup-us.ahrq.gov/toolssoftware/surgeryflags_svcproc/surgeryflags_svcproc.jsp). Date Accessed 02/08/2020.
- Dexter F, Ledolter J, Hindman BJ. Quantifying the diversity and similarity of surgical procedures among hospitals and anesthesia providers. *Anesth Analg* 2016; 122:251-263.
- Dexter F, Epstein RH, Thenuwara K, Lubarsky DA. Large variability in the diversity of physiologically complex surgical procedures exists nationwide among all hospitals including among large teaching hospitals. *Anesth Analg* 2018; 127:190-197.
- Dexter F, Epstein RH, Lubarsky DA. Hospitals with greater diversities of physiologically complex procedures do not achieve greater surgical growth in a market with stable numbers of such procedures. *J Clin Anesth* 2018; 46:67-73.
- Dexter F, Sae-Hwan P, Epstein RH, Sun E, O'Neill L. Hospitals with greater diversities of physiologically complex procedures do not achieve greater production of such inpatient surgical procedures. *Periop Care Oper Room Manag* 2019; 17:100079.
- Jost L. Effective number of species. [www.loujost.com/Statistics and Physics/Diversity and Similarity/EffectiveNumberOfSpecies.htm](http://www.loujost.com/Statistics%20and%20Physics/Diversity%20and%20Similarity/EffectiveNumberOfSpecies.htm). Date Accessed 11/12/2019.
- Dexter F, Traub RD, Fleisher LA, Rock P. What sample sizes are required for pooling surgical case durations among facilities to decrease the incidence of procedures with little historical data? *Anesthesiology* 2002; 96:1230-1236.
- Gosselin F. An assessment of the dependence of evenness indices on species richness. *J Theor Biol* 2006; 242:591-597.
- Jost L. Entropy and diversity. *Oikos* 2006; 113:363-374.
- Dexter F. Showing differences among hospitals and their surgical practices. University of Iowa Carver College of Medicine, Department of Anesthesia Web site. [www.franklindexter.net/Lectures/StrategicDifferentiating.pdf#page=29](http://www.franklindexter.net/Lectures/StrategicDifferentiating.pdf#page=29). Date Accessed 11/12/2019.
- Wikipedia. Diversity index. [https://en.wikipedia.org/wiki/Diversity\\_index#Inverse\\_Simpson\\_index](https://en.wikipedia.org/wiki/Diversity_index#Inverse_Simpson_index). Date Accessed 11/12/2019.
- The inverse Herfindahl-Hirschman Index as an "effective number of" parties. R-bloggers Web site. [www.r-bloggers.com/the-inverse-herfindahl-hirschman-index-as-an-effective-number-of-parties/](http://www.r-bloggers.com/the-inverse-herfindahl-hirschman-index-as-an-effective-number-of-parties/). Date Accessed 11/12/2019.
- American Board of Interventional Pain Physicians. Diplomates. American Board of Interventional Pain Physicians Web site. [www.abipp.org/diplomates](http://www.abipp.org/diplomates). Date Accessed 12/13/2019.
- Fiedler J, Feiveson AH. PARTTAU: Stata module to calculate Kendall's partial tau and confidence interval. *Statistical Software Components S457107*. Boston, Boston College Department of Economics; Revised 02/03/2010.
- Cohen J. Statistical power analysis for the behavioral sciences, 2nd ed. Hillsdale, NJ: Erlbaum, 1988, pp. 77-81.
- Nonsurgical Pain Management (NSPM) Subspecialty Credential. National Board of Certification and Recertification for Nurse Anesthetists Web site. [www.nbcna.com/exams/nspm/nspm-examination](http://www.nbcna.com/exams/nspm/nspm-examination). Date Accessed 11/11/2019.
- Centers for Medicare & Medicaid Services. Trump administration makes sweeping regulatory changes to help U.S. healthcare system address COVID-19 patient surge. Centers for Medicare & Medicaid Services Web site. [www.cms.gov/newsroom/press-releases/trump-administration-makes-sweeping-regulatory-changes-help-us-healthcare-system-address-covid-19](http://www.cms.gov/newsroom/press-releases/trump-administration-makes-sweeping-regulatory-changes-help-us-healthcare-system-address-covid-19). Date Accessed 04/08/2020.
- Epstein RH, Dexter F, Diez C, Potnuru P. Determination of geolocations for anesthesia specialty coverage and standby call allowing return to the hospital within a specified amount of time. *Anesth Analg* 2019; 129:1265-1272.
- Epstein RH, Dexter F, Smaka T. Obtaining and modeling variability in travel times from off-site satellite clinics to hospitals and surgery centers for surgeons and proceduralists seeing office patients in the morning and performing a to-follow list of cases in the afternoon. *Anesth Analg* 2020; 131:228-38.
- Pearson ACS, Dexter F, Epstein RH. Heterogeneity among hospitals in the percentages of all lumbosacral epidural steroid injections where the patient had received 4 or more in the previous year. *Anesth Analg* 2019; 129:493-499.