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Cascade of care of people diagnosed with HIV in New Zealand between 2006 and 2017

S McAllister,[1,*] H vanAsten,[1,*] A Anglemyer,[1] S Crengle,[2] J Zeng,[2] N Raymond,[3] R Handy,[4] M Giola,[5] N Dickson[1] and P Priest[1]

[1]*AIDS Epidemiology Group, Department of Preventive and Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand,* [2]*Department of Preventive and Social Medicine, Dunedin School of Medicine, University of Otago, Dunedin, New Zealand,* [3]*Capital and Coast District Health Board, Wellington, New Zealand,* [4]*Auckland District Health Board, Auckland, New Zealand and* [5]*Bay of Plenty and Lakes District Health Board, Tauranga and Rotorua, New Zealand*

Objectives

We estimated the proportion of people reported with HIV in New Zealand between 2006 and 2017, and alive in 2017–2019, who were on antiretroviral therapy (ART) and had a suppressed viral load (VL), and explored their associated characteristics.

Methods

Data were anonymously linked to information on ART and VL within the data collection period (January 2017 to August 2019) using the National Health Index (NHI), Ministry of Health and laboratory datasets, as well as information from clinical specialists. Logistic regression was used to test for associations. Sensitivity analyses were undertaken to estimate the range for the key proportions.

Results

Overall, 2355 people were reported with HIV, of whom 116 (5%) had died, 337 (14%) were overseas, and 1701 (72%) were alive in New Zealand; for the remaining 201 (9%) the outcome was unknown. Clinical data were available for 1490 people (87.6%): 1408 (94.5%) were on ART, 11 (< 1%) were not on ART, and for 71 (4.8%) this was unknown. Of those on ART, 1156 (82.1%) had a suppressed VL (< 200 copies/mL), 34 (2.4%) were unsuppressed, and for 218 (15.5%) this was unknown. The estimate of the proportion on ART ranged from 99% to 78%, and those with a suppressed VL ranged from 98% to 78%.

Conclusions

Among people with HIV in New Zealand who are under care, a high proportion were on ART and had suppressed VL. Increasing collection of NHIs and better linkage with laboratory information will reduce the number with unknown information and provide more complete VL results in the future.

Keywords: antiretroviral therapy, cascade, HIV, viral load

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Introduction

The outcomes for people infected with HIV can be significantly improved through antiretroviral therapy (ART), especially if treatment is initiated early [1,2]. In addition, over the last decade, there has been increasing interest in 'Treatment as Prevention (TasP)' [3–6] and 'Undetectable = Untransmittable (U = U)' [7] as public health strategies to control HIV that take advantage of the fact that early-initiated ART significantly reduces an individual's risk of transmission. For TasP and U = U to be most effective, the number with undiagnosed HIV infection needs to be minimized, and the proportions diagnosed with HIV on treatment with a suppressed viral load (VL) needs to be maximized [8,9].

The model used for monitoring care is referred to as the 'cascade of care' [10] which originally measured the

Correspondence: Dr Susan McAllister, AIDS Epidemiology Group, Department of Preventive and Social Medicine, Dunedin School of Medicine, PO Box 56, Dunedin, New Zealand. Tel: +64 3 479 7108; fax: + 64 3 479 7298; e-mail: sue.mcallister@otago.ac.nz

*Joint first authors.

number of people with HIV who had been: (a) diagnosed, (b) linked into HIV care, (c) retained in HIV specialist care, (d) on ART, and (e) had a suppressed VL. This has been simplified more recently in line with models built by United Nations AIDS (UNAIDS) which suggest the HIV epidemic would end worldwide if 90% of people living with HIV were diagnosed, 90% of those diagnosed receive ART, and 90% of people on ART have a suppressed VL – a target referred to as 90-90-90 [11]. Although the 90-90-90 concept is relatively simple, the measurement of these targets is challenging [12]. A systematic review of HIV care studies by Granich *et al.* [13] identified 53 countries with national-level data, only six of which were of high quality, categorized as using national estimates for the overall denominator of people living with HIV, a cohort or national programme database of everyone diagnosed with HIV, on ART, and with individual VL data. Sweden was the first country to have national-level data indicating achievement of the 90-90-90 targets, reporting in 2015 that 90% of all HIV-infected people were diagnosed, 95% were on ART, and 95% of those on treatment for at least 6 months had a suppressed VL [14]. Recently in the UK, the UNAIDS targets were also exceeded with estimated values of 93% diagnosed, 97% receiving treatment and 97% with a suppressed VL [15]. In Australia in 2017, an estimated 89% of infected people had been diagnosed, of whom 87% were on ART, and 95% of those on treatment had a suppressed VL [16].

In New Zealand, an audit in 2000 found that 71% of HIV-infected people under active follow-up were on ART, of whom 62% had a suppressed VL [17]. In 2016, assessment of the cascade of care for people living with HIV in the Wellington region showed that 89% of those under care were on ART, of whom 93% had a suppressed VL [18]. To date, however, no national data measuring the cascade of care of people living with HIV in New Zealand has been available.

Recent changes to HIV notification legislation in 2017, which allowed the collection of the National Health Index (NHI) for patients diagnosed with HIV, have now made it more feasible to measure the cascade of care. The NHI is a unique identifier that is assigned to every person using health and disability support services in New Zealand, irrespective of their residency status [19], and allows for anonymized data linkage across national Ministry of Health (MoH) datasets. Also, after July 2017, all people with HIV were eligible for subsidized ART irrespective of CD4 count, in line with international recommendations [20], making the proportion of all infected people in New Zealand on ART a valuable indicator of care. As a result of these changes, we are now able to undertake a national analysis of ART use and viral loads of people diagnosed with HIV in more recent years, which will contribute towards informing the second two UNAIDS 90-90-90 targets.

This study aims to estimate the treatment and VL status of people living with HIV in New Zealand in 2017–2019 and explore characteristics that might be associated with being on ART or achieving viral suppression.

Methods

Setting and study population

The AIDS Epidemiology Group (AEG), based at the University of Otago, New Zealand, has overseen the HIV/AIDS surveillance since 1989, under contract to the New Zealand MoH. Information on people diagnosed with HIV is provided to the AEG by laboratories. The AEG then requests a case report from the clinician who ordered the HIV test [21]. All data collected by the AEG uses an anonymized case code and, since 2017, the NHI.

To assemble the group of people living with HIV in 2017–2019 we started with the population of people reported with HIV in New Zealand from 1 January 2006 to 31 December 2017. These include people diagnosed in New Zealand and those previously diagnosed overseas having a VL test for HIV monitoring in New Zealand. While many of the 1991 people reported with HIV prior to 2006 and not known to have died or gone overseas are still likely to be living in New Zealand, they are not included in this study due to the difficulty in matching them to an NHI, which is necessary to obtain information on their ART and VL status.

Data sources

We used information from four main sources: (1) HIV and AIDS databases managed by the AEG; (2) clinicians caring for people living with HIV; (3) laboratories that undertake HIV diagnostic and VL testing; and (4) pharmaceutical claims, hospitalizations, and mortality datasets maintained by the MoH.

Data collection

Data were collected in 2018–2019, and the most recent ART and VL result between 1 January 2017 and 31 August 2019 (the 'data collection period') was used in the analysis. Hence, the ART and VL results are a cross-sectional snapshot of the status of people living with HIV during that period, who were reported with HIV in New Zealand from 2006 to 2017.

Clinical record data

Specialist HIV clinicians throughout New Zealand were sent a list of case codes for people in the study population and asked to provide information on whether or not their patients had died, gone overseas or moved to another part of New Zealand, and whether they were on ART, the date of the most recent ART prescription, and the date and result of the most recent VL test.

Determining NHI

Specialist HIV clinicians and the main laboratories that carry out HIV diagnostic testing were asked to match case codes to the person's NHI, for people in the study population whose notification did not include their NHI. Following this, a dataset containing the case codes of individuals still without NHIs was securely sent to the MoH to try to match them to an NHI using the case code and date of birth.

Linkage to national datasets

The MoH used all available NHIs to link notification data with: (1) the national pharmaceutical claims database with information on ART and other prescription claims, from which prescription dates were obtained; (2) the national mortality collection database to obtain information on deaths and when these had occurred; and (3) the National Minimum Dataset to obtain hospitalization information. To obtain the date and result of the most recent VL test for individuals when VL data were unavailable from clinical records, the case codes and NHIs of patients were securely sent to viral laboratories, and this information was requested.

Where data on ART use and viral load were available from both clinical records and linked datasets, the most recent result within the data collection period was used.

Definitions and categories

The following definitions and categories were used:

(1) Outcome:

- (a) Died: death was reported by a clinician or at least one data source.
- (b) Overseas: reported by a clinician to have left New Zealand, and no death, laboratory, pharmaceutical dispensing or hospitalization record indicating recent care in New Zealand.
- (c) Alive in New Zealand: not reported to have died or gone overseas, and clinical data within the data collection period were available from a clinician or at least one source.
- (d) Unknown outcome: reported with HIV, an initial case report form was received and the case code was able to be matched to an NHI, but there was no information from a clinician or any of the datasets within the data collection period.
- (e) Unconfirmed report: reported with HIV but the initial case report was never received, there was no available NHI, and no information on any of the datasets within the data collection period.

(2) Clinical data available:

- (a) Clinical data available: an NHI was able to be matched to a case code or a clinician was able to supply information on ART and/or VL through the case code.
- (b) Clinical data not available: no NHI was able to be matched to a case code and no data were therefore available either through an NHI or a case code.

(3) ART status:

- (a) On ART: ART prescribed within the data collection period evidenced from the pharmaceutical database, clinical records, or evidence of a suppressed VL regardless of ART data availability.
- (b) Not on ART: clinician caring for the person stated not on ART.
- (c) Unknown ART: no evidence of ART being prescribed within the data collection period.

(4) VL status:

- (a) Suppressed VL: the most recent VL result within the data collection period < 200 copies/mL evidenced from laboratory or clinical records.
- (b) VL not suppressed: the most recent VL result within the data collection period evidenced from laboratory or clinical records ≥ 200 copies/mL.
- (c) Unknown VL: no information on VL within the data collection period.

From the AEG database, demographic data included sex, current age (calculated from midpoint of data collection minus the date of birth), and ethnicity with multiple responses prioritized according to Statistics New Zealand with all other ethnicities prioritized above European [22]. HIV data included the year of HIV report grouped into three time periods (2006–2009, 2010–2013 and 2014–2017), place of first diagnosis (New Zealand, overseas), and main mode of infection defined as homosexual (including those for whom the mode of infection was reported as both homosexual and injecting drug use (IDU), heterosexual (including those for whom the mode of infection was reported as both heterosexual and IDU), and other (IDU alone, perinatal transmission and other

modes not further defined). Responses that were unknown or missing were retained as a separate category.

Statistical analysis

Logistic regression with robust standard error was used to assess the association between ART receipt and suppressed VL and each of the case characteristics separately. The results are reported as unadjusted odds ratios (UORs) with 95% confidence intervals (95% CIs). Additionally, sensitivity analyses were performed to evaluate the impact of using different assumptions or imputations on estimates with unknown values. All analyses were performed in Stata 12.1 [23].

Ethical approval

Ethical approval was granted by the Northern A. Health and Disability Ethics Committee (18/NTA/9). All data were stored on password-protected computers accessed only by AEG staff. All data transfers between the MoH, clinicians or laboratories were password-protected. No individual identifiable information was available to the research team.

Results

Characteristics of study population

A total of 2355 people were reported with HIV in New Zealand in the 12-year period from 1 January 2006 to 31 December 2017. Of these, 116 (4.9%) were known to have died, 337 (14.3%) were overseas, and 1701 (72.2%) were considered to be alive in New Zealand. Of the remaining, 111 (4.7%) were confirmed to have been reported with HIV, but we were unable to ascertain their outcome, and 90 (3.8%) were unconfirmed reports (Fig. 1; see Table S1 for information on the characteristics of people in each of these categories)

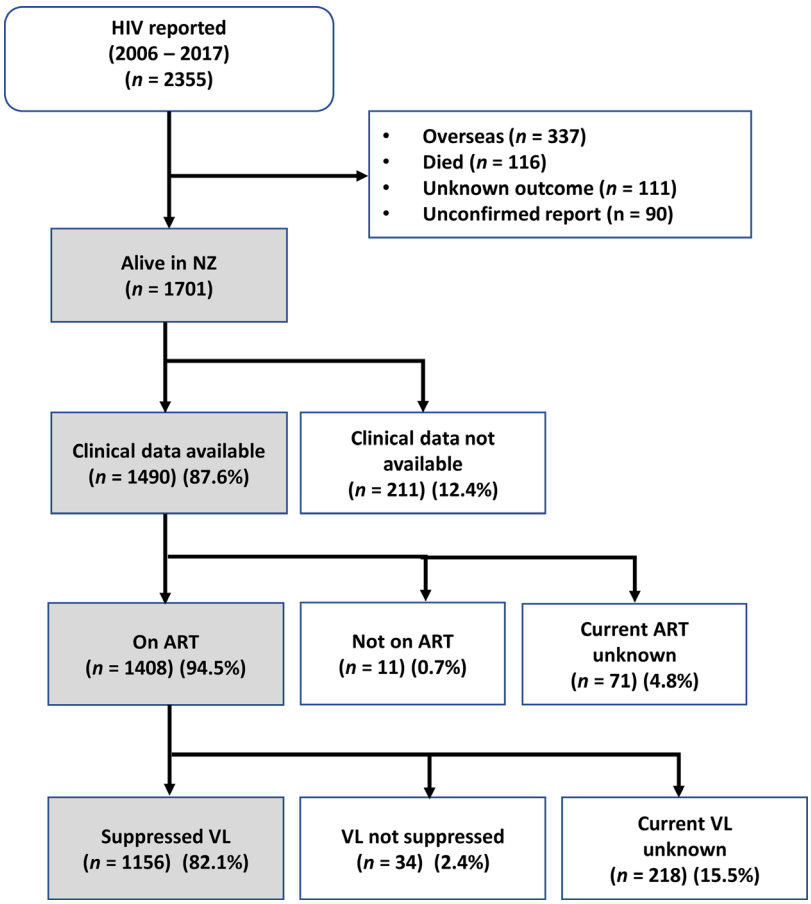

Fig. 1 Flow chart of study population. VL, viral load ART, antiretroviral therapy.

Clinical data

Of the 1701 people alive in New Zealand, clinical information was obtained for 1490 (87.6%). Groups having higher proportions with clinical data included those reported in more recent years (83.6% in 2006–2009, 90.6% in 2010–2013, 88.6% in 2014–2017), those first diagnosed in New Zealand (88.8%) compared with overseas (79.2%), men infected through homosexual contact (89.4%) compared with people infected through heterosexual contact (85.4%) and those of Māori ethnicity (95.3%) compared with Europeans (87.9%). People of 'other' ethnicity (80.8%) comprised the lowest proportion with clinical data available (Table 1).

ART status

Of the 1490 people with clinical data, 1408 (94.5%) were confirmed to be on ART, 11 (< 1%) were not on ART, and 71 (4.8%) had unknown ART status. Neither the year of HIV report nor any other characteristics for which we had data differed by ART (Table 2).

Of the 71 people whose ART status was unknown, 29 had a VL result out of the date range (25 suppressed and four not suppressed), and 42 did not have a VL result. Of the latter 42, there was evidence of all having received a prescription in New Zealand for non-ART medication within the data

Table 1 Characteristics of the study population according to availability of clinical data

Characteristics	Clinical data available		Clinical data not available		UOR (95% CI)
	n	%	*n*	%	
Total (*n* = 1701)	1490	87.6	211	12.4	
Sex					
Male	1274	88.0	173	12.0	1.00
Female	216	85.0	38	15.0	0.77 (0.53–1.13)
Year of report[a]					
2006–2009	450	83.6	88	16.4	1.00
2010–2013	434	90.6	45	9.4	1.88 (1.29–2.77)
2014–2017	606	88.6	78	11.4	1.52 (1.09–2.11)
Place of first diagnosis					
New Zealand	1319	88.8	166	11.2	1.00
Overseas	171	79.2	45	20.8	0.48 (0.33–0.69)
Current age (years)					
< 30	136	88.3	18	11.7	1.00
30–39	364	90.5	38	9.5	1.26 (0.70–2.30)
40–49	426	85.2	74	14.8	0.76 (0.44–1.32)
50+	564	87.4	81	12.6	0.92 (0.53–1.59)
Mode of HIV infection					
Homosexual contact	973	89.3	116	10.7	1.00
Heterosexual contact	362	85.4	62	14.6	0.70 (0.50–0.97)
Other	55	85.9	9	14.1	0.73 (0.35–1.51)
Unknown/not stated	100	80.6	24	19.4	0.50 (0.31–0.81)
Ethnicity					
European	826	87.9	114	12.1	1.00
Māori	142	95.3	7	4.7	2.80 (1.28–6.13)
Pacific	61	91.0	6	9.0	1.40 (0.59–3.32)
Asian	226	87.6	32	12.4	0.97 (0.64–1.48)
Other[b]	185	80.8	44	19.2	0.58 (0.40–0.85)
Unknown/not stated	50	86.2	8	13.8	0.86 (0.40–1.87)

UOR, unadjusted odds ratio; 95% CI, 95% confidence interval.
[a]Year of report to the AIDS Epidemiology Group can be the year of diagnosis or year of first notification of a viral load test in New Zealand for people previously diagnosed overseas.
[b]Other: Middle Eastern, Latin American, African, Other.

Table 2 Characteristics of the study population on antiretroviral therapy (ART) compared with those not on ART or in whom the ART status is unknown

Characteristics	On ART *n* (%)	Not on ART/unknown ART *n* (%)	UOR (95% CI)
Total (*n* = 1490)	1408 (94.5)	82 (5.5)	
Sex			
Male	1202 (94.3)	72 (5.7)	1.00
Female	206 (95.4)	10 (4.6)	1.23 (0.63–2.43)
Place of first diagnosis			
New Zealand	1246 (94.5)	73 (5.5)	1.00
Overseas	162 (94.7)	9 (5.3)	1.05 (0.52–2.15)
Year of report[a]			
2006–2009	431 (95.8)	19 (4.2)	1.00
2010–2013	412 (94.9)	22 (5.1)	0.83 (0.44–1.55)
2014–2017	565 (93.2)	41 (6.8)	0.61 (0.35–1.06)
Current age (years)			
< 30	127 (93.4)	9 (6.6)	1.00
30–39	339 (93.1)	25 (6.9)	0.96 (0.44–2.12)
40–49	401 (94.1)	25 (5.9)	1.14 (0.52–2.50)
50+	541 (95.9)	23 (4.1)	1.67 (0.75–3.69)
Mode of HIV infection			
Homosexual contact	918 (94.4)	55 (5.6)	1.00
Heterosexual contact	347 (95.9)	15 (4.1)	1.38 (0.77–2.49)
Other	50 (90.9)	5 (9.1)	0.60 (0.23–1.56)
Unknown/not stated	93 (93.0)	7 (7.0)	0.79 (0.35–1.80)
Ethnicity			
European	783 (94.8)	43 (5.2)	1.00
Māori	133 (93.7)	9 (6.3)	0.81 (0.39–1.70)
Pacific	58 (95.1)	3 (4.9)	1.06 (0.32–3.52)
Asian	212 (93.8)	14 (6.2)	0.83 (0.45–1.55)
Other[b]	175 (94.6)	10 (5.4)	0.96 (0.47–1.95)
Unknown/not stated	47 (94.0)	3 (6.0)	0.86 (0.26–2.88)

UOR, unadjusted odds ratio; 95% CI, 95% confidence interval.
[a]Year of report to the AIDS Epidemiology Group can be the year of diagnosis or year of first notification of a viral load test in New Zealand for people previously diagnosed overseas
[b]Other: Middle Eastern, Latin American, African, Other

Table 3 Characteristics of the study population on antiretroviral therapy (ART) and with suppressed viral load (VL) compared with those with VL not suppressed or in whom the VL status is unknown

Characteristics	Suppressed VL *n* (%)	VL not suppressed/unknown *n* (%)	UOR (95% CI)
Total (n = 1408)	1156 (82.1)	252 (17.9)	
Sex			
Male	983 (81.8)	219 (18.2)	1.00
Female	173 (84.0)	33 (16.0)	1.17 (0.78–1.74)
Place of first diagnosis			
New Zealand	1022 (82.0)	224 (18.0)	1.00
Overseas	134 (82.7)	28 (17.3)	1.05 (0.68–1.62)
Year of report[a]			
2006–2009	327 (75.9)	104 (24.1)	1.00
2010–2013	315 (76.5)	97 (23.5)	1.03 (0.75–1.42)
2014–2017	514 (91.0)	51 (9.0)	3.21 (2.23–4.61)
Current age (years)			
< 30	106 (83.5)	21 (16.5)	1.00
30–39	278 (82.0)	61 (18.0)	0.90 (0.52–1.56)
40–49	321 (80.1)	80 (19.9)	0.79 (0.47–1.35)
50+	451 (83.4)	90 (16.6)	0.99 (0.59–1.67)
Mode of HIV infection			
Homosexual contact	752 (81.9)	166 (18.1)	1.00
Heterosexual contact	282 (81.3)	65 (18.7)	0.96 (0.70–1.32)
Other	43 (86.0)	7 (14.0)	1.36 (0.60–3.07)
Unknown/not stated	79 (85.0)	14 (15.0)	1.25 (0.69–2.25)
Ethnicity			
European	645 (82.4)	138 (17.6)	1.00
Māori	104 (78.2)	29 (21.8)	0.77 (0.49–1.20)
Pacific	45 (77.6)	13 (22.4)	0.74 (0.39–1.41)
Asian	185 (87.3)	27 (12.7)	1.47 (0.94–2.28)
Other[b]	137 (78.3)	38 (21.7)	0.77 (0.52–1.16)
Unknown/not stated	40 (85.1)	7 (14.9)	1.22 (0.54–2.79)

UOR, unadjusted odds ratio; 95% CI, 95% confidence interval.
[a]Year of report to the AIDS Epidemiology Group can be the year of diagnosis or year of first notification of a viral load test in New Zealand for people previously diagnosed overseas.
[b]Other: Middle Eastern, Latin American, African, Other.

collection period, suggesting that they had been alive in New Zealand and connected with some health services for at least some of the period.

Sensitivity analysis

To evaluate the impact of using different assumptions or imputations on estimates with unknown values, here we present the plausible upper and lower limits of the proportion on ART. A maximum estimate of the proportion of the study population on ART is 99.3%, calculated by including all with clinical information known to be on ART (n = 1408) and those with unknown ART status (n = 71) in the numerator, and all people with clinical information in the denominator (n = 1490). Our estimate of the minimum proportion of people diagnosed with HIV who are on ART is 77.7%, calculated by including in the numerator those confirmed to be on ART (n = 1408), and in the denominator, all those believed to be alive in New Zealand as well as those with unknown outcome (1701 + 111) (Fig. 1).

Suppressed viral load

Of the 1408 people known to be on ART, 1156 (82.1%) had a suppressed VL, 34 (2.4%) were not suppressed, and 218 (15.5%) had unknown VL status. Amongst those on ART, the proportion who had a suppressed VL was lower in people reported in 2006–2009 (75.9%) and in 2010–2013 (76.5%), but increased to 91.0% for those reported in 2014–2017 (Table 3). Among the 218 people for whom the current VL status was unknown, there were 41 people who had a suppressed VL but for whom the last date of laboratory test was before the data collection date range.

For 26 of the 34 people without suppressed VL, no reason was available to indicate why they did not achieve viral suppression. For the remaining eight people, their clinicians reported a lack of treatment compliance. There was no evidence of any characteristics being associated with having a suppressed VL (Table 3).

Sensitivity analysis

Assuming that those with an earlier VL result showing suppression continued to have a suppressed VL (and were therefore likely to be on ART), then including them in both the numerator and denominator would give 82.6% of people on ART with a suppressed VL.

A maximum estimate of the proportion on ART with suppressed VL is 97.6%, calculated by including those with known suppressed VL (n = 1156) and assuming that all those with unknown VL (n = 218) were in fact suppressed, and using the denominator of those known to be on ART (n = 1408). A minimum estimate of the proportion on ART with suppressed VL is 78.2%, calculated by including in the denominator everyone on ART and those with unknown ART status (1408 + 71).

Discussion

Of the people reported with HIV in New Zealand between 2006 and 2017 for whom we were able to obtain clinical

data from clinicians or by anonymously linking to national datasets, we estimate that 95% were on ART and 82% of those on ART had a suppressed VL. For those reported with HIV in more recent years (2014–2017), these proportions were 93% and 91%, respectively, above the UNAIDS targets for 90% for these two measures.

This study has a number of strengths, including the collection of data on individuals, the ability to link data with centralized MoH datasets, and the collaboration of HIV specialist clinicians throughout the country. However, there are also several limitations. The study was cross-sectional and therefore we are only able to provide the proportion of people on ART and with a suppressed VL at one time period, and only of those who were reported with HIV in the 12-year period. While there is a close network of HIV specialist clinicians that allows for the collection of information on patients, the NHI to link to national MoH and laboratory datasets is crucial. The legislation allowing the AEG to hold NHIs was changed only in 2017 and therefore required case codes from earlier years to be manually matched to NHIs. This matching was not possible for 12% of our sample. Going forward it is important to ensure completeness of the NHI to facilitate future HIV care cascade studies.

A further limitation is the number of people diagnosed with HIV whose current status is unknown even after a search of medication dispensing, hospitalization and mortality databases, and also the number whose clinical data were unobtainable. It is likely that some of these people are not living in New Zealand, but in the absence of reliable emigration information and further searching of records this cannot be confirmed. It is also unclear why there was no record of ART status for a small number of people who were accessing other prescription medication and this would require closer investigation with clinicians caring from these individuals. There is the possibility of them having opted out of ART treatment or obtaining medication from overseas.

Our estimate of 82% of people on ART with a suppressed VL is likely to be an underestimate due to the lack of a central laboratory depository from which to obtain this information and the limited time and resources available to capture all laboratory and clinical data. These data did improve for those who had been reported with HIV in more recent years between 2014 and 2017 (91%) and an emphasis for future studies will be to ensure there is a good data capture system of VL information from all VL laboratories.

Undertaking sensitivity analyses for both the proportion on ART and those with a suppressed VL allowed us to account for cases with an unknown outcome or where clinical data were not available. This gave a range for the proportion on ART from 99% to 78%, and for those on ART with a suppressed VL from 98% to 78%. Ensuring the number of 'unknowns' is kept to a minimum will be important for future HIV care cascade studies.

Our study showed that of people under care for HIV, New Zealand has met the UNAIDS target of 90% receiving ART and is likely to have reached the third target, but due to study limitations this cannot be confirmed. The absence of recent New Zealand data on the proportion of people with HIV who are undiagnosed means that we cannot say whether or not New Zealand is meeting the first UNAIDS target. The most recent estimate was in 2011 in an Auckland study of men who have sex with men, which showed that 20.9% of HIV-infected men were undiagnosed [24]. Since then, there has been a scale-up of testing, which includes increased availability of home-testing kits and a number of testing campaigns, and provision of pre-exposure prophylaxis, which includes HIV testing. It is therefore likely that, with such testing and ongoing new diagnoses, and the increased survival of people living with HIV on ART, the proportion undiagnosed has decreased, but this cannot be confirmed until a further prevalence study is undertaken.

Comparing our results with countries with a similar HIV epidemiological profile, Australian data reported the percentages of people with diagnosed HIV on ART for the years 2015 (85%), 2016 (86%) and 2017 (87%), and these were similar to our findings; however, they reported a higher proportion who had a suppressed VL (91%, 93% and 95%, respectively) [16]. Sweden, reported to be the first country to achieve the 90-90-90 targets, had 95% of diagnosed HIV patients on ART and 95% with VL suppression using data derived from a cohort study established in 2003 [14]. The UK, in 2018, estimated 97% of people diagnosed with HIV were on ART and 97% virally suppressed [15]. Earlier data from Denmark in 2014 reported 91% diagnosed, 94% on ART and 94% virally suppressed, and corresponding proportions from Switzerland in 2015 were 82%, 91% and 97% [25]. The collection of cascade data in different countries, however, uses different methods, different time frames and different application of the standard definitions and it is therefore difficult to make direct comparisons.

This snapshot of HIV care cascade data shows that the majority of people who are under care for HIV in New Zealand are receiving ART and have a suppressed VL. This is what would be expected given the access to government-subsidized ART through a small network of HIV specialist clinicians who regularly monitor their patients and provide HIV services and treatment that are free of charge. This approach to HIV service provision probably explains the lack of significant patient characteristics

associated with being on ART or having a suppressed VL in this analysis. More research is required to track and understand the unknown cases, as well as to investigate the number and proportion of people living with HIV who are undiagnosed. Improved access to the NHI to carry out data linkage, combined with a system of ongoing collection of up-to-date data on an annual basis, is likely to achieve more complete data than a retrospective review. Data from this study, and the ongoing data collection, are necessary to contribute to better understanding of how New Zealand is meeting the goals to ending HIV.

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Conflict of interest: The authors declare that they have no conflicts of interest.

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Author contributions

SM, ND and PP designed the study. HvA and SM coordinated and undertook the data collection. HvA and AA performed the data management. SM performed the statistical analysis with advice from AA and JZ. NR, RH, MG and SC provided clinical advice. SM and HvA drafted the manuscript. All authors read, revised and approved the final manuscript.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Characteristics of the study population according to their status.