Research Article

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Melanoma Management

Impact of rurality on melanoma diagnosis in Utah

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Aim: To analyze trends in Utah melanoma diagnosis and study the impact of rurality. **Patients & methods:** State-wide melanoma incidence was calculated using Surveillance, Epidemiology, and End Results data (2005–2013). A subset of 5199 patients treated in an integrated healthcare system was further stratified for urban or rural residence. **Results:** Early-stage tumors accounted for most of the increase in melanoma incidence over time. Age-adjusted melanoma incidence rate was higher in rural counties (46.7 vs 39.4). Anatomic site and stage did not differ between rural and urban patients. Rural patients were more commonly diagnosed by a local primary care provider. **Conclusion:** Rurality had an impact on melanoma diagnosis in the specialty and location of the diagnosing provider.

First draft submitted: 8 December 2020; Accepted for publication: 12 February 2021; Published online: 4 March 2021

Keywords: diagnosis • epidemiology • melanoma • oncology • prevention • skin

Melanoma incidence and mortality in Utah is the highest in USA [1]. Melanoma incidence in Utah is 80% higher than the national average and mortality is 31% higher [2]. Furthermore, melanoma incidence is increasing yearly in Utah. Between 2005 and 2013, melanoma incidence in Utah increased overall by 33%.

Exposure to UV radiation from the sun or from artificial sources (i.e., tanning beds) is the key environmental risk factor for the development of melanoma [3]. The high incidence of melanoma in Utah likely stems from UV radiation exposure associated with high elevation and year-round outdoor activities, as well as to the fair skin type of many Utahns. The mean elevation in Utah is 6100 feet, which is the third highest in the country [4,5].

Interventions aimed at reducing melanoma incidence and prompting earlier diagnosis are needed. Rurality may impact the early diagnosis of melanoma.

96% of land in Utah is rural or frontier [5]. Patients from rural and frontier counties may have different pathways of care to a melanoma diagnosis. Rural patients may not have proximity to a diagnosing provider and the specialty of the diagnosing provider may be different compared with urban patients. Furthermore, patient and tumor characteristics may also be influenced by rural residence.

We analyzed Utah data from the National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) program to identify trends over time in melanoma incidence. We then further studied urban and rural melanoma patients treated in the Intermountain Healthcare system to identify meaningful targets for intervention efforts. Intermountain Healthcare is a Utah-based integrated healthcare system of 23 hospitals and 170 clinics that provides primary and specialty care throughout Utah, including many rural counties.

The key aims of the current study were to describe patient and tumor variables of Utah melanoma patients, to determine the specialty of the provider establishing the melanoma diagnosis, to identify any differences based on urban or rural county of residence, and to inform future melanoma prevention and early diagnosis efforts.

Future Medicine

Patients & methods

We queried Utah data from the National Cancer Institute SEER program research for melanoma patients aged 20 years and over diagnosed between 2005 and 2013 [6]. The annual age-adjusted incidence per 100,000 population was determined within subgroups defined by sex, age at diagnosis, Hispanic ethnicity and anatomic site. Annual average percent change (APC) was estimated as the geometric mean of annual proportional changes [7].

A cohort of melanoma patients (stage 0–IV) aged 18 years and older treated within the Intermountain Healthcare system (2005–2013) was further studied. The Intermountain Tumor Registry, the Utah Cancer Registry and the Utah Population Database were utilized to obtain comprehensive patient and tumor data including age at diagnosis, sex, the specialty and location of the healthcare provider performing the diagnostic biopsy, and for the patient's county of residence. Utah counties were classified as urban or rural based on a classification system from the National Center for Health Statistics where counties with 249,999 people or fewer are designated rural and counties with 250,000 or more people are designated urban. Frontier counties were grouped with rural counties in the analyses. Descriptive statistical analyses were performed for patient and tumor variables. A Pearson's chi-squared test for independence was performed for each contingency table when expected cell counts met assumptions. Otherwise, p-values were computed from a Monte Carlo simulation of Fisher's exact test. These statistical tests were performed in R. Statistical Analysis System software was used.

Results

Utah state-wide data

Utah state-wide melanoma incidence for the period 2005–2013 included 9447 cutaneous melanomas. A total of 38.8% were women, and 1.4% were Hispanic or Latino. Melanoma incidence increased over time in both men and women at 3.9% annual APC (Figure 1A). Annual incidence among men was higher overall and showed a steeper rate of increase, 4.5% APC, compared with 2.8% APC among women. By age, the population aged 75–84 had the steepest increases in melanoma incidence over time (7.0% APC) (Figure 1B). While Utahns of Hispanic or Latino origin had a much lower overall incidence of melanoma compared with non-Hispanics, an increase in melanoma incidence of 8.2% APC was also observed for Hispanics (Figure 1C). Upper limb and shoulder, trunk, and face were the most common anatomic sites of melanoma (Figure 1D). The rate of increase over time was highest for scalp and neck (7.6% APC) and for upper extremity melanoma (5.7% APC), which surpassed trunk melanomas as the most common anatomic site in 2013.

Of Utah's 29 counties, four were defined as urban and 25 as rural (frontier counties were included in rural group). The age-adjusted melanoma incidence rate (cases per 100,000 population per year) by urban or rural county was calculated using SEER data. Rural counties with fewer than ten cases per year, on average, were excluded. In urban counties, the melanoma incidence rate ranged from 30.8 to 46.9 with an average of 39.4 [8]. In rural counties, the melanoma incidence rate ranged from 32.3 to 72.8 with an average of 46.7. In comparison, the overall US age-adjusted melanoma incidence rate is 21.8 per 100,000 [8].

Intermountain cohort

In order to investigate the impact of rurality on melanoma diagnosis, a cohort of 5199 Utah patients treated in the Intermountain Healthcare system between 2005 and 2013 was selected and categorized by urban or rural county of residence at the time of melanoma diagnosis. Demographic characteristics of these patients are detailed in Table 1. Rural patients accounted for 31.5% of the cohort.

Rural melanoma patients were older and were more likely to be male.

The pathologic diagnosis of melanoma was most often established by a dermatologist in both urban and rural counties (59.8 and 63.3% of patients, respectively), but rural patients were more likely to be diagnosed by a family medicine provider and less likely to be diagnosed by a surgeon compared with urban patients (Table 1). To determine if rural patients were traveling to more populated urban regions for biopsy, we studied whether patients had the diagnosing biopsy performed in a rural or urban location. The pathology report was used to identify the diagnosing provider and the facility. For the entire cohort, 554 different providers from 17 different facilities rendered the melanoma diagnosis. The providers were classified as urban, rural or both based on their location of practice. The providers classified as 'both' had a practice in an urban location as well as routine outreach clinics in rural counties.

We were able to determine the urban or rural location of the diagnosing provider for 1459 of 1637 rural patients. As shown in Table 2, most rural patients in this analysis (76.6%) were diagnosed by a rural provider and an

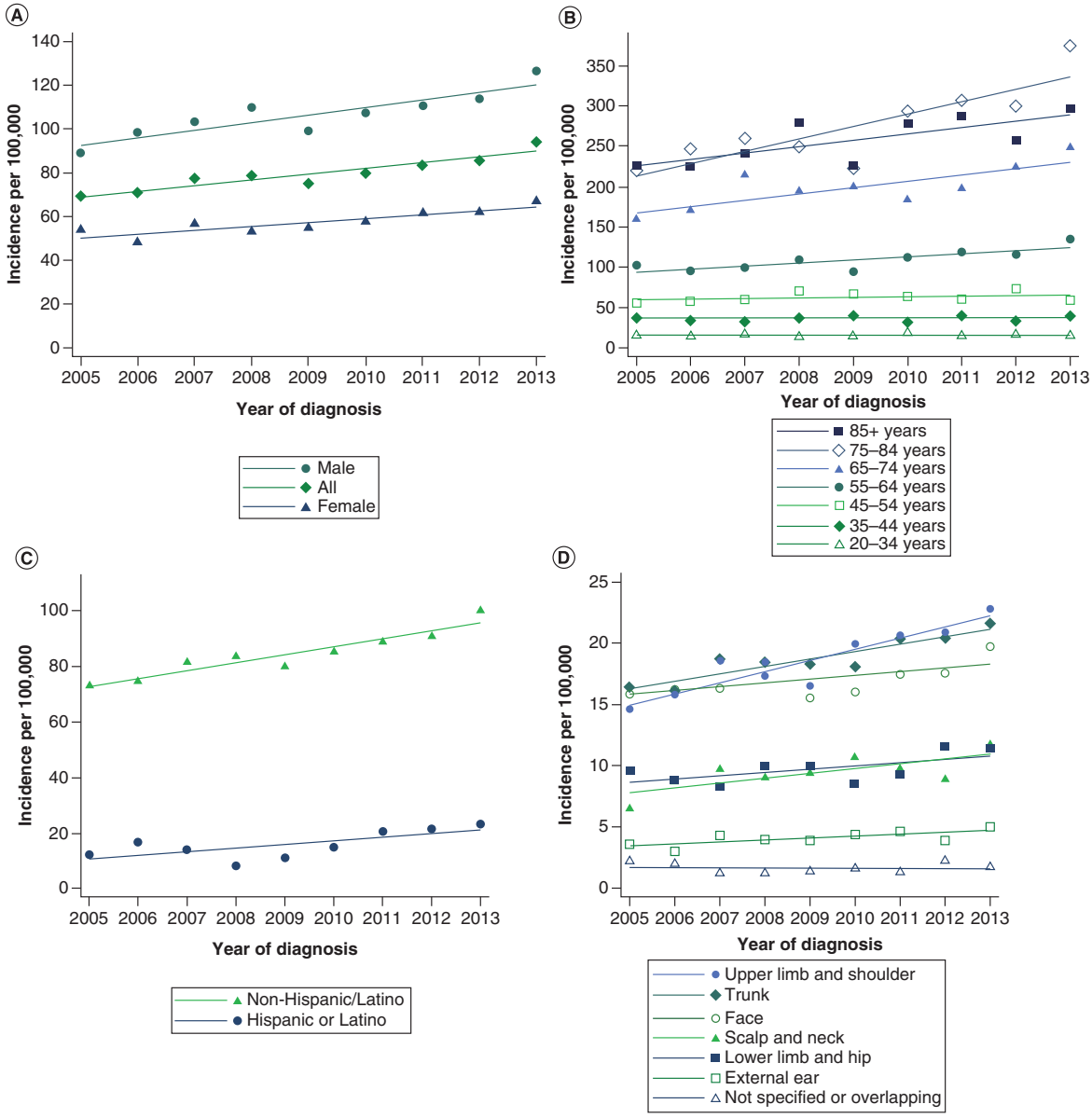

Figure 1. Utah state-wide melanoma incidence over time by (A) sex, (B) age, (C) Hispanic ethnicity and (D) anatomic site.

additional 1.3% were diagnosed by a provider primarily based in an urban region but providing outreach to a rural area. Most urban patients (96.3%) were diagnosed by an urban-based provider.

Stage at diagnosis of melanoma did not differ between rural and urban patients (Table 2). Histology did differ between counties, with rural counties having more lentigo maligna and nodular melanomas. The anatomic site distribution of melanoma was similar in rural and urban counties, with upper extremity, trunk and face melanoma most common, as seen in the Utah SEER data.

Discussion

Melanoma is the deadliest skin cancer and is the third most common malignancy diagnosed in Utah (preceded only by prostate and breast cancer), with an annual average of 848 cases between 2011 and 2013 [5]. Both men and women in Utah face a much higher risk of melanoma compared with the rest of the country. Therefore, prevention and early diagnosis efforts could impact the lives of thousands of Utahns.

10.2217/mmt-2020-0023

Table 1. Melanoma patient characteristics by urban or rural county of residence (Intermountain cohort).

	Rural (n = 1637)		Urban (n = 3562)		p-value
	n	%	n	%	
Age at diagnosis (years)					<0.001
18–45	261	16.1	770	21.8	
46–64	533	32.9	1365	38.6	
65–84	706	43.6	1200	34.0	
85+	118	7.3	197	5.6	
Unknown	19		30		
Sex					<0.001
Females	607	37.1	1527	42.9	
Males	1030	62.9	2035	57.1	
Ethnicity					0.01
Hispanic, Latino or Spanish origin	15	0.9	69	1.9	
Not Hispanic, Latino or Spanish origin	1622	99.1	3491	98.1	
Unknown	0		2		
Race					0.61
American Indian/Alaska Native	1	0.1	3	0.1	
Asian	1	0.1	2	0.1	
Black or African–American	0	0	0	0	
Native Hawaiian or Pacific Islander	3	0.2	11	0.3	
White	1629	99.7	3542	99.6	
Unknown	3		4		
Diagnosing provider, specialty					<0.001
Dermatology	727	63.3	1311	59.8	
Family medicine	194	16.9	334	15.2	
Surgical specialty	113	9.8	319	14.5	
Other	115	10	230	10.5	
Unknown	488		1368		
Diagnosing provider, location					
Both rural and urban	19	1.3	7	0.32	<0.001
Rural	1117	76.6	75	3.4	
Urban	323	22.1	2112	96.3	
Unknown	178		1368		

Observational and interventional studies have shown screening efforts can increase the detection of thinner melanomas and reduce mortality from melanoma [9]. While debate continues as to the optimal skin cancer screening approach on a population level, many Utahns have high-risk features (personal or family history of melanoma, light skin, many freckles and two or more atypical nevi) that place them at increased risk for developing melanoma [10]. Our study confirms that melanoma is increasing over time in men and women and most of this increase is due to early stage tumors.

Utah is a large state geographically but 96% of the land in Utah is designated as rural (more than six but fewer than 100 people per square mile) or frontier (six or fewer people per square mile) [5]. Of 29 Utah counties, four are designated as urban, 12 are rural and 13 are frontier. For this project, we combined rural and frontier counties (<=249,999) and compared them to urban (>=250,000). Both urban and rural counties in Utah have a higher age-adjusted melanoma incidence rate compared with the rest of the nation. As an example, one Utah rural county has a rate of 72.8 per 100,000 compared with the US national average of 21.8. Overall, Utah's rural counties have higher age-adjusted incidence rates compared with the urban counties.

Intermountain Healthcare is a nonprofit integrated healthcare system that has a large geographic footprint in Utah and provides key access for patients in rural areas. We focused on patients treated in this system to study differences between rural and urban melanoma diagnosis. Dermatologists diagnosed most of the melanomas in both urban and rural counties, despite the relatively lower density of dermatologists in rural areas [11]. Patients

Table 2. Melanoma tumor characteristics by urban or rural county of residence (Intermountain cohort).

	Rural (n = 1637)		Urban (n = 3562)		p-value
	n	%	n	%	
AJCC combined stage					0.71
0 (*in situ*)	455	30	953	28.7	
I	770	50.8	1755	52.8	
II	138	9.1	280	8.4	
III	113	7.4	243	7.3	
IV	41	2.7	95	2.9	
Unknown	120		236		
Histology					<0.001
Superficial spreading	488	29.8	1037	29.1	
Lentigo maligna	473	28.9	896	25.2	
Malignant melanoma, NOS	367	22.4	910	25.5	
Melanoma *in situ*	132	8.1	439	12.3	
Nodular	119	7.3	157	4.4	
Acral lentiginous	17	1	39	1.1	
Desmoplastic	11	0.7	39	1.1	
Other	30		45		
Anatomic site					0.28
Scalp/neck	191	11.7	405	11.4	
Face	304	18.6	592	16.6	
External ear	87	5.3	155	4.4	
Trunk	417	22.5	933	26.2	
Upper limb	363	22.2	826	23.2	
Lower limb	224	13.7	544	15.3	
Not specified	51	3.1	107	3.0	

AJCC: American Joint Committee on Cancer Staging, 6th and 7th edition; NOS: Not otherwise specified.

in rural areas were more likely to be diagnosed by a primary care provider (PCP) compared with urban patients. PCPs aligned with dermatology can improve the early diagnosis of melanoma due to the frequent contact patients have with PCPs. A review article estimated that PCPs perform the initial biopsy for melanoma in 1.4–13% of patients [9]. In our study, PCPs diagnosed and biopsied the melanoma in 16.9% of rural patients and in 15.2% of urban patients. In addition, it is likely that at least some of the melanomas diagnosed by dermatologists were initially observed as abnormal skin lesion by PCPs, followed by referral to dermatology for biopsy. We were not able to quantify this referral pattern in the current study. PCP education on skin cancer and experience in performing skin biopsies is variable. In addition to education and experience, time constraints and the many demands placed on PCPs may also impact the involvement of PCPs in early melanoma diagnosis.

We also showed that rural patients are most likely to be diagnosed by a rural provider, with only 22% of rural patients traveling to an urban area for melanoma biopsy. Only a small percentage of rural patients (1.3%) were diagnosed by a provider who provided rural outreach from an urban area. In other words, this study shows that rural melanoma patients in Utah were able to have a diagnostic biopsy performed in their county most of the time. We were not able to quantify the actual distance between the patient's home and diagnosing provider in this analysis. In larger rural counties, this distance to travel may be a factor in the convenience and cost to the patient and is of interest for future studies.

Our analysis showed no difference in the stage of diagnosis between rural and urban counties. This finding is in agreement with a recent Utah study that showed no survival difference in melanoma patients residing in metropolitan or rural areas, in contrast with brain, endometrial, oral cavity and pharyngeal, and kidney cancer [12]. As noted above, rural patients in our study appear to have access to rurally located providers, including dermatologists, which may decrease time delays in care and reduce stage at melanoma diagnosis. A Canadian study showed that patients who were seen by a dermatologist within the last year were less likely to present with stage III/IV disease and had improved overall survival [13].

A recent SEER analysis of melanoma patients in Iowa showed the rural location of melanoma diagnosis was correlated with increased risk of stage IV disease and increased all-cause mortality [14]. Similarly, Blake *et al.* [15] showed US rural patients had increased melanoma mortality and Zahnd *et al.* [16] showed rural melanoma patients included in the North American Association of Central Cancer Registries had higher rates of distant stage disease. Our analysis did not show an increase in stage IV disease in rural patients and mortality was not evaluated. Of note, SEER data gives the urban/rural location of melanoma diagnosis, but this may not correlate with the actual residence of the patient. In our study, which was based on the pathologic diagnosis of melanoma, we found that many rural providers sent melanoma pathology to urban-located pathology labs. Therefore, we had to use the location of the diagnosing provider, and not the location of the pathology lab, to best determine where the patient received their melanoma diagnosis. Using Intermountain Healthcare records, we were also able to determine the address of the patient as rural or urban. While Iowa and Utah have similarities in overall population and a significant rural population, there are likely additional unmeasured factors including overall access to healthcare, actual distance between the patient's home and provider location, and cultural patterns that impact early melanoma diagnosis.

Teledermatology may improve access for early melanoma diagnosis for both rural and urban patients. A recent review by Wang *et al.* reported teledermatology programs are becoming more common in the USA, with store-and-forward of images and live-interactive visit platforms in use [17]. Studies evaluating the accuracy of skin cancer diagnosis in teledermatology are often small in sample size and heterogeneous in methodology. One comprehensive database review of teledermatology for skin cancer reported a sensitivity of 59–100% and specificity of 30–100% for the accurate diagnosis of melanoma or melanoma precursor lesions [18]. A separate meta-analysis reported the diagnostic accuracy for skin cancer in face-to-face visits at 67–85% compared with 51–85% for teledermatology [19]. Patients did report high satisfaction with teledermatology and waiting time for a consultation was reduced.

Telemedicine requires an upfront investment for a secure network, equipment and training of staff. Intermountain Healthcare currently has an infrastructure already developed for telemedicine [20] and has demonstrated decreased medical costs for telemedicine visits for low acuity urgent conditions [21], decreased neonatal intensive care unit (NICU) transfers from outlying community hospitals by utilizing physician-to-physician telemedicine consultations and increased utilization of advanced practice providers in intensive care units with telemedicine support [22]. Expansion of teledermatology in Utah, utilizing this pre-existing telemedicine network in urban and rural settings, could further promote the early diagnosis of melanoma.

Study limitations

Limitations of the current study include designating the Intermountain cohort of patients from a linked pathology report; the internal cancer registry failed to identify all stage 0 melanoma *in situ* patients that were primarily treated in a clinic location and not a hospital location. This has led to a likely falsely lower number of melanoma *in situ* cases in the Intermountain cohort. Missing data across some of the variables studied (i.e., race/ethnicity) also limits the statistical power of our analyses.

Conclusion

In conclusion, melanoma incidence is increasing in Utahns, with rural patients representing over a third of the patients diagnosed in the state. Rural patients differ from urban patients in key demographics and tumor characteristics, which can be used to inform melanoma early diagnosis efforts. Rural patients have access to diagnosing providers within their rural counties, but increased efforts to educate PCPs on melanoma diagnosis and expansion of teledermatology may further improve access for rural patients.

Future perspective

The current study will be used to inform an early diagnosis of melanoma campaign in urban and rural areas of Utah. Next steps will include: development of a multifaceted patient and clinician educational campaign focused on the early diagnosis of melanoma in adult patients; identification of dermatology and primary care clinics in rural and urban areas that can serve as pilot and control sites for the melanoma campaign; and analysis of impact of melanoma campaign by assessing number of patients presenting for a skin exam and skin biopsies performed. Longer term end points would include overall melanoma incidence, stage at diagnosis and melanoma-specific mortality.

The melanoma educational materials, with a focus on the best messaging for Utah patients by urban or rural location, will be developed by a multidisciplinary team comprised of melanoma content experts, patients, marketing

experts and wellness advocates in our system. The materials will be tested in patient focus groups to help identify the most effective messaging on early melanoma diagnosis. Patient educational materials will include self-mailer postcards, table-top tent cards displayed in providers' offices and acute care clinics, and digital presentation of all materials on social media platforms. The focus group evaluation will also help identify barriers in patients presenting for skin exams. A key component of this preliminary work will be engaging PCPs and dermatology providers early in the project.

Summary points

- Utah melanoma incidence increased over time in both women and men, with a 3.9% annual average percent change between 2005 and 2013.
- While most Utah melanoma patients are white, 1.4% are Hispanic or Latino.
- Upper limb and shoulder, trunk, and face were the most common anatomic sites of melanoma.
- The rate of increase over time was highest for scalp and neck and for upper extremity melanoma, which surpassed trunk melanomas as the most common anatomic site in 2013.
- Melanoma incidence rate per 100,000 people was higher in rural counties compared with urban (46.7 vs 39.4).
- 31.5% of Utah melanoma patients reside in rural counties.
- There was no difference in anatomic site or stage of melanoma between county type.
- Most patients in urban and rural counties were diagnosed by a dermatologist, but rural patients were more likely to be seen by a primary care provider.
- Rural patients had their melanoma diagnosed within a rural county most of the time (76.6%).

Author contributions

All authors contributed to the conception of the work, and acquisition, analysis and interpretation of data. TL Bowles and C Sweeney participated in drafting of the work. J Snyder, J Gygi, B Bott, D Wray, TJ Yeatman and WT Sause were involved in critical revisions of the work. All authors gave final approval of the version to be published and were agree to be accountable for all aspects of the work.

Acknowledgments

The authors are grateful for the contributions of B Foy and S Firth, to the planning of the project and input on the analysis and to JR Bednarik for illustrative work. Additional thanks to D Navez and K Meade who assisted with chart review.

Financial & competing interests disclosure

This study is funded by Twine Clinical Consulting LLC (UT, USA). Utah Population Database is supported by NIH P30 CA2014. Utah Cancer Registry is supported by NIH Contract HHSN261201800016I and CDC Cooperative Agreement NU58DP0063200. TL Bowles is receiving time and effort support from Genentech for a melanoma prevention study and is the principal investigator for melanoma clinical studies sponsored by Amgen, Replimune and Polynoma. D Wray is a salaried employee of Twine Clinical Consulting LLC (Twine). Twine received grant funding from Genentech related to the work described herein. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

No writing assistance was utilized in the production of this manuscript.

Ethical conduct of research

The study was approved by the Institutional Review Boards at Intermountain Healthcare and the University of Utah.

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