

Engineering Management
Field Project

**Predicting Risk for Incidences of Homelessness
Among Veterans of Iraq and Afghanistan**

By

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This project is dedicated to the twelve homeless Veterans I met in 2014 in Madison, WI. It is further dedicated to my wife, and the people that didn't let me slip away when I transitioned. Homelessness is one step away from isolation.

Dr Stephen Metraux, at the National Center for Homelessness Among Veterans generously took the time to speak and correspond about his work, and suggest avenues of research.

Also my project advisor, Dr Tom Bowlin, who has tolerated my late submissions through two classes and now a master's project, and my committee members, Herb Tuttle and Linda Miller, for much of the same.

Executive Summary

As communities report significant decreases in Veteran homelessness from 2010 – 2015, mitigation efforts have turned from reactive care and rehabilitation to prevention. With significant populations of contemporary Veterans transitioning to civilian life from operations in Iraq and Afghanistan, there is an opportunity to adapt transition and integration processes to preclude the risk of homelessness.

This project attempts to curate priority intelligence requirements (PIR) aimed at identifying Veterans of Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn (OEF/OIF/OND) who are at risk of experiencing incidences of homelessness after ending service in the United States Army. Having developed effective PIR, this project attempts to deliver an immediate decision support tool for commanders, transition supervisors, and VA intake providers, as well as the framework to automate that information collection and risk analysis in the future.

A decision support tool with five binary outputs (yes or no) was developed based on an existing corroborated model of risk factors for homelessness developed by the National Center for Homelessness Among Veterans. The tool easily represents individuals of higher risk of homelessness to a screener, with no added time or data collection burden. Further, a freeware script, compatible with all common data collection and storage systems, was developed to provide a baseline for further digital management efforts.

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Acronyms, Terms, and Conventions

PIR-	Priority Intelligence Requirements, based on definition in US Army FM 34-2
VA -	United States Department of Veterans Affairs
HUD -	United States Department of Housing and Urban Development
OEF -	Operation Enduring Freedom, referring to operations in the Afghan theater
OIF -	Operation Iraqi Freedom, referring to operations in the Iraqi theater before August 2010
OND -	Operation New Dawn, referring to operations in the Iraqi theater after August 2010
NCHAV -	National Center on Homelessness Among Veterans, a VA research center
DHA-	Deployment Health Assessment

This report refers to post-9/11 era Veterans who have been deployed to Iraq or Afghanistan as OEF/OIF/OND Veterans

This report adheres to the US military and VA convention of capitalizing the word veteran when referring to a Veteran of US military service, as well as the word soldier when referring to a Soldier in the US Army.

1. INTRODUCTION

1.1 Purpose

This report attempts to curate priority intelligence requirements (PIR) aimed at identifying Veterans of Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn (OEF/OIF/OND) who are at risk of experiencing incidences of homelessness after ending service in the United States Army.

Based on research conducted by the US Veterans Administration (VA) and the National Center on Homelessness Among Veterans (NCHAV), and aided by relevant corroborative research from a variety of sources, this project identifies factors to drive information collection. Further, this report suggests a PIR list for commanders overseeing outbound transition as well as caregivers at VA intake in order to quickly identify at risk personnel, prioritize care, and potentially inform intervention.

Finally, this report attempts to extend work conducted by the NCHAV in order to develop a decision support tool for first line or intake caregivers at VA sites.

This report does not seek to evaluate the efficacy of military or VA homeless intervention or rehabilitation programs. All references to 'preemption' refer to use or enrollment in these existing programs. For further information in that vein, see the US Department of Housing and Urban Development (HUD) or US Interagency Council on Homelessness reports, or visit the Army Transition Assistance Program (TAP) or VA websites.¹

¹ US Department of Housing and Urban Development, Office of Community Planning and Development & US Department of Veterans Affairs, National Center for Homelessness Among Veterans (2010). Veteran Homelessness: A Supplemental Report to the 2010 Annual Homeless Assessment Report to Congress. Washington DC: authors.

United States Interagency Council on Homelessness. Report to Congress on Homeless Veterans. Washington DC: author; 2012. Available from: http://usich.gov/population/veterans/report_to_congress_on_homeless_veterans/

1.2 Problem

As communities report significant decreases in Veteran homelessness from 2010 – 2015, mitigation efforts have turned from reactive care and rehabilitation to prevention. With significant populations of contemporary Veterans transitioning to civilian life from operations in Iraq and Afghanistan, there is an opportunity to adapt transition and integration processes to preclude the risk of homelessness.

While there is generally more data available from OEF/OIF/OND Veterans upon transition than in previous conflicts, the immediacy of this population's transition means that research efforts are just catching up. Metraux, Elbogen, and Edens, along with their colleagues, have done significant work isolating risk factors for homelessness from the various socioeconomic and demographic differentiators between populations of veterans.² With roots in Rosenheck's work with Vietnam Veterans, these researchers have discovered that while OIF/OEF/OND service can indicate a higher risk, behavioral and socioeconomic factors are more likely to identify at-risk Veterans before they experience an incidence of homelessness.³

Statistical modeling has been effective in predicting Veterans at risk of suicide and violent behavior. The statistical analysis in the above studies can inform information requirements at

² Fargo J, Metraux S, Byrne T, et al. (2012). Prevalence and risk of homelessness among U.S. Veterans: A multisite investigation. *Preventing Chronic Disease* 2012;9: 110-112.

Elbogen EB, Sullivan CP, Wolfe J, Wagner HR, Beckham JC. Homelessness and Money Mismanagement in Iraq and Afghanistan Veterans. *American Journal of Public Health*. 2013;103(Suppl 2):S248-S254. doi:10.2105/AJPH.2013.301335.

Edens EL; Kaspro W; Tsai J; Rosenheck RA. Association of substance use and VA service-connected disability benefits with risk of homelessness among veterans. *The American Journal On Addictions / American Academy Of Psychiatrists In Alcoholism And Addictions*, 2011, vol. 20, issue 5, p 412, ISSN 15210391. ISBN 15210391.

³ Rosenheck R, Fontana A. A model of homelessness among male veterans of the Vietnam War generation. *American Journal of Psychiatry*. 1994 Mar;151(3):421-7. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/8109652>

the transition and Veteran's Affairs (VA) intake stages, and can potentially provide a screening tool to identify transitioning Veterans at greater risk of experiencing homelessness.

1.3 Research Objectives

1. Review current military outprocessing and VA intake with respect to potential incidences of homelessness
 - a. Identify opportunities in collection
 - i. Information requirements addressing identified risk factors
 - ii. Information requirements addressing risk notification for providers
2. **Deliverable:** Summarize opportunities to preempt incidences of homelessness with respect to information collection and offer priority information requirements
3. Attempt to build on the NCHAV's statistical model of incidence rates among OEF/OIF/OND Veterans
 - a. Assume the Cox model posited by NCHAV
 - b. Automate risk analysis when PIR are fulfilled
4. **Deliverable:** If possible, using results from 2 and 3b and the existing national homelessness screening instrument, automate delivery of risk notification at transition or intake

2. LITERATURE REVIEW

2.1 Definition of Homeless Veteran

This project defines a homeless Veteran as a person who simultaneously satisfies the criteria for a Veteran set forth by the VA, and for a homeless person according to The McKinney-Vento Homeless Assistance Act as amended by S. 896 The Homeless Emergency Assistance and Rapid Transition to Housing (HEARTH) Act of 2009 (Appendix 2). Essentially, this project refers to any Veteran without stable, permanent housing as a homeless Veteran. For more detail, reference Perl's analysis of the US Code definition.⁴

2.2 Veteran Homelessness

Incidences of homelessness among Veterans – especially those returning from OEF/OIF/OND – often serve as a broader representation of the struggle to transition and re-assimilate after combat or deployment. As noted above, there is significant government and public attention focused on Veterans experiencing homelessness, highlighted by President Obama's initiative to end Veteran homelessness by 2015.⁵

In 2010, the VA and US Department of Housing and Urban Development (HUD), added estimates of Veteran homelessness to HUD's Annual Homeless Assessment Report (AHAR). Beginning with that year, the AHAR included point-in-time (PIT) estimates of Veterans in various states of homelessness. \According to those counts; the number of Veterans experiencing incidences of homelessness declined by 12% between 2010 and 2011. By 2014, the number

⁴ Perl, L. Veterans and homelessness. Congressional Research Reports for the People. 2012

⁵ United States Interagency Council on Homelessness. Report to Congress on Homeless Veterans.

declined by almost a third.⁶ This trend is encouraging, and certainly in line with efforts to end Veteran homelessness by 2015. This project assumes substantial success for those efforts through 2015 and beyond, and focuses on the sustainment effort of preemption and intervention.

Broad estimates such as the ones discussed above are based on data collected in the field, from direct interaction with the target population. They do not gather circumstances of military service – that is, they do not differentiate between OEF/OIF/OND Veterans and all other Veterans.⁷

2.3 Homelessness Among OEF/OIF/OND Veterans

Beyond homelessness among Veterans in general, there is a growing body of work focusing on OEF/OIF/OND Veterans and their experience with incidences of homelessness. The current clinical environment accepts relatively contemporary considerations as Post Traumatic Stress Disorder and Military Sexual Trauma as risk factors for failures to adapt to civilian life, which could result in an incidence of homelessness. Further, there is greater acceptance that pre enlistment factors, factors not directly related to military service, and socioeconomic stressors act to increase the risk that OEF/OIF/OND Veterans will experience an incidence of homelessness after transitioning from the military.⁸ Given the immediacy of their transition, the

⁶ US Department of Housing and Urban Development, Office of Community Planning and Development & US Department of Veterans Affairs, National Center for Homelessness Among Veterans (2010). Homelessness: A Supplemental Report to the 2010 Annual Homeless Assessment Report to Congress

⁷ Henry M, Cortes A, Shivji A, Buck K. The 2014 Annual Homeless Assessment Report (AHAR) to Congress, Part 1: Point-in-Time Estimates of Homelessness [Internet]. Washington (DC): Department of Housing and Urban Development (US); 2014 Dec. Available from: <https://www.hudexchange.info/resource/4074/2014-ahar-part-1-pit-estimates-of-homelessness/>

⁸ Balshem H, Christensen V, Tuepker A, et al. A Critical Review of the Literature Regarding Homelessness Among Veterans [Internet]. Washington (DC): Department of Veterans Affairs (US); 2011 Apr. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK55705/>

population of OEF/OIF/OND Veterans offers a target for those responsible for military transition and VA intake to preempt incidences of homelessness among that population.

2.4 Risk Factors for OEF/OIF/OND Veterans

Accepting that there are a wide variety of possible factors affecting the likelihood of an incidence of homelessness, sustainment efforts for the declining trend in Veteran homelessness and preemption of homelessness in OEF/OIF/OND Veterans require target specificity. From an Engineering or Process Management perspective, factor curation and cause analysis facilitates development and implementation of processes to preempt incidences of homelessness in OEF/OIF/OND Veterans. While perhaps not following traditional cause analysis methodology, the developing body of scientific study on this topic increasingly returns commonalities.

Rosenheck and Fontana, analyzing a large cohort of scientifically surveyed Veterans of the Vietnam conflict, write “psychiatric disorder, and substance abuse had the strongest direct effects” on the likelihood of homelessness.⁹ Metraux et al, examining the first longitudinal study of a cohort of OEF/OIF/OND Veterans, also find that behavioral health disorders and substance abuse significantly increase the risk of a Veteran experiencing an incidence of homelessness. They were also able to add deployed service in OEF/OIF/OND and socioeconomic factors as strong predictors of risk.¹⁰

Elbogen et al write that “Veterans [without financial issues] were significantly less likely to have post-deployment adjustment problems such as... homelessness...probable major depressive

⁹ Rosenheck R, Fontana A. A model of homelessness among male veterans of the Vietnam War generation. *American Journal of Psychiatry*. 1994 Mar;151(3):421-7. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/8109652>

¹⁰ Metraux S, Clegg LX, Daigh JD, Culhane DP, Kane V. Risk Factors for Becoming Homeless Among a Cohort of Veterans Who Served in the Era of the Iraq and Afghanistan Conflicts. *American Journal of Public Health*. 2013;103(Suppl 2):S255-S261. doi:10.2105/AJPH.2013.301432.

disorder, posttraumatic stress disorder, and traumatic brain injury were associated with financial difficulties.”¹¹ This conclusion is significant, since it offers both a predictor and an exacerbating factor. That is, a Veteran with no history of other predictors of risk may suffer them as a result of financial issues.

2.5 Informing Care and Preemption

Approximately 61% of all OEF/OIF/OND Veterans accessed VA health care services between October 1, 2001 and March 31, 2015. 57% of those Veterans were diagnosed with mental health issues. The majority of those Veterans accessed VA care in the last year of the collection period.¹² Necessarily, OEF/OIF/OND Veterans in this group accessed VA care in a relatively timely manner – that is, approximately five years or less after transition from military service. This project makes the assumption that a small majority of OEF/OIF/OND will continue to access VA care in a relatively timely manner, with demand increasing through the year 2020.

The previously referenced paper by Metraux et al studies a cohort of these Veterans, and identifies twelve major risk factors impacting the likelihood of homelessness. Namely, rank at discharge, age, type of discharge, a PTSD diagnosis, several mental health diagnoses, and substance abuse. Rank at time of discharge directly affects the financial well-being identified by Elbogen et al as necessary for successful transition. PTSD and mental health diagnoses as risk

¹¹ Elbogen EB, Johnson CSC, Wagner HR, Newton VM, Beckham JC. Financial Well-Being and Post-Deployment Adjustment among Iraq and Afghanistan War Veterans. *Military Medicine*. 2012;177(6):669-675. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3390745/?report=classic>

¹² United States Department of Veterans Affairs. VA Health Care Utilization by Recent Veterans. Washington DC: author; 2014. Available from: <http://www.publichealth.va.gov/epidemiology/reports/oefoifond/health-care-utilization/index.asp>

factors are supported by the work done by Rosenheck and Fontana. Finally, Edens et al describe substance abuse as a strong contributing risk factor for homelessness.¹³

The strong scientific corroboration for the risk factors identified by Metraux et al offers the opportunity to inform military commanders and VA intake personnel of high risk transitioners, and begin work on simple process and automation for identification and preemption. At the current state, most substantive work of this nature is primarily reactive in nature. Of note, Peterson et al demonstrated ways to parse existing administrative data on Veterans to better identify incidences of homelessness, and indicate some opportunities for prevention.¹⁴ However, their work is predicated on past or imminent incidences of homelessness after transition. Similar work by McCarthy et al analyzing administrative data in order to preempt suicide attempts among Veterans proved mathematically successful, indicating that there is an opportunity to recreate these efforts focusing on homelessness.¹⁵ Most relevant to this project, Elbogen et al developed a successful screening tool to identify Veterans at a high risk of committing violent actions using the National Post Deployment Adjustment Survey.¹⁶ It is important to note that a Soldier transitioning from the Army after OEF/OIF/OND service has taken part in at least two

¹³ Edens EL; Kaspro W; Tsai J; Rosenheck RA. Association of substance use and VA service-connected disability benefits with risk of homelessness among veterans. *The American Journal On Addictions / American Academy Of Psychiatrists In Alcoholism And Addictions*, 2011, vol. 20, issue 5, p 412, ISSN 15210391. ISBN 15210391.

¹⁴ Peterson R, Gundlapalli AV, Metraux S, et al. Identifying Homelessness among Veterans Using VA Administrative Data: Opportunities to Expand Detection Criteria. Smalheiser NR, ed. *PLoS ONE*. 2015;10(7):e0132664. doi:10.1371/journal.pone.0132664. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4501742/>

¹⁵ McCarthy JF, Bossarte RM, Katz IR, et al. Predictive Modeling and Concentration of the Risk of Suicide: Implications for Preventive Interventions in the US Department of Veterans Affairs. *The American Journal of Public Health*. Published online ahead of print June 11, 2015: e1–e8. doi:10.2105/AJPH.2015.302737. Available from: <http://ajph.aphapublications.org/action/showCitFormats?doi=10.2105%2FAJPH.2015.302737>

¹⁶ Elbogen EB, Cueva M, Wagner HR, et al. Screening for Violence Risk in Military Veterans: Predictive Validity of a Brief Clinical Tool. *The American journal of psychiatry*. 2014;171(7):749-757. doi:10.1176/appi.ajp.2014.13101316. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4142592/>

similar surveys, which would deliver administrative data informing the risk factors discussed above.

2.6 Army Outprocessing

Veterans of the US Army account for the largest population of homeless Veterans, homeless OEF/OIF/OND Veterans, and Veterans who present with the risk factors discussed above.¹⁷

Any collection of administrative data for analysis begins prior to transition, while the Veteran is part of a military command structure.

All OEF/OIF/OND Veterans are required to complete Deployment Health Assessments (DHA) sixty days prior to deployment, thirty days surrounding redeployment, and 90-180 days after redeployment. These assessments are self reported, and contain demographic data and language that can identify substance abuse or mental health issues like those identified above. These assessments are considered medical documentation, and are available to medical service providers.¹⁸

The Army Substance Abuse Program, governed by Army Regulation 600-85, provides comprehensive services for Soldiers who use legal drugs, illicit drugs, or alcohol inappropriately. Soldiers can enter the program voluntarily or punitively by “command referral.” A Soldier who is referred involuntarily generates a record of punitive proceedings, and a personnel record preventing favorable personnel actions until successful completion of the program. The regulation provides significant privacy protection, and Soldiers who separate from the Army while in the program must request to be transferred to VA care – that is, notify the VA that they

¹⁷ Tsai J, KasproW WJ, Rosenheck RA. Latent Homeless Risk Profiles of a National Sample of Homeless Veterans and Their Relation to Program Referral and Admission Patterns. *American Journal of Public Health*. 2013;103(Suppl 2):S239-S247. doi:10.2105/AJPH.2013.301322.

¹⁸ Army G1 Program Management. DHAP Program

have a history of substance abuse. A Soldier who participates in the program voluntarily generates no lasting records.¹⁹

Official separation processing provides guidelines for pre-separation counseling, including relocation assistance, job search and placement, financial planning, and veterans benefits. The regulation further stipulates that a Soldier must receive “relevant information to facilitate a successful transition to civilian life.”²⁰ There is no counseling requirement at the command or caregiver level that mandates specific continuation of care counseling, personal risk assessments, or requires risk identification and notification of VA providers. Information about homelessness and other issues is presented in general form, with substantial discussion of the risk factors discussed above. There is however, an explicit requirement for a medical examination to “determine if the Soldier is medically fit for separation,” which would likely generate a medical record of any risk factors for homelessness, if diagnosed. Personal records, including medical records, are transmitted to the VA only if the Soldier requests it.²¹

¹⁹ US Department of the Army. Army Substance Abuse Program. Army Regulation 600-85. Washington DC: US Department of the Army, December 28, 2012.

²⁰ US Department of the Army. Separation Processing and Documents. Army Regulation 635-5. Washington DC: US Department of the Army, February 10, 2014.

²¹ US Department of the Army. Army Military Human Resource Records Management. Army Regulation 600-8-104. Washington DC: US Department of the Army, April 7, 2014.

3. RESEARCH PROCEDURE

This project uses the term Priority Intelligence Requirement to describe key information requirements that would inform preempting incidences of homelessness in OEF/OIF/OND Veterans. It is a commonly used military term, and will be familiar to personnel overseeing military transition. By definition, a Priority Intelligence Requirement is an intelligence requirement associated with a decision that will affect the overall success of the command's mission.²² In this case, the decision is whether a Veteran is at risk of an incidence of homelessness, and the mission is preempting all such incidences.

3.1 Factors Governing Selection of PIR

The Intelligence Officer's Handbook states that good PIR

1. Ask only one question
2. Focus on a specific fact, event, or activity
3. Provide intelligence required to support a single decision
4. Are tied to key decisions that the commander has to make
5. Give a Latest Time of Intelligence Value

For the purposes of this project, the selected PIR must identify presence of risk factors in binary and indicate imminence of the risk of an incidence of homelessness. First, they must identify whether a Veteran presents with a risk factor. Next, they must inform a caregiver's decision to identify a Veteran as high-risk or to take action to preempt an incidence of homelessness. Finally, they should indicate how long a positive response remains a risk.

²² US Department of the Army. Intelligence Officer's Handbook. Field Manual 34-8-2. Washington DC: US Department of the Army, May 1, 1998.

Further, data relevant to preempting incidences of homelessness is generally protected by legal or medical privacy regulations, or both. It is possible for a military commander to have knowledge of the presence of a risk factor in a Soldier's profile, but be legally bound to keep it confidential. Similarly, a Soldier's caregiver may know that a Soldier is at risk because of a medical condition, but not be able to inform the commander or transition supervisor. In all cases, no information of risk factors is transmitted to the VA without the Soldier's request. At the point of intake, VA information is limited to the records or information that a Veteran has volunteered.²³

Given that laws governing privacy protection are unlikely to change in the short future relevant to this project, PIR selection is then governed by how much information can be collected and legally transmitted to all personnel involved in a Soldier's transition to Veteran.

Further, this project seeks to integrate with current military transition and VA intake processes. As a result, PIR that require additional collection, data entry, or evaluation are not useful. PIR selected by this project must be informed by existing data, and delivered with little or no burden on systems or personnel.

Therefore PIR selected by this project must meet the following criteria:

1. Identify presence of risk factors with a binary output
2. Identify duration of risk factors
3. Deliver information without violating privacy protection
4. Require no additional data collection
5. Disseminate output easily

²³ US Department of the Army. Army Military Human Resource Records Management.

3.2 Intelligence Sources

As outlined in the previously cited Army Regulations, Soldiers may volunteer information to be transmitted to the VA. Informed counseling with a Soldier's commander or transition supervisor can be the primary source of immediate transmitted information, and requires minimal augmentation of existing pre-separation counseling. Discounting knowledge of medical information, a commander or transition supervisor will be informed of demographic information and many instances of substance abuse, informing a risk model. Similarly, VA intake involves an interview which requests voluntary disclosure of all risk factors discussed in the previous section.²⁴ There is no additional data entry requirement if risk factors are identified in the existing intake model.

Fundamentally, before any automation effort, all transition and intake personnel should be aware of the requirement to solicit information about risk factors. Multiple positive responses to identified PIR should indicate to the collector that there is an increased risk of an incidence of homelessness.

3.3 Identified Risk Factors

As stated in the research objectives, this project seeks to build upon the work completed by the NCHAV in order to deliver PIR and a simple tool for transition supervisors and intake providers to assess risk of an incidence of homelessness. As discussed in Metraux et al, the majority of OEF/OIF/OND Veterans who experience an incidence of homelessness are low ranking Soldiers.²⁵ Those soldiers are necessarily mostly 18-24 years old, and with maximum possible

²⁴ Ibid

²⁵ Metraux et al. Risk Factors for Becoming Homeless Among a Cohort of Veterans Who Served in the Era of the Iraq and Afghanistan Conflicts

base salaries less than three times the federal poverty guidelines.²⁶ They are used as the reference population.

The Universal Homeless Screening Instrument is employed universally, soliciting explicit denials of homelessness or imminent homelessness. This project accepts this instrument and its efficacy as adequate for the reference population. For a detailed analysis, see Montgomery et al.²⁷ For further risk factors, this project identifies the risk factors identified by Metraux et al, and corroborated by the work referenced above. These twelve factors are identified in Figure 1, and inform the PIR.

3.4 Data

Existing data on incidences of OEF/OIF/OND Veteran homelessness, treatment, medical characteristics, and demographic information is protected by privacy law. This project did not enjoy access to patient data from the VA, nor transition data from the military, but rather, depends on conglomerate data and third party analysis.

As such, this project accepts the model posited by the NCHAV in Metraux et al, and the associated hazard ratios for individual characteristics governing the risks of experiencing an incidence of homelessness. Practically, the lack of access to raw data simulates the situation a transition supervisor or intake provider is likely to be in.

The PIR and automation technique used by this project are not dependent on the model or results of the NCHAV work. Rather, they build on it as the result of rigorous scientific inquiry

²⁶ US Department of Health and Human Services. Annual Update of the HHS Poverty Guidelines. Washington DC: US Department of Health and Human Services, January 22, 2015

²⁷ Montgomery AE, Fargo JD, Byrne TH, Kane VR, Culhane DP. Universal Screening for Homelessness and Risk for Homelessness in the Veterans Health Administration. *American Journal of Public Health*. 2013;103(Suppl 2):S210-S211. doi:10.2105/AJPH.2013.301398. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3969117/>

corroborated by a large body of work. Both the PIR and automation that result from this project are easily modified to accept new research, models, or discovery, without changing the underlying principles or methods used in this project.

3.5 Automation

Each Soldier must complete three DHA associated with deployed service in OEF/OIF/OND, and complete formal separation procedures before transitioning out of the Army. This information is associated with the Soldier's name and social security number. A Soldier's medical records are also associated with the Soldier's name and social security number. Further, VA intake requires financial disclosure as part of enrollment.²⁸ Regardless of data formats between systems, a simple external script – as presented at the end of this project – can extract relevant information and associate it with an anonymous reference number. Having elicited responses to risk factors, the script could then output a simple high risk warning when applicable, while still protecting the patient's privacy.

If coupled with counseling or an interview soliciting specific information relevant to PIR, the same script could immediately output a risk indicator with relatively few inputs.

3.6 Proportional Hazards (Cox) Regression

In the work by Metraux et al, the NCHAV builds a Proportional Hazards Model in order to describe the likelihood of an individual with certain characteristics to experience an incidence of homelessness.

The hazard function is the probability that an individual will experience an event within a small period of time. For the purposes of this report, and the research that this report seeks to extend,

²⁸ US Department of Veterans Affairs. VHA HANDBOOK 1601A.01. Washington DC: US Department of Veterans Affairs, November 5, 2009

the hazard function describes the probability of an individual experiencing an incidence of homelessness at time t over a period of five years from the time of separation from the Army.

Proportional hazards regression, or Cox's regression, develops the relationship between multiple variables and the hazard function at a given time. The specific model in this case takes the form

$$h_i(t) = h_0(t) \times \exp[\beta_1 x_{i1} + \beta_2 x_{i2} \dots \beta_n x_{in}]$$

where β_{in} is the coefficient, or effect, of each variable x_{in} for each individual i .

In essence, in the case of this report, the model describes the likelihood of an individual i to experiencing an incidence of homelessness given the variables x_{i1-in} .

The variables in this report are shown in the row labels from the work by Metraux et al (Figure 1).²⁹ This report, being focused solely on the Army, disregards branch of service in those results, and assumes the same reference group.

²⁹ Metraux et al. Risk Factors for Becoming Homeless Among a Cohort of Veterans Who Served in the Era of the Iraq and Afghanistan Conflicts

Variable	OEF-OIF		Not OEF-OIF	
	Male (n = 152 592), HR (95% CI)	Female (n = 18 638), HR (95% CI)	Male (n = 110 974), HR (95% CI)	Female (n = 28 481), HR (95% CI)
Military pay grade	**	**	**	**
E1-E4 (Ref)	1.00	1.00	1.00	1.00
E5-E9	0.40 (0.37, 0.44)	0.33 (0.26, 0.42)	0.27 (0.23, 0.32)	0.43 (0.32, 0.56)
O1-O10	0.13 (0.09, 0.20)	0.14 (0.06, 0.34)	0.23 (0.16, 0.35)	0.24 (0.13, 0.46)
Other	0.09 (0.06, 0.14)	0.20 (0.09, 0.49)	0.13 (0.08, 0.21)	0.22 (0.10, 0.48)
Branch	**		**	**
Army (Ref)	1.00	1.00	1.00	1.00
Air Force	0.52 (0.43, 0.62)	0.67 (0.48, 0.94)	0.75 (0.62, 0.89)	0.94 (0.72, 1.22)
Marines	0.83 (0.75, 0.93)	0.80 (0.48, 1.34)	0.81 (0.68, 0.96)	0.75 (0.46, 1.21)
Navy	1.20 (1.07, 1.34)	1.05 (0.79, 1.38)	1.35 (1.18, 1.56)	1.65 (1.32, 2.08)
Other	0.63 (0.16, 2.52)	^a	1.34 (0.97, 1.86)	1.19 (0.56, 2.53)
Character of service	**		**	*
Honorable (Ref)	1.00	1.00	1.00	1.00
BC or dishonorable	1.79 (0.25, 12.70)	^a	8.18 (4.07, 16.45)	3.40 (0.47, 24.41)
Other than honorable	2.37 (1.93, 2.92)	0.76 (0.11, 5.42)	5.39 (4.23, 6.87)	2.91 (1.43, 5.95)
Uncharacterized or missing	1.06 (0.91, 1.24)	1.34 (0.88, 2.04)	0.81 (0.67, 0.99)	0.74 (0.51, 1.05)
Duty type				
Active duty (Ref)	1.00	1.00	1.00	1.00
Reserve or Guard	0.79** (0.73, 0.86)	0.74* (0.58, 0.94)	1.14 (0.97, 1.35)	1.34 (0.96, 1.87)
Age, y	**	*	**	*
18-24 (Ref)	1.00	1.00	1.00	1.00
25-34	1.20 (1.10, 1.30)	1.50 (1.20, 1.88)	1.36 (1.20, 1.54)	1.37 (1.10, 1.70)
35-44	1.26 (1.12, 1.42)	1.57 (1.12, 2.22)	1.46 (1.21, 1.77)	0.92 (0.64, 1.32)
45-54	1.37 (1.14, 1.64)	1.34 (0.75, 2.40)	1.32 (0.99, 1.77)	1.06 (0.62, 1.80)
55-64	0.64 (0.36, 1.13)	3.45 (1.04, 11.45)	0.83 (0.40, 1.70)	0.35 (0.05, 2.60)
Traumatic brain injury	1.20 (0.98, 1.46)	1.23 (0.54, 2.79)	1.59* (1.18, 2.15)	1.64 (0.85, 3.20)
Behavioral health disorders ^b				
PTSD	1.24** (1.09, 1.41)	1.57* (1.09, 2.26)	0.78 (0.54, 1.13)	0.86 (0.55, 1.34)
Adjustment disorders	1.53** (1.37, 1.71)	1.28 (0.96, 1.71)	1.45** (1.23, 1.72)	1.60** (1.26, 2.05)
Anxiety disorders ^c	1.03 (0.90, 1.18)	0.92 (0.65, 1.31)	1.38** (1.15, 1.67)	1.02 (0.77, 1.36)
Mood disorders	1.41** (1.25, 1.59)	1.31 (0.96, 1.77)	1.62** (1.37, 1.92)	1.79** (1.40, 2.29)
Personality disorders	1.46** (1.24, 1.72)	1.49 (1.00, 2.22)	1.39* (1.12, 1.73)	1.05 (0.74, 1.49)
Psychotic disorders	1.57** (1.22, 2.04)	4.22** (2.16, 8.23)	2.66** (2.04, 3.47)	3.18** (1.87, 5.39)
Substance use	2.59** (2.33, 2.87)	1.85** (1.28, 2.67)	2.72** (2.34, 3.16)	2.03** (1.47, 2.82)

Note. BC = bad conduct discharge; CI = confidence interval; DoD = US Department of Defense; E = enlisted; HR = hazard ratio; ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification; NS = nonsignificant (i.e., $P > .05$); O = officer; OEF = Operation Enduring Freedom; OIF = Operation Iraqi Freedom; PTSD = posttraumatic stress disorder; VA = Department of Veterans Affairs. 5-year adjusted incidence rates (%) are as follows: for OEF-OIF, 4.9 and 4.8 for men and women, respectively, and for not OEF-OIF, 3.7 and 4.1 for men and women, respectively. ^aInsufficient number of observations to generate a valid coefficient.

^bAll diagnoses were made in the 1-year period before separation from the military. The behavioral health categories used here are based on groupings of ICD-9-CM diagnoses, following the conventions used in Hoge et al.²⁴: any behavioral health disorder (290-319), adjustment disorders (309.0, 309.24, 309.28, 309.3, 309.4, 309.9), anxiety disorders (excluding PTSD; 300.01-300.03, 300.21, 300.22, 300.23, 300.29, 300.3, 308.3), PTSD (309.81), mood disorders (296.0, 296.2-296.7, 296.80, 296.89, 296.90, 300.4, 301.3, 301), major depression (296.2 and 296.3), personality disorders (301.0, 301.2, 301.4, 301.50, 301.6, 301.7, 301.81-301.84, 301.89, 301.9), psychotic disorders (295.1-295.4, 295.6, 295.7, 295.9, 297.1, 297.3, 298.8, 298.9), and substance use (291; 292, except 292.2; 303-305, except 305.1 and 305.8).

^cAnxiety disorder category does not include PTSD diagnosis (309.81).

* $P < .05$. ** $P < .001$.

Fig 1: Risk of Becoming Homeless Subsequent to Military Separation (Between July 1, 2005, and September 30, 2006) by Deployment in OEF-OIF and Gender: US VA- or DoD-Enrolled OEF- and OIF-Era Veterans (n = 310 685), Separation Through September 30, 2010

3.7 Model Automation

For the purposes of calculation, statistical software can describe a model measuring the effect of changes in an individual's characteristics – variables – on the likelihood of that individual becoming homeless.

Without access to restricted medical data, this report relies on the calculated risks in Figure 1 to assign values to the coefficients - β_i . At this point we acknowledge that low ranking, very young, honorably discharged Veterans of the Army make up a significant portion of Veterans who experience homelessness in five years. As discussed in a previous section, Veterans with these characteristics should receive augmented intake procedures. The purpose of this automation effort is to quickly identify combinations of characteristics that might not be as easily identified.

In the interest of easy reproducibility, this report used the freeware Anaconda distribution of Python 3.4 from Continuum Analytics, and the Scipy package for statistical computation in Python. All software and packages are available for free download. Figure 2 reproduces a simple iPython notebook

4. RESULTS

4.1 Application

Accepting the NCHAV's work, risk factors for an individual Soldier to experience an incidence of homelessness after transition are as follows:

1. Pay grade

In general, being of a higher rank reduces the likelihood that a Soldier will experience an incidence of homelessness. This is information readily available to a commander, supervisor, or intake provider.

2. Age

Somewhat contrary to superficial examination of the effect of pay grade, relatively older Soldiers are at a higher risk of experiencing homelessness. This possibly indicates Soldiers who are old relative to their pay grade as a result of disciplinary action or performance issues, which are also an indicator of risk. Age is easily determined.

3. Character of service

Any discharge status besides honorable is a strong risk factor, but problematic for a VA intake provider, who will likely not see Veterans without an honorable discharge, at least until several years after transition. This is because VA benefits are governed by discharge type. Less than honorable discharges can require time before eligibility for VA services, or bar a Veteran from those services. Commanders conducting transition counseling, or transition supervisors, will have this information readily available.

4. Duty type

Reserve or National Guard service seems to indicate a lesser risk of homelessness, and is easily available to a commander, supervisor, or provider.

5. TBI

Traumatic brain injury increases the likelihood of experiencing an incidence of homelessness, but its history would be medical data. A commander would likely know of a Soldier's history of TBI, but a transition supervisor or VA intake provider would be dependent on volunteered information.

6. Behavioral health disorders including substance abuse

This encompasses seven types of disorder, whose history is protected. A commander or transition supervisor would know about command referred substance abuse patients, as discussed above, but would be dependent on volunteered information otherwise. A VA intake provider would be solely dependent on volunteered information.

From the above summary, it is apparent that while a history of any of these risk factors would be known by at least one person among a Soldier's commander or military healthcare provider, many are not readily apparent or accessible to all personnel involved in a Soldier's transition. Since both Army separation and VA intake currently include questions indicating all of these risk factors, PIR can be structured to solicit this information in a coherent group, rather than across several sessions or screening instruments.

4.2 PIR Decision Support Tool

Therefore, adhering to the guidelines for PIR discussed above, suitable for both military and VA collectors, an easy to use decision support tool can be developed.

PIR1: Is or was the Soldier or Veteran E1-E4?	Y	N
PIR1a: If so, does the Soldier or Veteran have a negative financial event in the past year?	Y	N
PIR2: Is the Soldier or Veteran 25-54?	Y	N
PIR3: Does the Soldier or Veteran have a history of TBI?	Y	N
PIR4: Does the Soldier or Veteran have a history of behavioral health disorders?	Y	N
PIR5: Does the Soldier or Veteran have a history of substance abuse?	Y	N

Each PIR delivers a yes or no answer, facilitating ease of use for results. There is no requirement to understand hazard ratios or the statistical analysis behind these PIR selections. A commander or intake provider can deliver these PIR with practically no added time burden to already required separation or intake processing, and receive a visual result immediately.

As demonstrated by calculation displayed later in this project, a Soldier or Veteran that answers three of these questions affirmatively displays a higher risk for experiencing homelessness, and should potentially be directed to further support resources. In the absence of raw data, this project uses an arbitrary value of 40% greater risk than the reference as the decision point to label an individual “high risk”

It must be noted that only a very small proportion of Veterans actually experience an incidence of homelessness. Even among just the population of higher risk veterans, only a few will actually experience homelessness. However, given that the consequences for underreporting potential risk gravely outweigh those of false positives, this report chooses to err on the side of

caution. Fundamentally, this PIR list is a support tool, not a decision authority, and commanders and caregivers must still exercise discretion.

4.3 Automation

Creating the PIR informs the automation effort, and provides an initial analog tool for commanders, transition supervisors, and intake providers. Without any digital tools, or data entry, the PIR can inform the decision to advise a Soldier to seek further support, or direct a Veteran to appropriate VA programs.

With a script calculating the probability of an individual to experience homelessness, it becomes practical to expand PIR 5 to include specific queries about each type of behavioral disorder. As shown in Figure 2, the script prompts input for each type of behavioral disorder, and provides an exact calculation of the likelihood of an individual to experience homelessness compared to the reference. This script is easily modified to take more or less inputs, and to display outputs as percentages, high or low risk notifiers, or even recommendations, given proper expert information.

```
Enlisted? (Y/N)N
Officer? (Y/N)Y
Discharge Status? (H, BC, OTH, Missing)H
Transitioned from Active Duty? (Y/N)Y
Age?31
History of TBI? (Y/N)Y
History of PTSD? (Y/N)N
History of adjustment disorders? (Y/N)N
History of anxiety disorders? (Y/N)N
History of mood disorders? (Y/N)N
History of personality disorders? (Y/N)N
History of psychotic disorders? (Y/N)N
History of substance use? (Y/N)N

In [5]: #manually creating the model

e = np.exp(varLogMen['e5e9']*e5e9 + varLogMen['o1o10']*o1o10 +
varLogMen['other']*other + varLogMen['bc']*bc + varLogMen['oth']*oth +
varLogMen['missing']*missing+ varLogMen['res']*res+ varLogMen['_2534']*_2534+
varLogMen['_3544']*_3544+ varLogMen['_5564']*_5564+ varLogMen['tbi']*tbi+ varLogMen['ptsd']*ptsd+
varLogMen['ajdd']*ajdd+ varLogMen['anxd']*anxd+ varLogMen['moodd']*mood +
varLogMen['persd']*persd + varLogMen['psychd']*psychd + varLogMen['subs']*subs)

print("%f %% more likely to experience homelessness in five years, compared to the reference" % (e*100))

18.720000 % more likely to experience homelessness in five years, compared to the reference
```

Fig. 2: Input and output for a 31 year old officer with TBI

In Figure 2 above, the script calculates that a 31 year old officer discharged honorably from active duty with a history of TBI has a slightly greater chance than the reference of experiencing homelessness. The model validates the analog PIR tool above, since this input would only result in two Yes responses, prompting the interviewer to not direct the Soldier to further preemptive resources.

Using another input individual, shown in Figure 3 below, the script calculates a very high probability of experiencing an incidence of homelessness compared to the reference. The analog PIR agrees, given that this individual would register four Yes responses, prompting the interviewer to direct the Soldier to further resources.

```

Enlisted? (Y/N)Y
Grade number (E6 = 6)6
Discharge Status? (H, BC, OTH, Missing)H
Transitioned from Active Duty? (Y/N)Y
Age?30
History of TBI? (Y/N)Y
History of PTSD? (Y/N)Y
History of adjustment disorders? (Y/N)N
History of anxiety disorders? (Y/N)N
History of mood disorders? (Y/N)N
History of personality disorders? (Y/N)N
History of psychotic disorders? (Y/N)N
History of substance use? (Y/N)Y

In [8]: #manually creating the model

e = np.exp(varLogMen['e5e9']*e5e9 + varLogMen['o1o10']*o1o10 +
varLogMen['other']*other + varLogMen['bc']*bc + varLogMen['oth']*oth +
varLogMen['missing']*missing+ varLogMen['res']*res+ varLogMen['2534']*_2534+
varLogMen['_3544']*_3544+ varLogMen['_5564']*_5564+ varLogMen['tbi']*tbi+ varLogMen['ptsd']*ptsd+
varLogMen['adjd']*adjd+ varLogMen['anxd']*anxd+ varLogMen['moodd']*mood +
varLogMen['persd']*persd + varLogMen['psychd']*psychd + varLogMen['subs']*subs)

print("%f %% more likely to experience homelessness in five years, compared to the reference" % (e*100))

184.988160 % more likely to experience homelessness in five years, compared to the reference

```

Fig 3: Input and output for a 30 year old NCO with multiple risk factors

4.4 Review of Deliverables

The PIR table accurately reflects the hazard ratios calculated from the NCHAV proportional hazards model of the cohort of OEF/OIF/OND Veterans observed. The risk factors identified in the NCHAV work are corroborated significantly by work over a period of time beginning at the end of the Vietnam conflict. These PIR deliver immediate useful information to a commander,

transition supervisor, or VA intake provider, and a rapid decision support result with no added burden of time or work. The PIR table, added to existing separation and intake procedures, quickly and accurately classifies an individual as high risk.

Building on the PIR, the script takes advantage of computer calculation to expand the inputs, and deliver a more precise evaluation of an individual Veteran's likelihood to experience and incidence of homelessness. The script, written in Python 3, and presented in an iPython notebook, is easily modifiable to accept different inputs, deliver other types of output, and is compatible with most existing data collection and management systems. Further, the script can be modified to accept and parse raw data from a file, allowing it to be used by a commander, transition supervisor, or VA intake provider across the myriad of systems that store relevant Veteran data. Finally, since it can assign arbitrary identifiers to data, it can potentially search and return outputs based on privacy protected data.

5. SUGGESTIONS FOR FUTURE WORK

5.1 Limitation: Lack of Access to Alternative Data

Given that this project did not have access to military transition or VA intake records, all calculation and development was conducted based on existing work and summary data. While the work by Metraux et al for the NCHAV is significantly corroborated by diverse scientific study, the results of this projects PIR decision tool and script model are only accurate to that specific work. However, given that the NCHAV work further describes risk factors that are consistently identified in the body of work involving Veteran homelessness, each deliverable from this project should be easily modifiable to support new or modified conclusions from the data.

5.1 Recommendation for Further Work

Significant opportunity exists to test the PIR across actual datasets. A simple logit model fit to data from OEF/OIF/OND Veterans would not only validate the tool, but inform further opportunities to exploit data that is already gathered at transition and intake points.

5.2 Limitation: Dismissed Possibility of False Positives

As discussed previously in this report. This project dismissed the fact that the majority of individuals identified as high risk were still relatively unlikely to experience an incidence of homelessness. This report erred on the side of caution, and delivered accurate but imprecise tools. From a strict policy sense – and perhaps a moral one – it is better to over account for the consequences of a false positive, rather than discount it.

5.2 Recommendation for Further Work

As stated by every work cited in this report, more research needs to be done to isolate the root causes of incidences of homelessness. There are gaps in the research concerning the detailed effect of almost every risk factor enumerated here, as well as their relationship to traits like

demographic factors, region of the country, and life experiences. The body of work cited by this report identifies factors as diverse as childhood experiences and marital status that are not accounted for in the products developed by this project.

In addition, there appears to be an opportunity to study the most appropriate programs for prevention based on assessed risk factors. An effective preemption program for a young Veteran with a history of PTSD and substance abuse may not be successful for an older Veteran with a mood disorder.

6. CONCLUSIONS AND RECOMMENDATIONS

The VA's adaptation of data driven approaches is evident in the small but growing body of work presented by the NCHAV. This project was able to derive effective point of transition/point of intake tools using the just the first results of the NCHAV's work with OEF/OIF/OND data.

The PIR list and decision tool is effective, and is accurate assuming the effectiveness of the work it is based on. Even discounting the NCHAV work, the PIR tool delivered by this project describes a methodology that can easily be fit to any descriptive modeling of Veteran data. It can be deployed in its current state at military transition and VA intake locations to serve as a quick and reasonably accurate indicator of Veterans at a high risk of experiencing homelessness in the five years after their transition. Further, the script that builds on the PIR is easily modifiable to accept any input or data the user feels appropriate, and is able to be used across all military and VA data management systems.

Hopefully, this small work provides impetus for process development and information presentation among those working to treat and prevent homelessness among OEF/OIF/OND Veterans. With additional research in the areas described above, and continued effective work from organizations like the NCHAV and HUD there is real potential to further understand why Veterans experience incidence homelessness and how to identify and treat the root causes.

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APPENDIX 1 – Model Automation

The following screenshots show the simple iPython notebook used in this project.

Appendix 1

Model Automation and Notes For Further Work

```
In [9]: """
Created 1 October 2015 by Venkat Motupalli, venkat.motupalli@nyu.edu
"""

##Populating the interactive namespace with all possible required modules for calculation.
##Only some of these modules are used for the initial output.
##This combination of modules is sufficient for all suggested and possible work.

%pylab inline
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import statsmodels.api as sm
import statsmodels.formula.api as smf
from statsmodels.graphics.api import abline_plot
import patsy as pt
import seaborn as sns
sns.set(context='notebook', style='whitegrid', palette='deep', font='sans-serif', font_scale=1, rc=None)

Populating the interactive namespace from numpy and matplotlib

In [11]: # This initial output uses a forced model to demonstrate a decision support tool
# The framework to read data and create a Cox model is below
# Summary and analysis can be presented and saved as convenient using easily added code

#Create a dictionary of variables and odds for men and women
varOddsMen = {'e5e9':0.4, 'olo10':0.13, 'other':0.09, 'bc':1.79, 'oth':2.37,'missing':1.06, 'res':0.79, '2534':1.2, '3544':1.
26, '4554':1.37, '5564':0.64, 'tbi':1.2, 'ptsd':1.24, 'adjd':1.53, 'anxd':1.03, 'moodd':1.41, 'persd':1.46, 'psychd':1.57, 'subs':2
.59}
varOddsWomen = {'e5e9':.33, 'olo10':0.14, 'other':0.12, 'oth':0.76,'missing':1.34, 'res':0.79, '2534':1.5, '3544':1.57, '4554'
:1.34, '5564':3.45, 'tbi':1.23, 'ptsd':1.57, 'adjd':1.28, 'anxd':1.92, 'moodd':1.31, 'persd':1.49, 'psychd':4.22, 'subs':1.85}

#Create dictionaries for the log values of odds
varLogMen = varOddsMen
varLogWomen = varOddsWomen

#populate log odds dictionaries by looping across keys from original dictionaries
for key in varOddsMen:
    varLogMen[key]=np.log(varOddsMen[key])

for key in varOddsWomen:
    varLogWomen[key]=np.log(varOddsWomen[key])

In [32]: #create holding variables for characteristics
#All of these variables are categorical variables.
#If raw data is available, age could be unbinned
e5e9 = 0
olo10 = 0
other = 0
bc = 0
oth = 0
missing = 0
res = 0
_2534 = 0
_3544 = 0
_5564 = 0
tbi = 0
ptsd = 0
adjd = 0
anxd = 0
mood = 0
persd = 0
psychd = 0
subs = 0
```

```

In [33]: #create and populate input variables for characteristics

#gradeType and grade populate the e5e9, o1o10, and other variables
#the while loops curate user input...i.e. can't answer random when queried yes or no
while True:
    gradeType = input("Enlisted? (Y/N)")
    if gradeType.lower() not in ('y', 'n', 'yes', 'no'):
        print("Please answer yes or no")
    else:
        break
if gradeType.lower() in ('y', 'yes'):
    while True:
        try:
            grade = int(input("Grade number (E6 = 6)"))
        except ValueError:
            print ("Please enter just the number, i.e. 6 if the grade is E6")
            continue
        else:
            break
    if int(grade) >= 5:
        e5e9 = 1

elif gradeType.lower() in ('n', 'no'):
    while True:
        officer = input("Officer? (Y/N)")
        if officer.lower() not in ('y', 'n', 'yes', 'no'):
            print("Please answer yes or no")
        else:
            break
    if officer.lower() in ('y', 'yes'):
        o1o10 = 1
else:
    other = 1

#dischargeStatus populates the bc, oth, and missing variables
while True:
    dischargeStatus = input("Discharge Status? (H, BC, OTH, Missing)")
    if dischargeStatus.lower() not in ('h', 'bc', 'oth', 'missing', 'm', 'honorable', 'bad conduct', 'other than honorable'):
        print("Not a valid discharge status")
    else:
        break

if dischargeStatus.lower() not in ('h', 'honorable'):
    if dischargeStatus.lower() in ('bc', 'bad conduct'):
        bc = 1
    elif dischargeStatus.lower() in ('oth', 'other than honorable'):
        oth = 1
    else:
        missing = 1

#Active duty, reserve, or NG
while True:
    activeDuty = input("Transitioned from Active Duty? (Y/N)")
    if activeDuty.lower() not in ('y', 'n', 'yes', 'no'):
        print("Please answer yes or no")
    else:
        break
if activeDuty.lower() in ('n', 'no'):
    res = 1

#age populates _2534, _4554, _5564. In this case, we assume that no OEF/OIF/OND vet is >64 years old
while True:
    try:
        age = int(input("Age?"))
    except ValueError:
        print ("Please enter a number")
        continue
    else:
        break
if age <= 34:
    _2534 = 1
elif age <= 44:
    _3544 = 1
elif age <= 64:
    _5564 = 1

#Populates TBI
while True:
    itbi = input("History of TBI? (Y/N)")
    if itbi.lower() not in ('y', 'n', 'yes', 'no'):
        print("Please answer yes or no")
    else:
        break
if itbi.lower() in ('y', 'yes'):
    tbi = 1

```

```

#Populates PTSD
while True:
    iptsd = input("History of PTSD? (Y/N)")
    if iptsd.lower() not in ('y','n','yes','no'):
        print("Please answer yes or no")
    else:
        break
if iptsd.lower() in ('y','yes'):
    ptsd = 1

#Populates Adjustment Disorders
while True:
    iadjd = input("History of adjustment disorders? (Y/N)")
    if iadjd.lower() not in ('y','n','yes','no'):
        print("Please answer yes or no")
    else:
        break
if iadjd.lower() in ('y','yes'):
    adjd = 1

#Populates Anxiety Disorders
while True:
    ianxd = input("History of anxiety disorders? (Y/N)")
    if ianxd.lower() not in ('y','n','yes','no'):
        print("Please answer yes or no")
    else:
        break
if ianxd.lower() in ('y','yes'):
    anxd = 1

#Populates Mood Disorders
while True:
    imood = input("History of mood disorders? (Y/N)")
    if imood.lower() not in ('y','n','yes','no'):
        print("Please answer yes or no")
    else:
        break
if imood.lower() in ('y','yes'):
    mood = 1

#Populates Personality Disorders
while True:
    ipersd = input("History of personality disorders? (Y/N)")
    if ipersd.lower() not in ('y','n','yes','no'):
        print("Please answer yes or no")
    else:
        break
if ipersd.lower() in ('y','yes'):
    persd = 1

#Populates Psychotic Disorders
while True:
    ipsychd = input("History of psychotic disorders? (Y/N)")
    if ipsychd.lower() not in ('y','n','yes','no'):
        print("Please answer yes or no")
    else:
        break
if ipsychd.lower() in ('y','yes'):
    psychd = 1

#Populates substance use
while True:
    isubs = input("History of substance use? (Y/N)")
    if isubs.lower() not in ('y','n','yes','no'):
        print("Please answer yes or no")
    else:
        break
if isubs.lower() in ('y','yes'):
    subs = 1

```



```

Enlisted? (Y/N)y
Grade number (E6 = 6)6
Discharge Status? (H, BC, OTH, Missing)h
Transitioned from Active Duty? (Y/N)y
Age?30
History of TBI? (Y/N)y
History of PTSD? (Y/N)y
History of adjustment disorders? (Y/N)y
History of anxiety disorders? (Y/N)n
History of mood disorders? (Y/N)n
History of personality disorders? (Y/N)n
History of psychotic disorders? (Y/N)n
History of substance use? (Y/N)y

```

```
In [34]: #manually creating the model
```

```

e = np.exp(varLogMen['e5e9']*e5e9 + varLogMen['olo10']*olo10 +
varLogMen['other']*other + varLogMen['bc']*bc + varLogMen['oth']*oth +
varLogMen['missing']*missing+ varLogMen['res']*res+ varLogMen['_2534']*_2534+
varLogMen['_3544']*_3544+ varLogMen['_5564']*_5564+ varLogMen['tbi']*tbi+ varLogMen['ptsd']*ptsd+
varLogMen['adjd']*adjd+ varLogMen['anxd']*anxd+ varLogMen['moodd']*mood +
varLogMen['persd']*persd + varLogMen['psychd']*psychd + varLogMen['subs']*subs)

print("%f %% more likely to experience homelessness in five years, compared to the reference" % (e*100))

283.031885 % more likely to experience homelessness in five years, compared to the reference

```

Reading Data

Reading data requires adding some lines of code above the initial output generator given above. The example below assumes a Comma Separated Values File, but similar functions are available to read common dataset formats such as .dta or SAS output. Other options exist for importing database files.

```
In [ ]: #import data to a Pandas data frame element in <> is an input
data = pd.read_csv("<hyperlink_or_filepath>.csv")
```

At the time of this writing, R is the most rigorously curated freeware available to perform survival or hazard analysis. An option to the example below would be to use R to derive hazard ratios, then manual calculation in Python to deliver the decision tool. This example uses the Lifelines module available for Python.

For the purpose of illustration, this example assumes a dataset with individuals in the first column, variables in following columns, a duration, and a boolean indicating an incidence of homelessness. That is, each row would read Name, x1, x2, ...,duration, homeless T/F. Data presentation does not affect the underlying method used.

```
In [ ]: #import Lifelines package and tools
import lifelines as sa
from lifelines.utils import concordance_index, k_fold_cross_validation

#using Patsy (imported at beginning of notebook), all elements in <> are inputs
dft = pt.data('<individual>', data, return_type='dataframe')
design_info = dft.design_info
dft = dft.join(df[['<duration>','<homeless event>']])
```

Fitting a Cox Model and Viewing Hazard Coefficients

```
In [ ]: #using Lifelines (imported above) all elements in <> are inputs
cx = sa.CoxPHFitter(normalize=False)
cx.fit(df=dft, duration_col='<duration>', event_col='<homeless event>'
      ,show_progress=True, include_likelihood=True)

#view summary of coefficients
cx.summary
```

At this point it becomes simple to tell Python to pass variables for individuals to this model in order to predict their likelihood of experiencing an incidence of homelessness.

APPENDIX 2 – NCHAV and Identifying Risk Factors

The National Center For Homelessness Among Veterans

The National Center For Homelessness Among Veterans is a VA office that promotes data collection, collation, and analysis in order to drive and execute plans supporting efforts to end Veteran homelessness. From their website:

The National Center on Homelessness Among Veterans (NCHAV) works to promote recovery-oriented care for Veterans who are homeless or at-risk for homelessness by developing and disseminating evidence-based policies, programs, and best practices. Established in 2009, the Center supports the implementation of the Department of Veterans Affairs (VA)'s Five Year Plan to End Homelessness Among Veterans, which stems out of Opening Doors - Federal Strategic Plan to Prevent and End Homelessness (<http://www.va.gov/HOMELESS/docs/OpeningDoors2010FSP.pdf>). NCHAV's work is integrated and organized around four core activities:

- Policy Analysis
- Model Development & Implementation
- Education & Dissemination
- Research & Methodology

Specifically, the Center examines the prevalence of homelessness among Veterans, what services homeless Veterans use, and which programs most effectively serve them. The Center also identifies Veterans who are at-risk of homelessness and determines how to successfully intervene to improve their housing stability. Through a series of studies, NCHAV is producing a more accurate and reliable estimate of Veteran homelessness, investigating the demographic make-up of this population, and determining where they reside. In addition, the Center is uncovering the factors that predict homelessness among Veterans; developing and implementing evidence-based interventions in housing, healthcare, and supportive services; formulating policy recommendations; and disseminating findings and training opportunities.

Risk Factors for Becoming Homeless

Dr Stephen Metraux, Dr Limin Clegg, Dr John Diagh, Dr Dennis Culhane, and Vincent Kane, working under the auspices of the NCHAV, conducted the study of risk factors for contemporary Veteran homelessness referenced in this report. This project used their assessed risk factors and model to demonstrate a way to inform military transition and VA intake with respect to

identifying Veterans at a high risk of experiencing incidences of homelessness. From the abstract of that work:

Risk Factors for Becoming Homeless Among a Cohort of Veterans Who Served in the Era of the Iraq and Afghanistan Conflicts

Objectives. In this population-based cohort study, we assessed baseline risk factors for homelessness, including the role of service in the Iraq or Afghanistan conflicts, among a large cohort of recent veterans.

Methods. Data for this study came from administrative records for 310 685 veterans who separated from active military duty from July 1, 2005, to September 30, 2006. We used survival analysis methods to determine incidence rates and risk factors for homelessness, based on baseline data for military factors, demographic characteristics, and diagnoses of behavioral health disorders and traumatic brain injury.

Results. Service in Iraq or Afghanistan and, more specifically, posttraumatic stress disorder among veterans deployed there, were significant risk factors of modest magnitude for homelessness, and socioeconomic and behavioral health factors provided stronger indicators of risk. Gender was not a significant indicator of differential risk.

Conclusions. Although service in Iraq and Afghanistan was significant, socioeconomic and behavioral health indicators show more promise in efforts to use administrative data to inform prevention efforts by identifying veterans who are at elevated risk for becoming homeless upon their return to civilian life.

Metraux et al used the only population based cohort study available on OEF/OIF/OND Veterans to date. The success of NCHAV's work, combined with this project, highlight the potential benefits of studies of this type. Given that OEF/OIF/OND Veterans pass through significant administrative accountability phases as they transition out of the military and to the VA, data on this population is more readily available than for any other post deployment population of Veterans. Work in the future has the opportunity to train models to refine prediction, and conduct root cause analysis to a level of precision and granularity not yet represented in the literature.