Modeling population viral load metrics for monitoring impact of treatment as prevention

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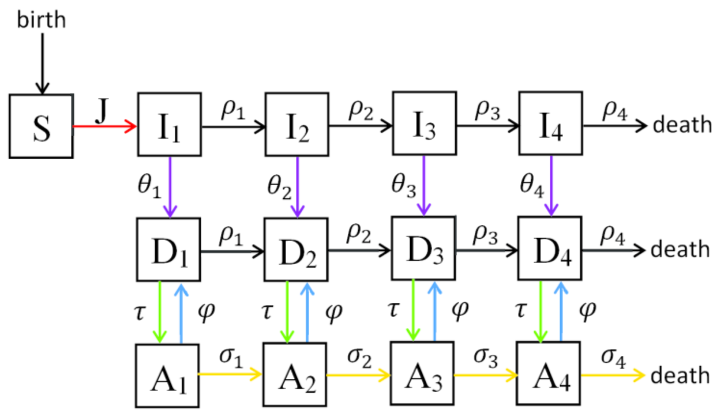
Background

- Population viral load (**VL**) measures are used to assess the impact of antiretroviral treatment (**ART**) as prevention on HIV transmission (guidelines by CDC, 2011)
- Conclusions regarding their correlation with trends in incidence are controversial (Miller et al 2013)
- Interpretation of these measures is difficult because of methodological uncertainties and sampling biases due to *hidden populations* (undiagnosed and persons with primary infection)

Methods

- Sexual transmission model for HIV infection, diagnosis and treatment
- 2 epidemiological scenarios: generalized epidemic in sub-Saharan Africa (**SSA**) and concentrated epidemic among men who have sex with men (**MSM**) in Western Europe (**WE**)
- Different parameters: average time to diagnosis in chronic infection, annual dropout percentage, HIV prevalence before ART, VL in primary infection



- VL measures:

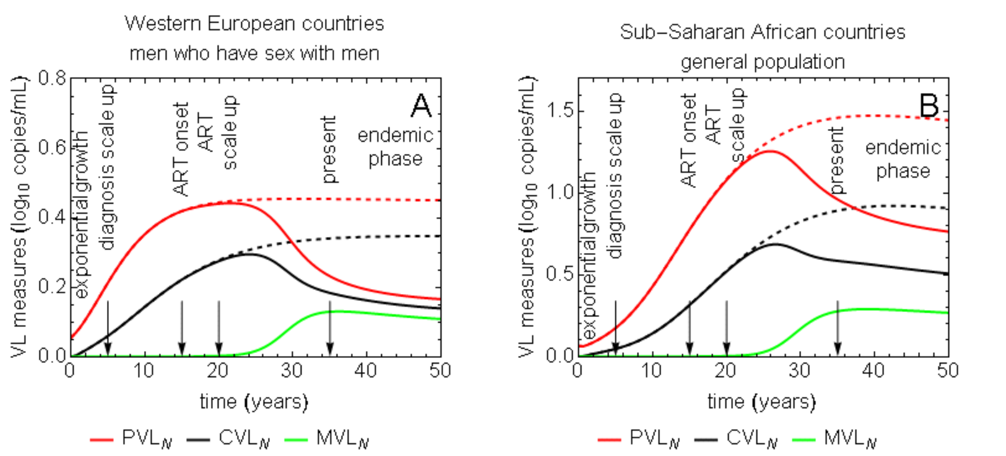
population VL (**PVL**), community VL (**CVL**), monitored VL (**MVL**)

- 2 methods of averaging of individual VLs

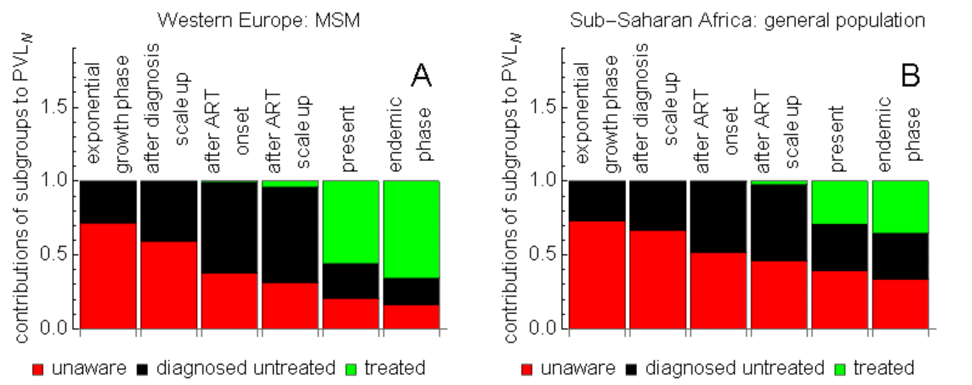
notation	definition
PVL_N	$\sum_{k=1}^{4}(VLI_k \times I_k + VLD_k \times D_k + VLA_k \times A_k)/N$
CVL_N	$\sum_{k=1}^{4}(VLD_k \times D_k + VLA_k \times A_k)/N$
MVL_N	$\sum_{k=1}^{4}(VLA_k \times A_k)/N$
PVL_{IDA}	$\sum_{k=1}^{4}(VLI_k \times I_k + VLD_k \times D_k + VLA_k \times A_k)/\sum_{k=1}^{4}(I_k + D_k + A_k)$
CVL_{DA}	$\sum_{k=1}^{4}(VLD_k \times D_k + VLA_k \times A_k)/\sum_{k=1}^{4}(D_k + A_k)$
MVL_A	$\sum_{k=1}^{4}(VLA_k \times A_k)/\sum_{k=1}^{4} A_k$

Results

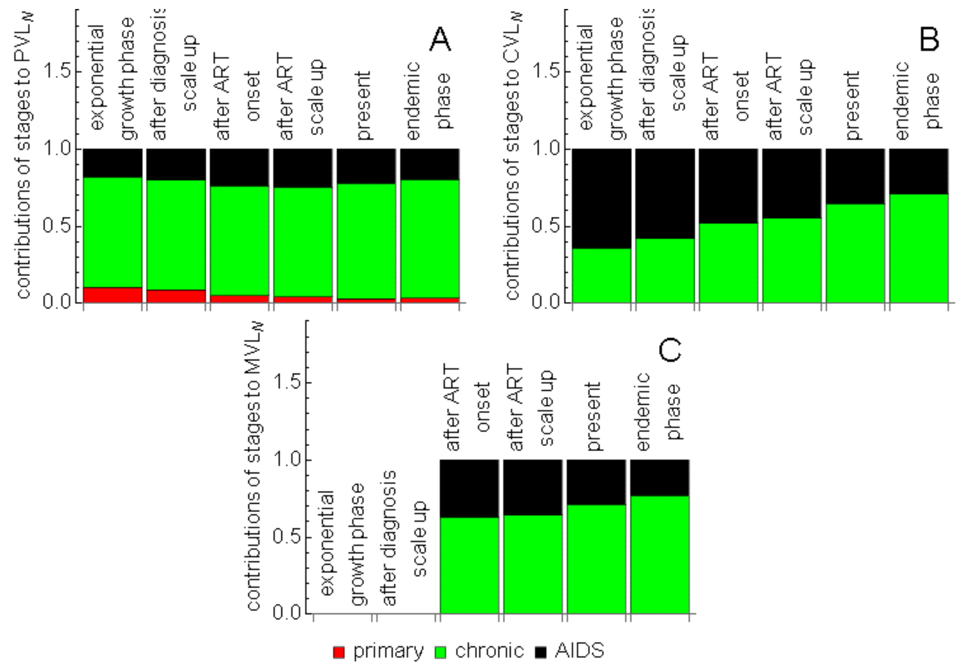
- Time dependent dynamics of VL measures



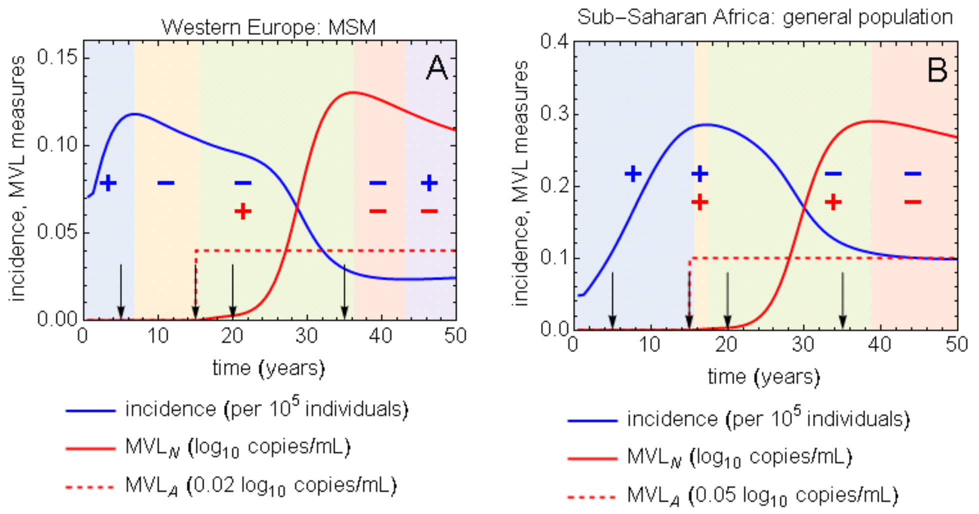
- Relative contributions of infected subgroups to PVL



- Relative contributions of infection stages to PVL, CVL and MVL (SSA)



- Association between HIV incidence and MVL



Conclusions

- Temporal dynamics of PVL, CVL, MVL are complex and depend on timings of different interventions
- Relative contributions of infected subgroups and infection stages to these measures are independent of the methodology
- Relative contribution of undiagnosed population to PVL is twice higher for SSA than for WE (34% and 16%)
- Reductions in MVL and incidence may have the same but also opposite trends
- MVL is not a key determinant of HIV incidence
- Other measures (e.g. % of individuals with VL above 400 cp/mL) might be more useful for surveillance purposes

References: CDC, Guidance on community viral load, 2011

Miller, Powers, Smith, Cohen, Lancet Inf Dis 13, 459, 2013