HIV Care Continuum System Dynamics Model: Variables, Definitions and Calibrations

TABLE 4: RYAN WHITE CASE MANAGEMENT SERVICES MODULE

(green: parameters that can be modified by users) (blue: dynamic formula) (purple: dynamic outcomes exported to other module[s])

Variable Name	Variable Type	Unit	Initial Parameter Values and Formulas	Variable Definition/Specification and Sources of Initial Parameters and Stock Values
Ryan White Medical Case Management Service Utilization				
All Diagnosed PLWH	stock	Persons	All PLWH(t - dt) + (HIV test positive rate - Mortality rate) * dt {NON-NEGATIVE} **Initial value** = HIV INFECTION AND TREATMENT AS PREVENTION.Init DIAGNOSED PLWH	The number of all diagnosed PLWH in the catchment area at any given point in time, which increases with new infections and decreases with mortality. The initial value of diagnosed PLWH for this stock is imported from the "HIV Infection and Treatment as Prevention" module.
HIV test positive rate	flow	Persons/ month	HIV TESTING AND PREVENTION SERVICES.Newly diagnosed persons per month {UNIFLOW}	Monthly rate of newly diagnosed PLWH. This number is being imported from the "HIV Testing and Prevention Services" module.
Mortality rate of diagnosed PLWH	flow	Persons/ month	All Diagnosed PLWH * HIV INFECTION AND TREATMENT AS PREVENTION.Prop deaths of PLWH per month {UNIFLOW}	Monthly rate of all diagnosed PLWH who die of any cause, using the CT DPH HIV Surveillance rate of HIV deaths per month.[1] This mortality rate is being generated in and imported from the "HIV Infection and Treatment as Prevention" module.
Initial number of PLWH receiving HI RW CM	Auxiliary	Persons	250	(HI RW CM = High Intensity Ryan White Case Management) Based on the number of Ryan White case management clients served in the catchment area (Hartford TGA – Hartford, Middlesex, and Tolland Counties, CT) in 2017 (approximately 500), divided equally between high intensity and low intensity.
Initial number of PLWH receiving LI RW CM	auxiliary	Persons	250	(LI RW CM = Low Intensity Ryan White Case Management) Based on the number of Ryan White case management clients served in the catchment area (Hartford TGA – Hartford, Middlesex, and Tolland Counties, CT) in 2017 (approximately 500), divided equally between high intensity and low intensity.
Prop of new cases who need case management	auxiliary	dmnl	.33	Stakeholder-estimated[a] proportion of newly diagnosed PLWH who need case management at the time of their diagnosis, based on clinical and case management experiences in the catchment area (Hartford TGA).
RW CM Intake Rate	flow	Person/ Month	HIV test positive rate * Prop of new cases who need case management {UNIFLOW}	Monthly rate at which newly infected PLWH enter Ryan White medical case management triage.
Clients in RW Case Management TRIAGE	stock	Persons	Clients in RW Case Management TRIAGE(t - dt) + (RW CM Intake Rate + Drop out of HI CM rate + Drop out of LI CM rate - Clients starting RW CM - Clients in Triage mortality rate) * dt {NON-NEGATIVE} **Initial value** = 0	Number of PLWH who are in need of medical case management awaiting assignment to a case manager over time.
Clients in Triage mortality rate	flow	Person/ Month	Clients in RW Case Management TRIAGE * HIV INFECTION AND TREATMENT AS PREVENTION.Prop deaths of PLWH per month {UNIFLOW}	Monthly rate at which PLWH awaiting assignment die before being assigned to a case manager, using the CT DPH HIV Surveillance rate of HIV deaths per month.[1] The mortality rate is being generated in and imported from the "HIV Infection and Treatment as Prevention" module.

Variable Name	Variable Type	Unit	Initial Parameter Values and Formulas	Variable Definition/Specification and Sources of Initial Parameters and Stock Values
Time needed to start CM	auxiliary	Months	.25	Stakeholder-estimated[a] average time in case management triage before being assigned to and meeting with a medical case manager, based on case management experiences.
Clients starting RW CM	flow	Person/ Month	Effect of CM Capacity on starting HI CM * (Clients in RW Case Management TRIAGE / Time needed to start CM) {UNIFLOW}	Monthly rate at which PLWH in need of case management are assigned to and meet with a medical case manager, based on case management capacity in the catchment area (see below).
Clients receiving HIGH INTENSITY HI RW CM	stock	Persons	Clients receiving HIGH INTENSITY HI RW CM(t - dt) + (Clients starting RW CM - Clients trans to LI RW CM - Mort rate HI RW CM - Drop out of HI CM rate) * dt {NON-NEGATIVE} **Initial value** = Initial number of PLWH receiving HI RW CM	Number of PLWH receiving high intensity case management over time. High intensity case management is defined by local case managers as meeting with the client at least weekly and more than monthly.
Mort rate HI RW CM	flow	Person/ Month	Clients receiving HIGH INTENSITY HI RW CM * HIV INFECTION AND TREATMENT AS PREVENTION.Prop deaths of PLWH per month {UNIFLOW}	Monthly rate at which PLWH receiving high intensity (monthly or more frequently) case management die, using the CT DPH HIV Surveillance rate of HIV deaths per month.[1] The mortality rate is being generated in and imported from the "HIV Infection and Treatment as Prevention" module.
Prop drop out HI RW CM	auxiliary	dmnl	.2	Stakeholder-estimated[a] proportion of PLWH who are receiving high intensity case management who drop out of case management before completing care, based on case management experiences.
Time to Drop Out of HI RW CM	auxiliary	Months	6	Stakeholder-estimated[a] average time for a PLWH in high intensity case management to drop out of case management before completing care, based on case management experiences.
Drop out of HI CM rate	flow	Person/ Month	Clients receiving HIGH INTENSITY HI RW CM * Prop drop out HI RW CM/Time to Drop Out of HI RW CM {UNIFLOW}	Monthly rate at which clients receiving high intensity case management (defined as several visits per month) drop out of case management before completing care.
Time needing HI CM	auxiliary	Months	60	Stakeholder-estimated[a] average time for a PLWH in high intensity case management to no longer need as frequent visits and move into needing low intensity case management, based on case management experience.
Clients trans to LI RW CM	flow	Person/ Month	Clients receiving HIGH INTENSITY HI RW CM / Time needing HI CM {UNIFLOW}	Monthly rate at which PLWH in high intensity case management transition to low intensity case management, defined as monthly or less frequent visits.
Clients receiving LOW INTENSITY LI RW CM	stock	Persons	Clients receiving LOW INTENSITY LI RW CM(t - dt) + (Clients trans to LI RW CM - Ending RW CM rate - Mort rate LI RW CM - Drop out of LI CM rate) * dt {NON-NEGATIVE} **Initial value** = Initial number of PLWH receiving LI RW CM	Number of PLWH receiving low intensity case management over time. Low intensity case management is defined by local case managers as meeting with the client once monthly or less frequently, or as needed only.
Mort rate LI RW CM	flow	Person/ Month	Clients receiving LOW INTENSITY LI RW CM * HIV INFECTION AND TREATMENT AS PREVENTION.Prop deaths of PLWH per month {UNIFLOW}	Monthly rate at which PLWH receiving low intensity (monthly or less frequently) case management die, using the CT DPH HIV Surveillance rate of HIV deaths per month.[1] The mortality rate is being generated in and imported from the "HIV Infection and Treatment as Prevention" module.

Variable Name	Variable Type	Unit	Initial Parameter Values and Formulas	Variable Definition/Specification and Sources of Initial Parameters and Stock Values
Prop drop out LI RW CM	auxiliary	dmnl	.1	Stakeholder-estimated[a] proportion of PLWH who are receiving low intensity medical case management who drop out of case management before completing care, based on case management experiences.
Time to Drop Out of LI RW CM	auxiliary	Months	12	Stakeholder-estimated[a] average time for a PLWH in low intensity medical case management to drop out of case management before completing care, based on case management experiences.
Drop out of LI CM rate	flow	Person/ Month	Clients receiving LOW INTENSITY LI RW CM * Prop drop out LI RW CM / Time to Drop Out of LI RW CM {UNIFLOW}	Monthly rate at which clients receiving low intensity case management (defined as monthly visits or less frequent) drop out of medical case management before completing care.
Avg time needing CM	auxiliary	Months	120	Stakeholder-estimated[a] average time for a PLWH in low intensity case management to no longer need any case management, based on case management experience.
Ending RW CM rate	flow	Person/ Month	Clients receiving LOW INTENSITY LI RW CM / Avg time needing CM {UNIFLOW}	Monthly rate at which low intensity case management clients no longer needing case management end it altogether.
Total RW Case Management Clients	auxiliary	Persons	Clients receiving HIGH INTENSITY HI RW CM + Clients receiving LOW INTENSITY LI RW CM + Clients in RW Case Management TRIAGE	Sum of all PLWH receiving high or low intensity case management or in medical case management triage.
Prop PLWH receiving RW CM	auxiliary	dmnl	Total RW Case Management Clients / All Diagnosed PLWH	Proportion of PLWH who are receiving medical case management out of all diagnosed PLWH.
Ryan White Medical Case Management Resources and Capacity				
Total number of Case Managers	auxiliary	Case Manager	18	Sum of “initial number of RW case managers” and “additional or fewer case managers” in simulation runs.
MAX HI CM Caseload	auxiliary	Persons/ Case Manager	20	Stakeholder-estimated[a] caseload of clients per case manager who need high intensity (HI) case management (CM), based on case management experiences and local protocols in the catchment area for total case load, balanced with their caseload of clients receiving low intensity case management.
MAX HI CM Capacity	auxiliary	Persons	MAX HI CM Caseload * Total Case Managers	Calibrates the total number of PLWH receiving high intensity medical case management the system can bear given the available number of case managers and their caseload limits.
MAX LI CM Caseload	auxiliary	Persons/ Case Manager	25	Stakeholder-estimated[a] caseload of clients per case manager who need low intensity (LI) case management (CM), based on case management experiences and local protocols in the catchment area for total case load, balanced with their caseload of clients receiving high intensity case management.
MAX LI CM Capacity	auxiliary	Persons	MAX LI CM Caseload * Total Case Managers	Calibrates the total number of PLWH receiving low intensity medical case management the system can bear given the available number of case managers and their caseload limits.
MAX CM Capacity	auxiliary	Persons	MAX HI CM Capacity + MAX LI CM Capacity	Calibrates the total number of PLWH receiving both high and low intensity medical case management the system can bear given the available number of case managers and their caseload limits for each type of client.

Variable Name	Variable Type	Unit	Initial Parameter Values and Formulas	Variable Definition/Specification and Sources of Initial Parameters and Stock Values
Effect of CM Capacity on starting HI CM	auxiliary	dmnl	GRAPH(Total RW Case Management Clients / MAX CM Capacity) (0.900, 1.000), (1.0500, 0.0001)	Graphical function of the effect of maximum case management capacity on the rate of PLWH in case management triage starting medical case management. The graph specifies a linear relationship whereby lowest proportion of clients seeking case management (0.900) is associated with the highest effect of capacity on PLWH entering high intensity case management (1.000), and the highest proportion of clients seeking case management (1.0500) is associated with the lowest effect of capacity on PLWH entering high intensity case management (0.0001) (see **Fig 4.1**). Effect of CM capacity is a multiplier in the rate formula for Clients starting RW CM.
Unmet Ryan White Medical Case Management Needs and Effects				
Prop of all PLWH who need case management	auxiliary	dmnl	.13	Stakeholder-estimated[a] proportion of all PLWH in the catchment area (Hartford TGA) who are in need of medical case management at any point in time and in any stage along the HIV care continuum, based on case management experience.
Potential Need for CM	auxiliary	Persons	All Diagnosed PLWH * Prop of all PLWH who need case management	Simulates the need over time for case management services among all diagnosed PLWH in the catchment area.
Prop PLWH receiving HI RW CM	auxiliary	dmnl	Clients receiving HIGH INTENSITY HI RW CM / All Diagnosed PLWH	Simulates the proportion of all diagnosed PLWH who are receiving high intensity medical case management.
Prop PLWH receiving LI RW CM	auxiliary	dmnl	Clients receiving LOW INTENSITY LI RW CM / All Diagnosed PLWH	Simulates the proportion of all diagnosed PLWH who are receiving low intensity medical case management.
Prop Unmet Need for CM Sum	auxiliary	dmnl	Clients in RW Case Management TRIAGE / (Clients receiving HIGH INTENSITY HI RW CM + Clients receiving LOW INTENSITY LI RW CM + Clients in RW Case Management TRIAGE)	Simulates the proportion of PLWH in triage awaiting initiation of case management out of all PLWH who need case management, including those in triage and those already receiving high and low intensity case management services.
Prop Unmet Need for CM	auxiliary	dmnl	Prop Unmet Need for CM Sum	Equal to the “Prop Unmet Need for CM Sum” variable.
Effect of UNMET NEED FOR CM on Linked to Care rate	auxiliary	dmnl	GRAPH(Prop Unmet Need for CM) (0.000, 1.965), (0.071, 1.904), (0.143, 1.868), (0.214, 1.754), (0.286, 1.561), (0.357, 1.272), (0.429, 0.904), (0.500, 0.605), (0.571, 0.474), (0.643, 0.404), (0.714, 0.333), (0.786, 0.289), (0.857, 0.254), (0.929, 0.202), (1.000, 0.193)	This is a graphic function of the relationship between unmet need for case management services and the rate of newly infected PLWH being linked to care. This relationship follows a non-linear reverse-S-curve, with lowest proportion unmet needs for case management services (0.000) associated with the highest effect of unmet need on the linked to care rate (1.965), and highest proportion of unmet CM needs (1.000) associated with the lowest effect of unmet need on the linked to care rate (0.193). (Interim points on the reverse-S-curve graph are indicated in the formula and in **Fig. 4.2**.) This variable is exported to the “Medical Care Services” module as a multiplier with the “Linked to care rate” flow variable.

Variable Name	Variable Type	Unit	Initial Parameter Values and Formulas	Variable Definition/Specification and Sources of Initial Parameters and Stock Values
Effect of UNMET NEED FOR CM on Lost to Care Rate	auxiliary	dmnl	GRAPH(Prop Unmet Need for CM) (0.000, 0.114), (0.071, 0.158), (0.143, 0.254), (0.214, 0.325), (0.286, 0.474), (0.357, 0.675), (0.429, 1.009), (0.500, 1.228), (0.571, 1.535), (0.643, 1.675), (0.714, 1.789), (0.786, 1.877), (0.857, 1.947), (0.929, 1.991), (1.000, 2.000)	This is a graphic function of the relationship between unmet need for case management services and the rate of PLWH who miss medical appointments and become lost to care. This relationship follows a non-linear S-curve, with lowest proportion unmet need for case management services (0.000) associated with the lowest effect on the lost to care rate (0.114), and highest proportion of unmet case management needs (1.000) associated with the highest effect on the linked to care rate (2.000). (Interim points on the S-curve graph are indicated in the formula and in **Fig. 4.3**.) This Effect variable is exported to the "Medical Care Services" module as a multiplier with the "Effect of Unmet Needs on Risk of being Lost to Care" variable.

[a] Stakeholder-estimated parameters were set through a deliberative process with a broadly mixed stakeholder community modeling group that represented the spectrum of HIV medical and other care services and PLWH.

1. CT Department of Public Health. Epidemiological Profile of HIV in Connecticut. 2018.

Fig. 4.1 Effect of CM Capacity on starting HI CM

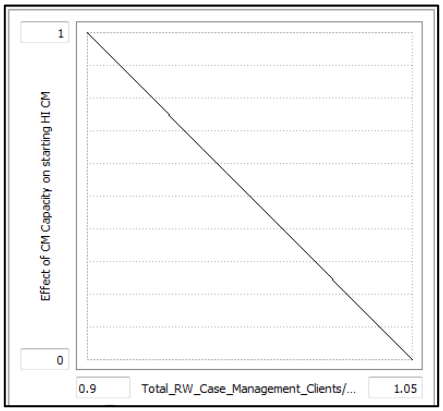

Fig. 4.2 Effect of UNMET NEED FOR CM on Linked to Care rate

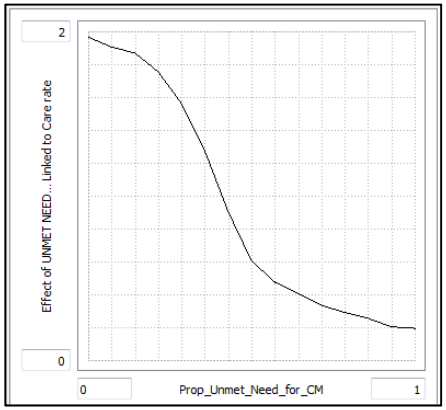

Fig. 4.3 Effect of UNMET NEED FOR CM on Lost to Care Rate