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Characterization of Telehealth Use in Veterans with Spinal Cord Injuries and Disorders

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Et al.

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Short Running Title: Characterization of Telehealth Use

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Abstract

Background: Individuals with spinal cord injuries and disorders (SCI/D) require frequent interdisciplinary health care to address impairments in mobility, autonomic functions, and secondary complications. Telehealth has the capacity to substantially transform healthcare delivery and improve care by increasing access and communication. However, relatively little is known about telehealth use in this specific population. Here, we attempt to fill part of this gap.

Objective: To investigate the frequency and characteristics associated with telehealth use in Veterans with SCI/D.

Design: Cross-sectional, descriptive project

Setting: Veterans Health Administration (VHA) facilities

Participants: 15,028 Veterans living with SCI/D whom received services from the VHA SCI/D System of Care.

Intervention: Not applicable

Outcome Measures: Frequency and characteristics associated with VHA telehealth utilization.

Results: Of the 15,028 Veterans with SCI/D included in the evaluation, 17% used some form of telehealth in VHA Fiscal Year (FY)2017. Veterans over the age of 65 had lower odds (OR = 0.88, $p < 0.05$, CI: 0.80-0.98) of using telehealth. Being Caucasian (OR = 1.29, $p < 0.01$, CI:

1.09-1.52), living in rural areas (OR =1.16, $p < 0.01$, CI: 1.05-1.28), living greater distances away from the VHA ($p < 0.01$ for all distances), and being in priority group 8, meaning that Veterans have higher copayment requirements (OR=1.46, $p < 0.001$, CI: 1.19-1.81), were all significantly associated with greater odds of telehealth use. The most frequent types of telehealth used were real-time clinical video and store-and-forward between a provider and patient within the same hub network.

Conclusion: There are opportunities to increase telehealth adoption in the SCI/D arena. The findings from this project highlight which Veterans are currently using telehealth services, as well as gaps regarding telehealth adoption in this population.

Key words: Spinal Cord Injuries and Disorders, Spinal Cord Injury, Telehealth, Veterans

Introduction

Spinal cord injuries and disorders (SCI/D) can result in significant, life-long disabilities that substantially alter one's life physically, emotionally, and socially. Current estimates indicate that up to 1.2 million individuals are living with an SCI/D in the United States alone (1, 2), with 17,700 new cases a year (3). The Veterans Health Administration (VHA) provides comprehensive care to nearly 17,500 Veterans with SCI/D each year (4), making it the single largest integrated network of care for persons living with SCI/D. Individuals with SCI/D require frequent interdisciplinary health care to address impairments in mobility and autonomic functions (5, 6), as well as secondary complications including bowel or bladder dysfunction (7),

pressure injuries (8), pain (9, 10), and depression (11–14). One of the major barriers to accessing health care that individuals with SCI/D (especially Veterans) face are difficulties with transportation from their home to healthcare facilities (15–17).

In effort to increase access to high-quality, lifelong SCI/D care for Veterans across the nation, the VHA SCI/D System of Care is organized as an integrated hub-and-spoke network. This network is comprised of 25 regional SCI/D Centers (hub sites) that provide primary and specialty care by interdisciplinary clinical teams and over 120 additional VHA facilities designated as spoke sites (consisting of a physician, nurse, and social worker to provide primary and some types of specialty care for Veterans with SCI/D) (18). Telehealth technologies offer an additional strategy for improving access to healthcare services for persons with SCI/D. This is particularly pertinent now during the COVID-19 outbreak, when visiting a health care facility in-person can pose significant risks of infection. Over the past several years, the VHA has made a considerable investment in the national implementation of telehealth technologies. Telehealth comes in two forms: synchronous forms that encompass the use of interactive telephone or video conferencing either to the patient's home (home telehealth) or to a separate healthcare facility (clinical video telehealth; CVT); and asynchronous forms that include the store-and-forward (S&F) technologies that save and forward (via email or messaging) text, documents or images. Examples of store-and-forward encounters include transmission of clinical information such as bone density scan results, lab test results, radiological results/images, pressure wound images, as well as educational health material like mental health videos and wound care support

information. Telehealth across the VHA SCI/D System of Care also supports services such as transitions of care (when a Veteran transfers from one VHA facility to another), specialty and medical services, home evaluations, and health training/education.

In recent years, a small number of studies investigating the benefits of telehealth use in Veterans with SCI/D have been conducted. Hill et al. investigated the use of telehealth for pressure injury evaluation in Veterans with SCI/D (19) and found that clinical video telehealth (CVT) was equally as effective as in-person healthcare services for diagnosing and clinically assessing pressure injuries in this population. Additionally, a modeled analysis study focused on Veterans with SCI/D found reductions in pressure injury costs and progression (to stage III and stage IV) when using telehealth (20). Studies outside VHA have also indicated the utility of telehealth technologies for improving functional status and quality of life, decreasing depressive symptoms, and reducing rehospitalizations (21, 22). Aside from these interventional studies, little is actually known about telehealth use in the SCI/D population. In order to best support the implementation and use of telehealth within the context of SCI/D care, we need to understand which Veterans with SCI/D are using telehealth services, and what they are using them for, to identify needs for additional support. The aim of this project was to investigate the frequency and characteristics associated with telehealth use in Veterans with SCI/D who receive VHA care, and examine the most common types of telehealth utilized in this population.

Methods

Population

Our cohort for this project was obtained from the VHA's Allocation Resource Center list (ARC), which identifies Veterans with SCI/D based on SCI/D diagnostic codes (*23*). We identified 64,824 Veterans with SCI/D using the ARC list. We excluded 39,752 of those Veterans due to death prior to fiscal year (FY) 2017 and an additional 4,575 due to diagnoses of amyotrophic lateral sclerosis (ALS), multiple sclerosis (MS), Acute Myelitis, Guillian-Barre Syndrome, 594 due to missing demographic data, and another 4,875 that did not have utilization for the project period. After all exclusions, the final cohort (Figure 1) consisted of 15,028 Veterans living with SCI/D who received services from the VHA SCI/D System of Care during FY2017.

Data Sources and Measures

Patient Characteristics. Data on patient characteristics (e.g., age, race, sex, ethnicity, rurality, geographic location, VHA priority group), and common secondary conditions (e.g. pressure injuries, urinary tract infections, depression, pain and diabetes) for all individuals in our final cohort were obtained from VHA's Corporate Data Warehouse. Secondary conditions were identified using relevant International Classification of Diseases (ICD)-9/10 codes (see supplemental Table 1). Individuals who had at least 1 relevant diagnostic code in FY2017 were considered to have the condition. Geographic location was derived using Veterans' home ZIP code, and distance from VHA was a calculation from patients' home ZIP code to the nearest

VHA facility (i.e., not specifically an SCI/D hub). The region designated as 'other' refers to areas outside of mainland U. S. (e.g. Guam, Puerto Rico and the Virgin Islands). Rural Urban Commuting Areas (RUCA) were used to identify type of town (rural vs urban). We also identified the VHA priority group for each Veteran in our cohort. The VHA priority group is a rating that VHA uses to guide Veteran copayment requirements. In general, Veterans living with more disability and/or having lower income have higher priority numbers (group 1 being highest priority) (Supplemental Table 3).

Injury characteristics were obtained from the Spinal Cord Injuries and Disorders Outcomes (SCIDO) historical registry data set. Missing/unknown categories are noted where appropriate.

Telehealth Use Data. We separated Veterans with SCI/D into two groups depending on telehealth use: (1) those utilizing at least one telehealth service in 2017 (Telehealth), and (2) those not utilizing telehealth services (No Telehealth). We used primary or secondary stop codes to identify use of specific telehealth services. Primary stop codes identified telehealth services specific for SCI/D or VA telehealth programs. Secondary codes included asynchronous and synchronous forms of telehealth (Supplemental Table 2).

Analysis

All analyses were performed using STATA MP Version 14.2 software (StataCorp, College Station, TX). Chi-squared tests were estimated to compare patient demographics, injury, VHA priority groups and geographic characteristics between Telehealth and No Telehealth groups. Unadjusted and adjusted logistic regression analyses were used to determine associations of patient variables (demographics and injury characteristics, geographic location, VHA priority groups and existence of common secondary complications) with telehealth use (outcome variable). Tables report results of adjusted models. An alpha level of 0.05 was used to determine statistical significance. We also described telehealth use among the Veterans in our cohort broken out by telehealth type (e.g. synchronous, asynchronous), on a person-level. The work presented in this manuscript was reviewed by the VA Hospital Institutional Review Board and designated as program evaluation for quality improvement purposes, exempting it from further oversight.

Results

Characteristics of SCI/D Cohort (Table 1)

Of the 15,028 Veterans with SCI/D included in the project, 17.4% (2,617) used some form of telehealth in 2017 compared to 82.6% (12,411) that did not. Overall, our cohort mainly consists of Caucasian males, with a large percentage having an injury for at least 10 years (45.4%). Geographically, the majority of our cohort resided in urban areas (65.8%), with more than 60.0% of our cohort within 20 miles of any VHA facility (not specifically an SCI/D center).

Relative percentages of injury and demographic characteristics within each group (No Telehealth and Telehealth) were comparable. However, a higher percentage of individuals in VA priority category 8 were in the Telehealth compared to the No Telehealth group. There were also differences in the proportion of Veterans diagnosed with secondary conditions who did and did not use telehealth (Table 1).

Characteristics Associated with Telehealth Use (Table 2)

When we examined characteristics associated with telehealth use, Caucasian Veterans had greater odds of using telehealth compared to Veterans that were not Caucasian (OR = 1.29, p = 0.003, CI: 1.09 – 1.52). Living in rural areas, compared to urban areas, was significantly associated with greater odds of being a telehealth user (OR = 1.16, p = 0.004, CI: 1.05 – 1.28). Being greater distances away from the VHA (OR $\geq$ 1.29, p < 0.001 for all distances) or in VHA priority groups 6 (OR = 1.43, p = 0.001, CI: 1.15 – 1.77) and 8 (OR = 1.46, p < 0.001, CI: 1.19 – 1.81) were also significantly associated with greater odds of telehealth use compared to those that lived <5 miles away or were in a higher VHA priority group, respectively. Veterans who were over the age of 65 had lower odds (OR = 0.88, p = 0.01, CI: 0.80 – 0.98) of using telehealth compared to those that were under 65.

Having pain (OR = 1.30, p < 0.001, CI: 1.15 – 1.47), hypertension (OR = 1.16, p = 0.004, CI: 1.05 – 1.29), pressure injuries (OR = 1.27, p < 0.001, CI: 1.15 – 1.41), post-traumatic stress disorder (OR = 1.33, p < 0.001, CI: 1.19 – 1.48), depression (OR = 1.31, p < 0.001, CI:1.19 – 1.45) and/or panic disorders (OR = 1.14, p = 0.02, CI:1.02 – 1.26) were all significantly

associated with greater odds of using telehealth compared to not having these conditions. Additionally, having diabetes was significantly ($p < 0.001$) associated with greater odds of telehealth use by almost two-fold (OR = 1.99, CI: 1.81 – 2.19).

Types of Telehealth Use (Table 3)

Overall, 2,617 person-level telehealth encounters were identified during VHA fiscal years (FY)2017 (Table 3). These encounters are grouped by primary codes (Table 3A) indicating general categories of telehealth use; and secondary codes (Table 3B) detailing more specific information on the sites involved in the telehealth encounter (i.e., sites within the same hub, between hubs or to non-VA sites). Of the FY2017 encounters we identified, 1,148 were related to SCI/D telehealth/Virtual Care (Table 3A). These encounters include anything from clinical examinations/direct care to secure messaging and/or eConsults. There were also 117 encounters (Table 3A) related to Home Telehealth Programs (i.e. Care Coordination), a national home monitoring program for Veterans with chronic conditions (which includes those with SCI/D) (24). We then examined secondary codes for telehealth to further examine how telehealth (synchronous and asynchronous) is being used for communication or consultations within and/or outside the VHA system of care.

The most frequent types of synchronous telehealth encounters were scheduled, real-time CVT by a provider to a patient within their hub (Table 3B: 2,173 encounters). These encounters include telehealth between a provider and a patient who is at home and a provider and a patient who is at a spoke site within the same hub. Real-time CVT visits across VHA hub networks were

also present in 2017, but at a substantially lower frequency (Table 3B: 304 encounters). Real-time CVT encounters related to emergency, unscheduled consultations (Table 3B: 29 encounters) and to non-VHA sites (Table 3B: 3 encounters) were also infrequent.

The most frequent types of asynchronous (Table 3B; 965 encounters) telehealth were store-and-forward encounters to patients or providers within the same hub; these encounters often involve providers communicating patient health information to patients or other providers. Store-and-forward telehealth between two different hub networks was also common (322 encounters). However, store-and-forward telehealth with non-VHA sites was almost non-existent (only 1 encounter). For more details regarding exact secondary codes for each category (in both synchronous and asynchronous forms) (Supplemental Table 2).

Discussion

Currently, relatively little is known about characteristics and frequency of telehealth use in Veterans with SCI/D. We found that approximately 17% of Veterans with SCI/D used VHA telehealth services during FY2017. While this number may seem low, it is higher than telehealth use in the general Veteran population, which hovers around 12% (25). The relatively slow adoption of telehealth in general has been noted by others (26–28), and is not exclusive to the SCI/D population; however, powerful contemporary drivers, specifically the ongoing COVID-19 pandemic, is poised to change that trend.

Non-technological barriers (physician buy-in, equipment costs, regulatory/legal issues, workflow challenges, insurance costs) are the most discussed and heavily cited issues regarding telehealth uptake (29–32), but patient technology literacy has also begun to be explored. Past research has shown that face-to-face visits are still preferred, with technology considered a complement to in-person care (29, 30, 33). Anecdotally, SCI/D providers have also noted that many Veterans with SCI/D prefer face-to-face visits. In addition, traditionally low telehealth adoption rates could partially be explained by Veteran socio-demographic factors. Studies on Veteran technology literacy, exemplified by computer and/or internet use, have shown that older male Veterans with fair/poor health have lower computer/internet use (33, 34). These studies also show that lower income and education levels are significantly associated with less computer and Internet use. Like the general Veteran population, Veterans with SCI/D are largely older males, with lower levels of income and education, and poorer health status. As such, this group of individuals may be less familiar and comfortable with technology, thus requiring targeted outreach and education efforts to support telehealth adoption. Additionally, for this particular group of Veterans, functional limitations (e.g., issues with hand or finger function) could also play a role in lower telehealth adoption. Use of voice and eye-controlled technology options are not yet widespread, and not readily available throughout the VHA system. However, the availability of these devices has the potential to further improve telehealth adoption for Veterans with SCI/D.

Previous work by Adams et al. (35) found that Veterans living > 30 miles from a primary care center and > 60 miles from a secondary care center had 2.7 greater odds of interactive telehealth use. This same study also showed that interactive telehealth use was more likely among rural and highly rural Veterans, after accounting for VHA and personal characteristics. Our analysis mirrors those results, but with reduced odds. Specifically, we found those living greater than 40 miles from the VA had ~1.50 greater odds of telehealth use compared to those <5 miles, and rural Veterans with SCI/D had 1.6 greater odds of telehealth use compared to those in urban areas after accounting for socio-demographic characteristics. Veterans with SCI/D in priority groups 8 also had 1.5 greater odds of telehealth use compared to those in lower priority group status. This is not surprising given that these individuals have higher income status and/or no service-connected disability (and agree to co-pays). These two factors can be indicative of Veterans with SCI/D currently working, making availability to travel to the VHA for appointments even more difficult.

Secondary conditions in individuals with SCI/D have been shown to be associated with increased health (medical or specialty) care utilization (6, 36, 37); and telehealth could improve access to routine, quality care. Secondary conditions (both physical and psychological) in our cohort had greater odds of telehealth use. Several telehealth services and/or education programs regarding the care and management of these secondary complications for Veterans with SCI/D exist. Examples of the most common VHA telehealth services/programs include pressure injury diagnosis and follow up (38, 39), weight management (TeleMOVE) (40), and mental health

services (41). Other telehealth programs include: the telerehabilitation program (42) that offers individualized in-home rehabilitation services for weight management, pressure injuries, or counseling; the Spinal Cord Injury Disease Management Protocol program (43) that offers specialty care (including rehabilitation and psychology) via telehealth to newly injured Veterans; and the Care Coordination/Home telehealth program (24) that uses existing disease management programs to assist with care in Veterans' homes. Despite availability of all of these telehealth programs, numbers of SCI/D Veterans with secondary conditions who participated in telehealth were still relatively low. This represents an area for targeted outreach and educational efforts. This may prove especially important given increases in frequency of secondary complications with age (44–46).

Interestingly, the only secondary complication that was not associated with greater of telehealth use in Veterans with SCI/D was existence of urinary tract infections. This could be because urinary tract infection care involves in-person procedures or tests (physical examinations, culture testing and IV administration of antibiotics). Although some of these procedures could also be done at outpatient clinics (i.e., urine cultures) with results of tests delivered via CVT back to the SCI/D Center, many urinary specialists prefer to do these in-house. Outpatient clinics also lack the clinical beds to house the Veteran if intravenous therapy (IV) antibiotics are needed. Educational material regarding urinary tract infection prevention practices would likely be the only material delivered via telehealth for this secondary complication.

The current project also found that the most frequently used synchronous telehealth was real-time CVT between a provider and patient within the same hub network, and the most frequent asynchronous telehealth was for home monitoring programs and store-and-forward between providers and patients within the same hub. Currently, there is very little use of telehealth outside of the VHA network. Other preliminary work by our group suggests that the majority of Veterans with SCI/D exclusively use the VHA for their health services, thus limiting the need for telehealth between the VHA and outside providers (data not published).

Limitations

Telehealth data collected for this project was limited to one specific year. This should be taken into consideration when extrapolating or generalizing results. Additionally, the registry from which our cohort was derived may not include all Veterans in the U.S. with SCI/D, and a portion of Veterans with SCI/D that largely use non-VHA healthcare may have been missed. Based on other work, however, we believe that the number missed is very low. Due to the clinical nature of the registry, not all SCI/D characteristics were available (i.e. level and type of injury); the high prevalence of missing data for some of these covariates may introduce some bias and results should be interpreted with this potential bias in mind. This project also lacks additional information explaining what specific program or health condition telehealth encounters were used for, and there is also no way to identify whether some encounters were provider to patient or provider to provider. Future studies capable of collecting this data via

structured interviews/surveys of VHA staff who use telehealth, or detailed retrospective chart reviews are needed. Lastly, this data was collected prior to the rapid adoption of telehealth seen during the COVID-19 pandemic. It is possible that telehealth use in Veterans with SCI/D is substantially higher at this time.

Conclusion

Despite availability, Veterans with SCI/D have been slow to use telehealth services thus far, even in the face of significant advances made throughout the VHA regarding access to telehealth and the technology supporting these healthcare services. Rurality, distance from the VHA and existence of secondary complications are associated with greater odds of telehealth use in this population. Among those who use telehealth, the most frequent types of telehealth used were real-time clinical video and store and forward transmissions between patients and providers within the same hub. There is a need for targeted outreach and education efforts within VHA's SCI/D population to increase telehealth adoption; with special attention paid to those with secondary complications, below the age of 65, lower VHA priority status, and/or significant functional limitations.

References

1. Christopher and Dana Reeve Foundation, One Degree of Separation (2009).

2. National Spinal Cord Injury Statistical Center (NSCISC), Spinal Cord Injury (SCI) Facts and Figures at a Glance (2015), (available at https://www.nscisc.uab.edu/Public/Facts%202015.pdf).

3. NSCIS-Facts and Figures - 2018.pdf, (available at https://www.nscisc.uab.edu/Public/Facts%20and%20Figures%20-%202018.pdf).

4. Department of Veterans Affairs, VA research on Spinal Cord Injury.

5. C. M. Curtin, P. A. Suarez, L. A. Di Ponio, S. M. Frayne, Who are the women and men in Veterans Health Administration's current spinal cord injury population? *J Rehabil Res Dev*. **49**, 351–360 (2012).

6. D. M. Dryden, L. D. Saunders, B. H. Rowe, L. A. May, N. Yiannakoulias, L. W. Svenson, D. P. Schopflocher, D. C. Voaklander, Utilization of health services following spinal cord injury: a 6-year follow-up study. *Spinal Cord*. **42**, 513–525 (2004).

7. S. J. T. Guilcher, B. C. Craven, M. A. McColl, L. Lemieux-Charles, T. Casciaro, S. B. Jaglal, Application of the Andersen's health care utilization framework to secondary complications of spinal cord injury: a scoping review. *Disabil Rehabil*. **34**, 531–541 (2012).

8. A. Scheel-Sailer, A. Wyss, C. Boldt, M. W. Post, V. Lay, Prevalence, location, grade of pressure ulcers and association with specific patient characteristics in adult spinal cord injury patients during the hospital stay: a prospective cohort study. *Spinal Cord*. **51**, 828–833 (2013).

9. J. J. E. Adriaansen, F. W. A. van Asbeck, E. Lindeman, L. H. V. van der Woude, S. de Groot, M. W. M. Post, Secondary health conditions in persons with a spinal cord injury for at least 10 years: design of a comprehensive long-term cross-sectional study. *Disabil Rehabil*. **35**, 1104–1110 (2013).

10. B. Etingen, S. Miskevics, S. L. LaVela, The relationship between pain inerference and psychological well-being among Veterans with spinal cord injury/disorders. *Journal of Neuroscience Nursing*. **In Press** (2017).

11. J. R. Fann, C. H. Bombardier, J. S. Richards, D. G. Tate, C. S. Wilson, N. Temkin, PRISMS Investigators, Depression after spinal cord injury: comorbidities, mental health service use, and adequacy of treatment. *Arch Phys Med Rehabil*. **92**, 352–360 (2011).

12. P. M. Ullrich, R. K. Lincoln, M. J. Tackett, S. Miskevics, B. M. Smith, F. M. Weaver, Pain, depression, and health care utilization over time after spinal cord injury. *Rehabil Psychol*. **58**, 158–165 (2013).

13. V. K. Noonan, N. Fallah, S. E. Park, F. S. Dumont, J. Leblond, J. Cobb, L. Noreau, Health care utilization in persons with traumatic spinal cord injury: the importance of multimorbidity and the impact on patient outcomes. *Top Spinal Cord Inj Rehabil*. **20**, 289–301 (2014).

14. M. W. M. Post, C. M. C. van Leeuwen, Psychosocial issues in spinal cord injury: a review. *Spinal Cord*. **50**, 382–389 (2012).

15. K. Knox, N. Rohatinsky, M. Rogers, D. Goodridge, G. Linassi, *Access to traumatic spinal cord injury care in Saskatchewan, Canada: A qualitative study on community healthcare provider perspectives* (2014), vol. 3.

16. S. L. LaVela, B. Smith, F. M. Weaver, S. A. Miskevics, Geographical proximity and health care utilization in veterans with SCI&D in the USA. *Soc Sci Med*. **59**, 2387–2399 (2004).

17. D. Goodridge, M. Rogers, L. Klassen, B. Jeffery, K. Knox, N. Rohatinsky, G. Linassi, Access to health and support services: perspectives of people living with a long-term traumatic spinal cord injury in rural and urban areas. *Disabil Rehabil*. **37**, 1401–1410 (2015).

18. Department of Veterans Affairs, *VHA Handbook 1176.01-SCI&D System of Care* (2011; http://vaww.sci.va.gov).

19. M. L. Hill, R. C. Cronkite, D. T. Ota, E. C. Yao, B. J. Kiratli, Validation of home telehealth for pressure ulcer assessment: a study in patients with spinal cord injury. *J Telemed Telecare*. **15**, 196–202 (2009).

20. M. W. Smith, M. L. Hill, K. L. Hopkins, B. J. Kiratli, R. C. Cronkite, A modeled analysis of telehealth methods for treating pressure ulcers after spinal cord injury. *Int J Telemed Appl*. **2012**, 729492 (2012).

21. L. Dallolio, M. Menarini, S. China, M. Ventura, A. Stainthorpe, A. Soopramanien, P. Rucci, M. P. Fantini, THRIVE Project, Functional and clinical outcomes of telemedicine in patients with spinal cord injury. *Arch Phys Med Rehabil*. **89**, 2332–2341 (2008).

22. V. L. Phillips, S. Vesmarovich, R. Hauber, E. Wiggers, A. Egner, Telehealth: reaching out to newly injured spinal cord patients. *Public Health Rep*. **116 Suppl 1**, 94–102 (2001).

23. B. M. Smith, C. T. Evans, P. Ullrich, S. Burns, M. Guihan, S. Miskevics, S. L. LaVela, S. Rajan, F. M. Weaver, Using VA data for research in persons with spinal cord injuries and disorders: lessons from SCI QUERI. *J Rehabil Res Dev*. **47**, 679–688 (2010).

24. A. Darkins, P. Ryan, R. Kobb, L. Foster, E. Edmonson, B. Wakefield, A. E. Lancaster, Care Coordination/Home Telehealth: the systematic implementation of health informatics, home telehealth, and disease management to support the care of veteran patients with chronic conditions. *Telemed J E Health*. **14**, 1118–1126 (2008).

25. Department of Veterans Affairs, VA Telehealth Services Fact Sheet (2018), (available at https://www.va.gov/anywheretoanywhere/Telehealth_Services_factsheet.PDF).

26. M. J. Field, J. Grigsby, Telemedicine and Remote Patient Monitoring. *JAMA*. **288**, 423–425 (2002).

27. S. H. Stumpf, R. R. Zalunardo, R. J. Chen, Barriers to telemedicine implementation. Usually it's not technology issues that undermine a project--it's everything else. *Healthc Inform*. **19**, 45–48 (2002).

28. R. L. Bashshur, G. Shannon, E. A. Krupinski, J. Grigsby, Sustaining and realizing the promise of telemedicine. *Telemed J E Health*. **19**, 339–345 (2013).

29. V. R. A. Call, L. D. Erickson, N. K. Dailey, B. L. Hicken, R. Rupper, J. B. Yorgason, B. Bair, Attitudes Toward Telemedicine in Urban, Rural, and Highly Rural Communities. *Telemed J E Health*. **21**, 644–651 (2015).

30. J. N. Haun, M. Chavez, K. Nazi, N. Antinori, C. Melillo, B. A. Cotner, W. Hathaway, A. Cook, N. Wilck, A. Noonan, Veterans' Preferences for Exchanging Information Using Veterans Affairs Health Information Technologies: Focus Group Results and Modeling Simulations. *J. Med. Internet Res.* **19**, e359 (2017).

31. R. N. Martinez, T. P. Hogan, S. Balbale, K. Lones, B. Goldstein, C. Woo, B. M. Smith, Sociotechnical Perspective on Implementing Clinical Video Telehealth for Veterans with Spinal Cord Injuries and Disorders. *Telemed J E Health*. **23**, 567–576 (2017).

32. R. N. Martinez, T. P. Hogan, K. Lones, S. Balbale, J. Scholten, D. Bidelspach, N. Musson, B. M. Smith, Evaluation and Treatment of Mild Traumatic Brain Injury Through the Implementation of Clinical Video Telehealth: Provider Perspectives From the Veterans Health Administration. *PM R*. **9**, 231–240 (2017).

33. S. L. LaVela, G. Schectman, J. Gering, S. M. Locatelli, A. Gawron, F. M. Weaver, Understanding health care communication preferences of veteran primary care users. *Patient Educ Couns*. **88**, 420–426 (2012).

34. D. K. McInnes, A. L. Gifford, L. E. Kazis, T. H. Wagner, Disparities in health-related internet use by US veterans: results from a national survey. *Inform Prim Care*. **18**, 59–68 (2010).

35. S. V. Adams, M. J. Mader, M. J. Bollinger, E. S. Wong, T. J. Hudson, A. J. Littman, Utilization of Interactive Clinical Video Telemedicine by Rural and Urban Veterans in the Veterans Health Administration Health Care System. *J Rural Health* (2019), doi:10.1111/jrh.12343.

36. R. Hamilton, S. Driver, S. Noorani, L. Callender, M. Bennett, K. Monden, Utilization and access to healthcare services among community-dwelling people living with spinal cord injury. *J Spinal Cord Med*. **40**, 321–328 (2017).

37. J. St. Andre, B. Smith, K. Stroupe, S. Burns, C. Evans, D. Ripley, K. Li, Z. Huo, T. Hogan, F. Weaver, A Comparison of Costs and Health Care Utilization for Veterans with Traumatic and Nontraumatic Spinal Cord Injury. *Topics in Spinal Cord Injury Rehabilitation*. **16**, 27–42 (2011).

38. M. L. Hill, R. C. Cronkite, D. T. Ota, E. C. Yao, B. J. Kiratli, Validation of home telehealth for pressure ulcer assessment: a study in patients with spinal cord injury. *J Telemed Telecare*. **15**, 196–202 (2009).

39. V. L. Phillips, A. Temkin, S. Vesmarovich, R. Burns, L. Idleman, Using telehealth interventions to prevent pressure ulcers in newly injured spinal cord injury patients post-discharge. Results from a pilot study. *Int J Technol Assess Health Care*. **15**, 749–755 (1999).

40. D. E. Goodrich, J. C. Lowery, J. A. Burns, C. R. Richardson, The Phased Implementation of a National Telehealth Weight Management Program for Veterans: Mixed-Methods Program Evaluation. *JMIR Diabetes*. **3**, e14 (2018).

41. E. A. Abel, S. L. Shimada, K. Wang, C. Ramsey, M. Skanderson, J. Erdos, L. Godleski, T. K. Houston, C. A. Brandt, Dual Use of a Patient Portal and Clinical Video Telehealth by Veterans with Mental Health Diagnoses: Retrospective, Cross-Sectional Analysis. *J. Med. Internet Res.* **20**, e11350 (2018).

42. M. Galea, J. Tumminia, L. M. Garback, Telerehabilitation in spinal cord injury persons: a novel approach. *Telemed J E Health*. **12**, 160–162 (2006).

43. C. Woo, J. M. Seton, M. Washington, S. C. Tomlinson, D. Phrasavath, K. R. Farrell, B. Goldstein, Increasing specialty care access through use of an innovative home telehealth-

based spinal cord injury disease management protocol (SCI DMP). *J Spinal Cord Med*. **39**, 3–12 (2016).

44. J. J. E. Adriaansen, L. E. M. Ruijs, C. F. van Koppenhagen, F. W. A. van Asbeck, G. J. Snoek, D. van Kuppevelt, J. M. A. Visser-Meily, M. W. M. Post, Secondary health conditions and quality of life in persons living with spinal cord injury for at least ten years. *J Rehabil Med*. **48**, 853–860 (2016).

45. J. J. E. Adriaansen, M. W. M. Post, S. de Groot, F. W. A. van Asbeck, J. M. Stolwijk-Swüste, M. Tepper, E. Lindeman, Secondary health conditions in persons with spinal cord injury: a longitudinal study from one to five years post-discharge. *J Rehabil Med*. **45**, 1016–1022 (2013).

46. J. E. Frontera, P. Mollett, Aging with Spinal Cord Injury: An Update. *Phys Med Rehabil Clin N Am*. **28**, 821–828 (2017).

Tables and Legends

Table 1. Comparisons of SCI/D Cohort Demographics, Injury Characteristics and Secondary Conditions Among Veterans who Did vs. Did Not Use Telehealth[a].

		No Telehealth	**Telehealth**	**Total**
		% (#)	% (#)	% (#)
	P-value	82.6 (12,411)	17.4 (2,617)	100.0 (15,028)
Injury Characteristics				
Level of injury	0.01			
Paraplegia		30.3 (3,762)	31.3 (820)	30.5 (4,582)
Tetraplegia		30.8 (3,821)	33.0 (864)	31.2 (4,685)
Missing/unknown		38.9 (4,828)	35.7 (933)	38.3 (5,761)
Type of injury	0.004			

Traumatic		25.3 (3,141)	23.9 (625)	25.1 (3,766)
Non-traumatic		17.7 (2,201)	20.4 (534)	18.2 (2,735)
Missing/unknown		57.0 (7,069)	55.7 (1,458)	56.7 (8,527)
Duration of injury	0.001			
<4 yrs		8.3 (1,032)	10.4 (272)	8.7 (1,304)
5-9 yrs		11.4 (1,409)	12.6 (330)	11.6 (1,739)
10 + yrs		45.4 (5,631)	45.2 (1,184)	45.4 (6,815)
Missing/unknown		35.0 (4,339)	31.8 (831)	34.4 (5,170)
Demographic Characteristics				
Male	0.04	96.0 (11,918)	96.9 (2,535)	96.2 (14,453)
Age	0.02			
18 – 65		53.1 (6,589)	50.5 (1,322)	52.6 (7,911)
65 +		46.9 (5,822)	49.5 (1,295)	47.4 (7,117)
Race				
African American	<0.001	23.0 (2,851)	19.7 (515)	22.4 (3,366)
Caucasian	<0.001	67.4 (8,367)	73.2 (1,916)	68.4 (10,283)
Ethnicity				
Hispanic	0.02	5.8 (714)	7.0 (182)	6.0 (896)
Rurality	<0.001			
Urban		66.9 (8,306)	60.3 (1,578)	65.8 (9,884)
Rural		33.1 (4,105)	39.7 (1,039)	34.2 (5,144)
VA Priority Category	<0.001			
Group 1		23.2 (2,880)	21.3 (558)	22.9 (3,438)
Group 2		4.7 (577)	4.6 (121)	4.6 (698)
Group 3		9.8 (1,212)	10.6 (276)	9.9 (1,488)
Group 4		4.2 (516)	4.6 (121)	4.2 (637)
Group 5		39.8 (4,934)	37.0 (969)	39.3 (5,9030
Group 6		4.0 (495)	5.9 (155)	4.3 (650)
Group 7		9.7 (1,208)	9.6 (250)	9.7 (1,458)
Group 8		4.8 (589)	6.4 (167)	5.0 (756)
Geographic Location	<0.001			
Midwest		18.4 (2,289)	20.3 (532)	18.8 (2,821)
Northeast		9.5 (1,182)	16.0 (419)	10.7 (1,601)
South		48.5 (6,020)	41.5 (1,086)	47.3 (7,106)
West		22.3 (2,769)	19.5 (509)	21.8 (3,278)
Other		1.2 (151)	2.7 (71)	1.5 (222)
Distance to VA	<0.001			

<5		34.9 (4,331)	27.2 (713)	33.6 (5,044)
5 – 19		30.3 (3,762)	31.2 (816)	30.5 (4,578)
20 – 39		17.0 (2,111)	20.7 (542)	17.7 (2,653)
40 – 59		8.8 (1,096)	10.2 (266)	9.1 (1,362)
60 +		9.0 (1,111)	10.7 (280)	9.3 (1,391)
Secondary Conditions				
General health				
Pain	<0.001	79.5 (9,863)	85.6 (2,240)	80.5 (12,103)
Diabetes	<0.001	29.5 (3,663)	47.3 (1,239)	32.6 (4,902)
Hypertension	<0.001	62.1 (7,706)	70.5 (1,844)	63.6 (9,550)
Pressure Injuries	<0.001	33.0 (4,101)	40.2 (1,053)	34.3 (5,154)
Urinary Tract Infections	<0.001	47.7 (5,921)	51.4 (1,345)	48.4 (7,266)
Mental health				
PTSD[a]	<0.001	21.5 (2,673)	30.0 (784)	23.0 (3,457)
Depression	<0.001	43.5 (5,392)	55.4 (1,449)	45.5 (6,841)
Panic disorder/anxiety	<0.001	21.5 (2,673)	27.6 (721)	22.6 (3,394)

[a]Post-Traumatic Stress Disorder

Table 2. Factors Associated with Telehealth Use[a]

	OR	*Stnd. Error*	*P > |z|*	*95% Conf. Interval*
Injury Characteristics				
Level of Injury (ref: paraplegia)				
Tetraplegia	*0.95*	*0.05*	*0.40*	*0.85 – 1.07*
Missing/unknown	*0.76*	*0.07*	*0.003***	*0.64 – 0.91*
Type of Injury (ref: Non-traumatic)				
Traumatic	*0.98*	*0.07*	*0.81*	*0.85 – 1.14*
Missing/unknown	*1.00*	*0.07*	*0.93*	*0.86 – 1.14*
Injury duration (ref: < 5 yrs)				
5 – 9	*0.88*	*0.08*	*0.17*	*0.73 – 1.06*
10 – 19 yrs	*0.83*	*0.08*	*0.04**	*0.70 – 1.00*
20 – 29 yrs	*0.91*	*0.09*	*0.35*	*0.75 – 1.11*
30 – 39 yrs	*0.86*	*0.09*	*0.17*	*0.70 – 1.07*

40 – 49 yrs	*0.99*	*0.11*	*0.92*	*0.79 – 1.24*
Missing/unknown	*0.94*	*0.11*	*0.58*	*0.75 – 1.18*
Demographic information				
Male (ref: female)	*1.18*	*0.15*	*0.19*	*0.92 – 1.51*
Age in yrs (ref: < 65)				
65 +	*0.88*	*0.04*	*0.01**	*0.80 – 0.98*
Marital Status (ref: not married)				
Married	*1.17*	*0.12*	*0.001**	*1.07 – 1.28*
Race				
African American (ref: Other)	*1.19*	*0.12*	*0.07*	*0.98 – 1.45*
Caucasian (ref: Other)	*1.29*	*0.11*	*0.003**	*1.09 – 1.52*
Ethnicity (ref: not Hispanic)				
Hispanic	*0.97*	*0.10*	*0.77*	*0.79 – 1.19*
Geographic Characteristics				
Region (ref: Midwest)				
Northeast	*1.70*	*0.13*	*<0.001***	*1.45 – 1.97*
South	*0.76*	*0.05*	*<0.001***	*0.67 - 0.85*
West	*0.84*	*0.06*	*0.02**	*0.73 - 0.97*
Other	*2.08*	*0.39*	*<0.001***	*1.45 – 3.00*
Rural (ref: Urban)				
Rural	*1.16*	*0.06*	*0.004**	*1.05 – 1.28*
Distance from VA				
(Ref: < 5 miles)				
5 – 19 miles	*1.29*	*0.08*	*<0.001***	*1.15 – 1.46*
20 – 39 miles	*1.55*	*0.11*	*<0.001***	*1.36 – 1.78*
40 – 59 miles	*1.50*	*0.13*	*<0.001***	*1.27 – 1.78*
60 + miles	*1.69*	*0.15*	*<0.001***	*1.43 – 2.00*
VA Priority Status				
(Ref: Group 1)				
Group 2	*0.95*	*0.11*	*0.68*	*0.76 – 1.20*
Group 3	*1.06*	*0.09*	*0.47*	*0.90 – 1.26*
Group 4	*1.23*	*0.14*	*0.07*	*0.98 – 1.55*
Group 5	*1.02*	*0.07*	*0.78*	*0.90 – 1.16*
Group 6	*1.43*	*0.16*	*0.001***	*1.15 – 1.77*
Group 7	*1.04*	*0.09*	*0.66*	*0.87 – 1.24*
Group 8	*1.46*	*0.16*	*<0.001***	*1.19 – 1.81*
Secondary Conditions				

Pain (ref: no pain)	*1.30*	*0.08*	*<0.001***	*1.15 – 1.47*
Diabetes (ref: no diabetes)	*1.90*	*0.10*	*<0.001***	*1.81 - 2.19*
Hypertension (ref: no hypertension)	*1.16*	*0.06*	*0.004**	*1.05 - 1.29*
Pressure Injury (ref: no pressure injury)	*1.27*	*0.06*	*<0.001***	*1.15 – 1.41*
Urinary Tract Infections (ref: no UTI)	*1.00*	*0.05*	*0.89*	*0.90 – 1.09*
PTSD[b] (ref: no PTSD)	*1.32*	*0.07*	*<0.001***	*1.19 – 1.48*
Depression (ref: no depression)	*1.31*	*0.07*	*<0.001***	*1.19 – 1.45*
Panic Disorder/Anxiety (ref: no panic/anxiety)	*1.14*	*0.01*	*0.02**	*1.02 – 1.26*

[a]A single asterisk (*) denotes p-values ≤ 0.01 whereas ** denotes p – values ≤ 0.001. Base values for each category are listed.
[b]Post-Traumatic Stress Disorder

Table 3. Frequency of Telehealth Use by Type of Telehealth Modality

† Encounters are at person-level: added percentages may be > 100% due to multiple encounter types per individual. Types of telehealth	Frequency # of person-encounters (out of 2,617)	Frequency Percent %[†]
A. Primary Telehealth Codes		
Spinal Cord Injury & Virtual Care	1,146	43.8
Home Telehealth Programs (Real Time CVT[a])	117	4.5
Home Telehealth Non-video (S&F[b])	575	22.0
B. Secondary Telehealth Codes		
Synchronous		
Real Time CVT within the same VHA Hub[c]	2,108	81.6
Real Time CVT across VHA Hubs[d]	296	11.3
Real Time CVT Emergency Consultation	29	11.1
Real Time CVT to Non-VHA Site	0	-
Asynchronous		
S&F within same Hub[c]	930	35.5
S&F across VHA Hubs[d]	307	11.7
S&F to Non-VHA Site	1	0.04

[a]Clinical Video Telehealth

[b]Store-and-Forward Telehealth

[c]Encounters and percentages for provider-to-patient at home, provider-to-patient at spoke, and provider-to-provider in the same hub network were combined.

[d]Encounters and percentages for provider-to-patient and provider-to-provider across different hub networks were combined.

† Encounters are at person-level: added percentages may be > 100% due to multiple encounter types per individual.

Figure and Supplemental Table Legends

Figure 1. Cohort Derivation Diagram (see attachments)

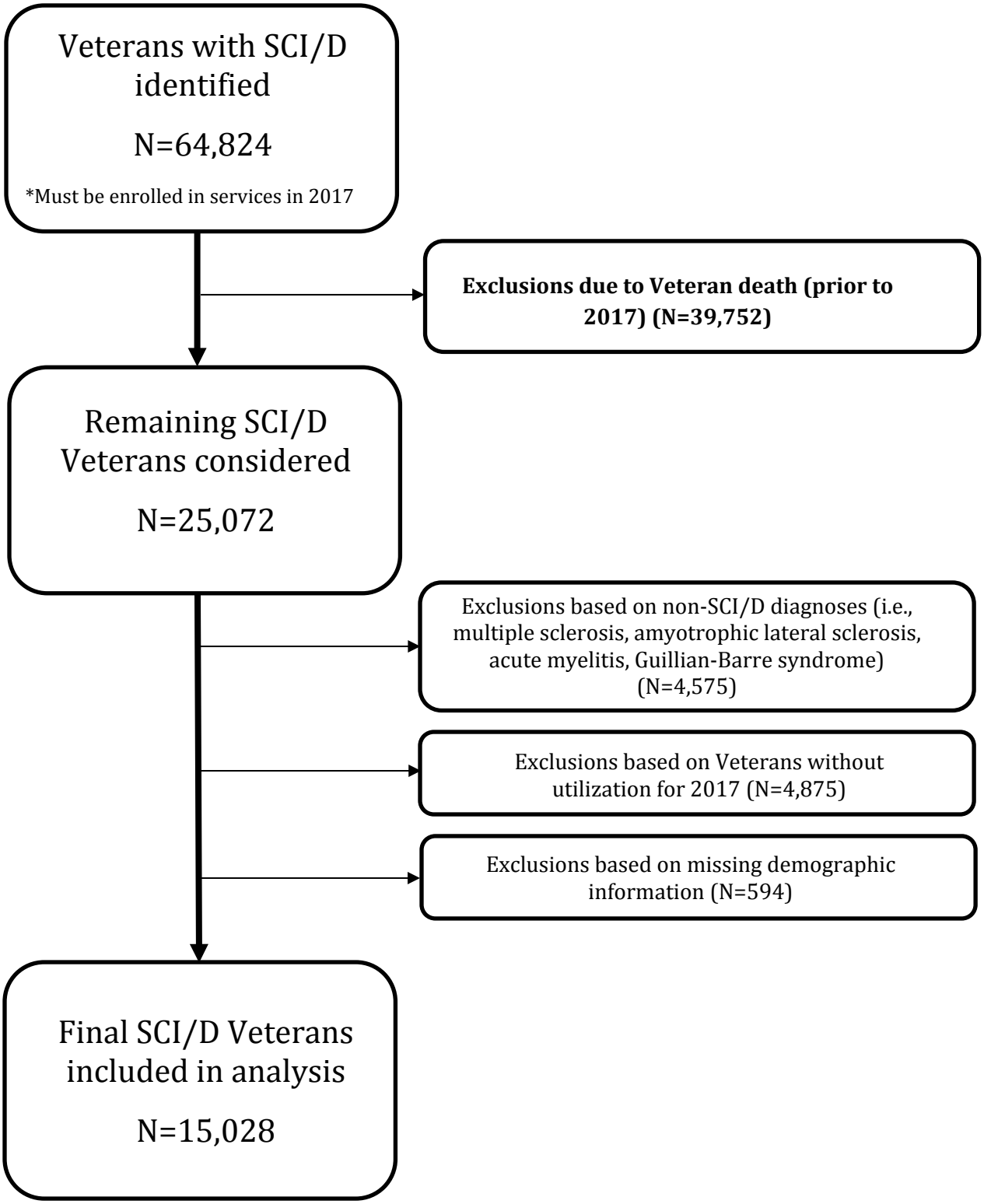

Figure 1: Cohort Derivation Diagram