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Homelessness and Risk of End- stage Renal Disease

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Abstract

To identify homeless people with chronic kidney disease (CKD) who were at highest risk for end-stage renal disease (ESRD), we studied 982 homeless and 15,674 domiciled people with CKD receiving public health care. We developed four risk prediction models for the primary outcome of ESRD. Overall, 71 homeless and 888 domiciled people progressed to ESRD during follow-up (median: 6.6 years). Homeless people with CKD experienced significantly higher incidence rates of ESRD than poor but domiciled peers. Most homeless people who developed progressive CKD were readily identifiable well before ESRD using a prediction model with five common variables. We estimated that program following homeless people in the highest decile of ESRD risk would have captured 64–85% of those who eventually progressed to ESRD within five years. Thus, an approach targeting homeless people at high risk for ESRD appears feasible and could reduce substantial morbidity and costs incurred by this highly vulnerable group.

Keywords

Homelessness; end-stage renal disease; risk prediction; vulnerable populations; chronic kidney disease

Approximately 3.5 million people are currently homeless in the U.S. Homeless people with chronic illnesses face unique barriers to obtaining effective ambulatory care which often drive them to seek emergency department care and other costly alternatives.^{1,2} The care of homeless people with chronic kidney disease (CKD) can be particularly challenging. Lack of dietary control, difficulty with securing and storing medications, and unreliable transportation and contact options frequently complicate treatment and lead to fragmented, ineffective care.¹

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Recent clinical studies have reported promising reductions in use of acute care services and in public costs through rapid housing interventions for homeless people with chronic illnesses.^{3,4} These housing interventions frequently couple independent housing with additional support services based on perceived need. However, few data are available on the prevalence, incidence, and influence of specific risk factors for end-stage renal disease (ESRD). Thus, in terms of ESRD prevention (or, when necessary, preparation for ESRD care) it is unclear which subgroup might benefit most from housing, other social services, or medical interventions and what type of ancillary care might attenuate the high mortality, morbidity, and costs incurred by this marginalized group.

To address these issues, we examined data from 982 homeless and 15,674 domiciled people with CKD who received ambulatory care through a large safety-net health system in the U.S.. The primary objective was to identify a subgroup of homeless people who were at particularly high risk for experiencing disease progression. We further sought to identify modifiable risk factors for progression of CKD to ESRD among this vulnerable group. We tested the hypothesis that most homeless people with CKD who eventually develop ESRD can be identified well in advance, using commonly available demographic and laboratory variables.

Methods

Design, participants, and setting

We assembled a cohort of people with non-dialysis requiring CKD stages 3–5 who received ambulatory care within the Community Health Network (CHN). The CHN is the health care delivery system of the Department of Public Health of the City and County of San Francisco. The CHN provides ambulatory and acute care to the majority of the estimated 130,000 uninsured residents of San Francisco. Services are available for free, or on a sliding scale based on income. Specific details of the cohort including a description of the CHN have been previously published.⁵

Data sources

The study cohort included 16,656 adults aged 18 years or older with non-dialysis-requiring CKD stages 3–5 who received ambulatory care in the CHN from January 1, 1996 to February 29, 2008. We defined CKD based on at least two outpatient eGFR measurements $<60 \text{ mL/min/1.73 m}^2$ as calculated by the re-expressed Modification of Diet in Renal Disease (MDRD) study equation based on calibrated serum creatinine, age, race, and sex, separated by at least three months.⁶

Outcome measures

The primary outcome was time to ESRD, defined as having a first service date for maintenance dialysis or kidney transplantation. To ascertain ESRD, we performed linking with the national ESRD registry (United States Renal Data System) files based on patient last name, first name, date of birth, and Social Security Number.⁷ To identify people lost to follow-up due to death, we performed identifier-matching with the National Death Index files using the same identifiers indicated above. We assessed ESRD and death through

December 31, 2010, the last date that data were available for both outcomes at the time of identifier linkage. Time to ESRD was defined as time from the first outpatient eGFR date until ESRD, death or the end of follow-up through December 31, 2010, whichever occurred first.

Independent variables

We extracted data on important sociodemographic and clinical factors that we hypothesized might predict progression of established CKD to ESRD among the urban poor based on prior studies.^{3,5,8} Covariates were measured at the visit closest to (and within one year of) the index-qualifying eGFR measurement. Individual-level sociodemographic covariates included age, sex, race-ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Asian/Pacific Islander, or other), and health insurance coverage (uninsured, Medicaid, Medicare, or commercial insurance) based on administrative data. We ascertained comorbid conditions based on established algorithms using discharge diagnostic codes, ambulatory diagnostic codes, and procedural codes for diabetes mellitus, hypertension, cardiovascular disease, chronic viral disease (hepatitis B virus, hepatitis C virus, HIV or AIDS), and drug or alcohol abuse.⁵ Laboratory covariates included eGFR, hemoglobin, serum calcium, serum albumin, and serum cholesterol concentrations, and proteinuria according to dipstick urinalysis.^{3,8}

Statistical analysis

We summarized the characteristics of the CHN cohort according to housing status using means (standard deviations) and proportions.

Model development—In order to estimate risk of progressing to ESRD, we developed four proportional hazards models each building on the previous.^{3,5,8} Starting with age, sex, race-ethnicity, and eGFR (model 1), we added dipstick proteinuria (model 2), health insurance coverage, comorbidities (diabetes mellitus, CVD, hypertension, substance abuse, and chronic viral disease) (model 3), and additional laboratory variables (serum albumin, serum calcium, serum cholesterol, and hemoglobin) (model 4). Because the association of eGFR and risk of ESRD is modified according to the presence and degree of proteinuria, we added an eGFR-proteinuria interaction term to models 2–4.⁹ All models were stratified by housing status. We assessed model fit using the Akaike Information Criterion and compared the fit of nested models using the likelihood ratio test.

Multiple imputation procedure and model fitting—In the full cohort, 18% of patients were missing dipstick proteinuria; 12% were missing serum cholesterol; and fewer than 2% were missing values for serum albumin, serum calcium, or hemoglobin. To reduce potential bias caused by excluding patients with missing data, we performed multiple imputation by chained equations method with 20 imputations for these variables using the R package ‘mice’ (version 2.18) and R (version 3.0.2, <http://cran.r-project.org>).^{10,11} Prior to imputation we transformed select covariates as necessary and checked for collinearity among covariates. To obtain estimates of the association between each covariate and ESRD, we fit the four models to each of the 20 imputed datasets. The model estimates were then averaged

and exponentiated. The standard errors were calculated accounting for the variability within and between the imputed datasets.

Model performance—Our primary interest was to develop a predictive model with an ability to discriminate among homeless people who would and would not progress to ESRD within a five-year time frame. Thus, we used the following measures to assess the predictive performance of each model: (1) area under the received operating characteristics curve (AUC),¹² (2) proportion of cases followed (PCF), and (3) proportion of the population needed to be followed (PNF).¹³ Proportion of cases followed and PNF are measures of concentration of risk that are directly relevant to public health decision-making. The expression $PCF(q)$ represents the estimated proportion of cases that would be captured if we followed proportion q of the population at highest risk. Larger values of PCF indicate better performance. The expression $PNF(p)$ represents the estimated proportion of the population at highest risk that would need to be followed in order to capture proportion p of the cases.¹³ Smaller values of PNF indicate better performance.

To obtain the aforementioned estimates of prediction capacity, we first estimated risk of ESRD within one, three, and five years. Risk of an event before year 1 was defined as one minus the ESRD-free survival probability up to year 1, similarly for years 3 and 5. To estimate risk of ESRD, we split each of the 20 imputed datasets into training and validation sets, generating three training-validation dataset pairs for each imputation. We fitted each model to the training data and obtained the predicted survival curves and the probability of ESRD-free survival beyond year 1, 3 and 5 for each subject based on the corresponding validation dataset. We repeated this process for each of training-validation dataset pair and evaluated the predictive capacity of these models using a three-fold cross validation.¹⁴

All measures were estimated nonparametrically using the predicted risks for each individual. We used inverse probability weighting, estimated using the Kaplan-Meier estimator, to account for censoring.¹⁵ The estimates for AUC, PCF, and PNF were obtained for each validation set based on a predictive model trained on the corresponding training set; these were averaged to obtain the final estimates along with their empirical standard errors. The United States Renal Data System and the institutional review boards at the University of Washington and University of California San Francisco reviewed and approved the study protocol.

Results

Patient characteristics

Compared with CKD cohorts from other health care settings,^{16–18} the study cohort was relatively young and racially-ethnically diverse. Most cohort members were indigent and either lacked health insurance or were enrolled in Medicaid (Table 1).

Homeless people with CKD were on average 10 years younger than their poor but domiciled counterparts. Most were men who were disproportionately of Black or White race. Notably, homeless people had a modestly lower prevalence of traditional ESRD risk factors such as diabetes mellitus and hypertension. As anticipated, the prevalence of substance abuse and

chronic viral diseases was substantially higher among homeless people. At cohort entry, homeless people appeared to have more advanced disease than domiciled peers as evidenced by higher degrees of proteinuria, lower concentrations of serum albumin and serum calcium, and lower levels of hemoglobin and estimated glomerular filtration rate (eGFR) (Table 1).

Incidence and determinants of ESRD

Overall, 71 (7%) homeless and 888 (6%) domiciled individuals progressed to ESRD over a median follow-up of 6.6 years. Incidence rates of ESRD were significantly higher among homeless people (10.9 for homeless vs. 7.4 for domiciled per 1000 person-years). Among the homeless, Blacks and people with diabetes mellitus, hypertension, and chronic viral disease experienced the highest incidence of ESRD (Table 2). After covariate adjustment, younger age, Black race, lower initial eGFR, dipstick proteinuria, and diabetes mellitus were independently associated with a higher adjusted risk of progressing to ESRD. In contrast, history of substance abuse, chronic viral disease, and lacking insurance or being enrolled in Medicaid were not associated with risk of ESRD after adjustment (Appendix Table 1).

Model performance and risk distribution

In this public health cohort, a simple model (model 2) incorporating age, sex, race-ethnicity, eGFR and dipstick proteinuria performed well in predicting risk of progression to ESRD within one year and offered substantial improvement over a model incorporating only age, sex, race-ethnicity, and eGFR (Table 3). Adding health insurance coverage and clinical comorbidities to model 2 did not meaningfully improve the ability to discriminate among homeless people who did and did not progress to ESRD within one year. The discriminatory ability of model 2 remained high and was equivalent to more complex models (models 3 and 4) at three and five years (Appendix Figure 1).

Figure 1 shows the correspondence between the predictive ability of model 2 and the observed outcomes for homeless patients who progressed to ESRD at one, three, and five years. As shown in Figure 1 (top panel), nearly all (96%) of homeless people who progressed to ESRD within one year were captured by considering only those in the highest decile of ESRD risk. Most patients who progressed to ESRD were captured by following similar “high risk” subgroups when extending the time frame to three and five years (Figure 1, middle and lower panels). In other words, as evidenced by the high proportion of cases followed (PCF) and low proportion of the population needed to be followed (PNF) estimates in Table 3, ESRD risk was highly concentrated in a small proportion of homeless people at highest risk for progressive disease.

Discussion

Among homeless people with moderate- to-advanced CKD receiving ambulatory care within a large public health system, we observed that ESRD risk was highly concentrated among relatively few individuals. Homeless individuals who suffered from diabetes mellitus and hypertension were at particularly high risk for ESRD as well as for death. Most homeless individuals who progressed to ESRD were easily identifiable several years before reaching ESRD using a prediction model that incorporated age, sex, race, eGFR and dipstick

proteinuria. Accordingly, a targeted program that followed homeless people in the highest decile of ESRD risk, for example, could have potentially captured the vast majority of those who progressed to ESRD within one year, and most of those who progressed to ESRD within three or five years. Our study findings may assist policymakers in evaluating the potential effectiveness and feasibility of programs that aim to reduce mortality, morbidity, and costs among homeless people with CKD. In addition to supportive housing, these individuals might receive more intensive risk factor management, and, when necessary, preparation to initiate ESRD or palliative care.

Due to the lack of surveillance systems for tracking the care of the poor or uninsured, few data are available on the prevalence of risk factors for kidney disease progression and their influence on ESRD risk among economically disadvantaged groups.⁵ While limited by short-term follow-up, we previously observed that homeless people with CKD experienced higher composite rates of ESRD and death, and used costly, non-primary care acute services more frequently than domiciled counterparts.² In the present study, we found that disproportionately high rates of ESRD (and death) among homeless people compared with domiciled peers continued to increase over longer follow up. In particular, we observed that homeless people with diabetes mellitus experienced remarkably poor outcomes: one in seven progressed to ESRD and one in three died during follow-up (compared with one in 14 homeless people overall). Homeless people with hypertension also suffered significantly higher rates of ESRD and death. These sobering outcomes are perhaps unsurprising given the numerous barriers that complicate effective management of chronic conditions such as CKD, diabetes mellitus, and hypertension among the urban poor. As evident in biochemical markers suggesting more severe disease and by more frequent acute care use, most homeless people with kidney disease in our cohort probably sought medical attention only when their condition was more advanced and/or symptomatic, or when treatment aligned with securing basic human needs (i.e., food, clothing, and shelter). As a result, measures of eGFR and proteinuria likely captured the majority of ESRD risk attributable to the aforementioned conditions, as they reflect antecedent control (or lack thereof) of the underlying disease process.

Needless to say, the challenges faced by vulnerable patients in managing their chronic conditions are magnified substantially when bereft of stable housing. Despite clear benefits in reducing CKD morbidity and mortality, interventions such as lowering of blood pressure and serum lipids and use of renin-angiotensin-aldosterone system inhibitors appear to be underutilized in disadvantaged populations.^{19–23} Particularly with homeless people, many providers may be reticent to prescribe therapies for non-life threatening conditions, due to unstable contact information and limited ability to monitor for adverse treatment effects.^{24,25} Homeless people may also adhere less frequently to treatment recommendations (e.g., salt reduction, nephrotoxin avoidance, medication adherence) due to their struggles to secure adequate nutrition and a safe place to store medications. As a result, proven interventions to slow CKD progression and reduce mortality are frequently not given high priority, leading to less effective care in earlier and in advanced stages of CKD.^{5,25}

Because the majority of patients with CKD do not progress to ESRD, public health systems are further challenged in identifying those individuals who will eventually develop

progressive disease. Until recently, disadvantaged patients with non- dialysis- requiring CKD in the U.S. were for all intents and purposes “invisible” to much of the health care system, unless they reached ESRD. However, increasing use of electronic health records now allows public health officials to identify groups of individuals with CKD who may benefit from more intensive surveillance, risk factor management, and when necessary preparation for ESRD care. While prior studies have yielded numerous risk predictive models for ESRD, these models have been developed in universally insured populations of predominantly elderly, non- Hispanic White adults for use by individual clinicians in calculating patient-level risk.²⁶ In contrast, we assessed our risk prediction models using two recently proposed criteria (proportion of cases followed and proportion needing follow up) which were designed to inform public health decisions, for example, in evaluating the potential effectiveness or feasibility of a care program.¹³ By pragmatically assessing these models from the perspective of public health, our results suggest that an intervention approach targeting a relatively small subgroup of homeless people at particularly high ESRD risk might be effective in capturing most individuals who will progress to ESRD in the short- to medium-term while being feasible in scale. In addition to heightened management of social risk factors for morbidity and mortality (e.g., substance abuse, mental illness), these individuals might receive additional care that specifically focuses on reducing their risk of ESRD, such as management of diabetes mellitus, hypertension, and chronic viral disease. Our results further demonstrate that such “high-risk” patients can be readily identified through systematic queries of the electronic health records. In turn, the electronic health records might be leveraged to mobilize resources (e.g., case management) through automated alerts when such patients interact with the health system.^{16,18,27,28}

Recent clinical trials have reported promising reductions in use of acute care services and in public costs through rapid housing interventions for homeless people with chronic conditions.^{3,4} Larimer *et al.* found marked reductions in public service costs and daily alcohol ingestion at six months among predominantly “roofless” people (i.e., homeless people living in the streets without a shelter that would constitute living quarters) with a history of alcohol abuse who received independent housing and on- site support services compared with wait- listed peers.³ Sadowski *et al.* observed modest reductions in acute care service and costs among homeless people who were randomly assigned to receive independent housing and case management compared with those who were assigned to receive usual care.^{4,29} Examined in the context of our results, these studies collectively suggest that provision of supportive housing coupled with risk factor management might not only be feasible but also lead to improved clinical outcomes and reduced public costs related to CKD, and particularly to ESRD.

Strengths and limitations

Our study is strengthened by the inclusion of homeless adults with moderate- to- advanced CKD from a large safety- net health system—a marginalized group rarely accessed in prior studies of CKD. In addition to providing detailed demographic and clinical data, we were able to link our cohort to national registries to obtain complete or nearly complete capture of treated ESRD and vital status. Our study also had several limitations. First, while the study included a diverse group of homeless people, our cohort may not be fully reflective of

homeless people (particularly “roofless” individuals) receiving care from public hospitals or safety-net health systems in other U.S. regions. However, the demographic composition of homeless people in our study and the high prevalence of socially determined comorbidities (including substance abuse and chronic viral diseases) align with estimates from other U.S.-based studies.³⁰ Second, our assessment of comorbid conditions was based on diagnostic codes and thus may underestimate the prevalence and severity of comorbidities such as cardiovascular disease, diabetes mellitus, hypertension, viral disease, and drug or alcohol abuse in this population. However, our prediction models incorporated important measures that at least partly reflected antecedent control of these comorbidities such as eGFR and dipstick proteinuria. As evidenced by little to no improvement in model performance with the addition of comorbidities, these intermediates appeared to capture a large fraction of the ESRD risk attributable to the aforementioned conditions and may have mitigated some degree of comorbidity under-ascertainment. Third, while it is possible that we have misclassified some people with acute kidney injury or with near normal kidney function as having CKD, we attempted to reduce this potential misclassification by requiring at least two outpatient eGFR determinations and one additional ambulatory visit for study inclusion. Lastly, misclassification of CKD and its severity using population-based GFR estimating equations may also be operative since the MDRD study equation was derived in a population of largely White and Black patients with moderate-to-advanced CKD, very few of whom had diabetes mellitus.⁶

Conclusions

Most homeless people with CKD who progress to ESRD can be easily and accurately identified earlier in their disease course by applying a simple risk model using commonly available variables. Leveraging risk prediction in the health care safety net may improve the effectiveness and reduce costs of CKD-related care by directing resources to a relatively small subcohort of homeless patients who are at highest risk for adverse clinical events.

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Notes

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Figure 1.

The estimated proportion of ESRD cases captured among the homeless (PCF) if a given proportion of the homeless subjects at highest predicted risk of ESRD (PNF) were to be followed. The predictions were based on model 2 (age, sex, ethnicity, eGFR, dipstick proteinuria, interaction of eGFR and dipstick proteinuria, and stratified by homeless status) and were made for one, three, and five- year time frames. To obtain the estimates, we generated 20 multiply imputed datasets. For each of those sets, we fit model 2 to all of the domiciled subjects and a randomly selected two- thirds of the homeless subjects in that dataset. We then predicted ESRD risk for the remaining third of the homeless subjects. The process was repeated for each of the 20 imputed datasets and three (mutually exclusive) splits of the homeless subjects per dataset. The black dots represent the estimated PCF for a given PNF in one of the 60 estimations. The blue line is a spline fit (with three degrees of freedom) and the 95% confidence intervals are shown in grey. The solid grey vertical line

corresponds to $PCF(0.1) = 0.96$ (at one year), which means that an estimated 96% ($n = 10/11$) of all ESRD cases that were diagnosed within the one- year time frame were among the 10% of all subjects at highest risk as predicted by model 2. Similarly, the solid grey lines correspond to $PCF(0.1) = 0.66$ ($n = 19/30$) and 0.64 ($n = 31/49$) at three and five years, respectively. The dashed vertical grey lines correspond to $PCF(0.1) = 1.00$ ($n = 11/11$), 0.85 ($n = 25/30$) and 0.84 ($n = 41/49$) at one, three, and five years, respectively.

Table 1

**BASELINE CHARACTERISTICS OF THE COMMUNITY HEALTH NETWORK COHORT
ACCORDING TO HOUSING STATUS (N = 16 656)**

Characteristics	Homeless N=982	Domiciled N=15 564	p-value ^a
Demographics			
Age (years) (mean, sd)	49.6 (10.9)	59.3 (13.6)	<.001
Male (n, %)	668 (68)	7112 (45)	<.001
Race or ethnicity (n, %)			
White	462 (47)	4213 (27)	<.001
Black	351 (36)	3117 (20)	
Hispanic	95 (10)	3011 (19)	
Asian	47 (5)	4926 (31)	
Other ethnicity	27 (3)	407 (3)	
Health insurance status			
Uninsured or Medicaid (n, %)	785 (80)	9184 (59)	<.001
Comorbidities			
Diabetes mellitus (n, %)	153 (16)	3568 (23)	<.001
Hypertension (n, %)	305 (31)	7552 (48)	<.001
Cardiovascular disease (n, %)	147 (15)	3015 (19)	.001
Substance abuse (n, %)	554 (56)	2573 (16)	<.001
Chronic viral disease (n, %)	421 (43)	3557 (23)	<.001
Laboratory data			
eGFR mL/min/1.73m ² (n, %)			<.001
45–59	709 (72)	12 470 (80)	
30–44	175 (18)	2205 (14)	
15–29	70 (7)	744 (5)	
<15	28 (3)	255 (2)	
Proteinuria dipstick (n, %)			<.001
None or trace	488 (54)	7839 (62)	
1+	210 (23)	2393 (19)	
2+	144 (16)	1581 (13)	
3+	58 (6)	827 (7)	
Albumin (g/dL) (mean, sd)	3.6 (0.8)	3.9 (0.7)	<.001
Calcium (mg/dL) (mean, sd)	8.7 (1.0)	9.1 (0.8)	<.001
Hemoglobin (g/dL) (mean, sd)	12.3 (2.3)	12.9 (2.0)	<.001
Serum creatinine (mg/dL) (mean, sd)	1.8 (1.2)	1.5 (1.1)	<.001
Cholesterol (mg/dL) (mean, sd)	169.3 (49.6)	196.9 (53.5)	<.001

^aP-values for continuous characteristics were calculated using a two-sided t-test, those for categorical covariates were calculated using a Chi-squared test.

Table 2

INCIDENCE RATES OF END-STAGE RENAL DISEASE (ESRD) AMONG HOMELESS PERSONS IN THE COMMUNITY HEALTH NETWORK COHORT

Variable	No. at risk	ESRD events	Time at risk (person-years)	Incidence rate (per 1000 person-years)	Attributable risk percent
All	982	71	6501.0	10.9	
Age (years)					
18–39	165	17	1211.8	14.0	(reference)
40–49	368	27	2470.8	10.9	–22.1
50–59	299	25	1794.6	13.9	–0.7
60	150	2	1023.8	2.0	–86.1
Sex					
Women	314	18	2143.7	8.4	(reference)
Men	668	53	4357.3	12.2	31.0
Race or ethnicity					
White	462	19	3077.9	6.2	(reference)
Black	351	45	2310.7	19.5	68.3
Other	169	7	1112.4	6.3	1.9
Comorbidities					
No hypertension	677	42	4609.4	9.1	(reference)
Hypertension	305	29	1891.6	15.3	40.6
No diabetes	829	51	5590.3	9.1	(reference)
Diabetes mellitus	153	20	910.6	22.0	58.5
No viral disease	561	41	3844.5	10.7	(reference)
HIV, HCV or HBV	421	30	2656.5	11.3	5.6
No h/o abuse	428	35	3013.6	11.6	(reference)
Substance abuse	554	36	3487.4	10.3	–11.1

Table 3

PREDICTION PERFORMANCE OF STUDY MODELS BASED ON THE COMMUNITY HEALTH NETWORK COHORT (N = 16 656)^a

	Model 1	Model 2	Model 3	Model 4
Year 1				
AUC	0.90	0.97	0.97	0.98
PCF(0.1)	0.62	0.96	0.90	0.95
PCF(0.2)	0.86	1.00	1.00	1.00
PNF(0.8)	0.14	0.07	0.05	0.03
PNF(0.9)	0.23	0.09	0.07	0.07
Year 3				
AUC	0.75	0.90	0.90	0.90
PCF(0.1)	0.41	0.66	0.67	0.70
PCF(0.2)	0.62	0.85	0.80	0.84
PNF(0.8)	0.51	0.18	0.18	0.17
PNF(0.9)	0.73	0.30	0.32	0.30
Year 5				
AUC	0.74	0.90	0.90	0.90
PCF(0.1)	0.31	0.64	0.64	0.67
PCF(0.2)	0.48	0.84	0.82	0.84
PNF(0.8)	0.45	0.17	0.17	0.17
PNF(0.9)	0.64	0.32	0.32	0.33

^a Average of estimates of prediction performance of models 1–4 obtained by fitting the models to all of the domiciled subjects and a randomly selected 2/3 of the homeless subjects and evaluated on the remaining 1/3 of the homeless subjects, repeated over 20 imputed datasets and for each 1/3 of the homeless subjects per imputed dataset. The imputed datasets were based on the Community Health Network cohort (n = 16 656). AUC = area under the ROC curve; PCF(q) = proportion of cases followed if proportion q of the population at highest risk is followed; PNF(p) = proportion of the population at highest risk that needs to be followed to capture the proportion p of the cases. The mean standard error for year 1 was 0.07, for year 3 = 0.07 and for year 5 it was = 0.06. The maximum standard error for year 1 was 0.17, for year 3 = 0.16 and for year 5 it was = 0.17.