Assessing the cost of managed behavioral care

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Abstract: Showing the important role feedback plays in managed behavioral care is crucial because case management aggressiveness determines the financial performance of health care programs. This study shows how feedback affects the financial performance of a managed mental health and substance abuse program which, not only reimburses for treatment, but also guides the treatment plan for each patient's case and even determines how much treatment will be paid for.

The program is funded by a flat capitation rate received from its members. Its expenses depend on the treatment authorized by its case managers, who aim at authorizing the least treatment sessions while keeping the treatment effective. In turn, the authorized treatment depends on case management aggressiveness, which is relative to illness severity. Our system dynamics modeling process aimed at evaluating exactly how case management aggressiveness affects the program's effectiveness and efficiency.

Introduction

It is crucial for case managers to see the important role that feedback plays in behavioral care. Given that inpatient care is more expensive than outpatient care, intuitively, it often seems cost effective to case managers to move patients into outpatient care as soon as possible. When inpatient care is cut too short, however, patients that have not had enough time to recover are re-admitted into hospitals and, consequently, the cost of behavioral care rises despite the initial intent.

This essay describes the system dynamics simulation model built for a managed mental health and substance abuse program. The study's purpose was to determine what level of case management aggressiveness yields the best financial performance. The program under study not only reimburses for treatment, but also guides the patient treatment plan, and determines how much treatment will be paid for. The firm that oversees the program receives a flat rate of income, its capitation rate, which is based on its membership, while expenses depend on the amount of treatment authorized for each patient's case. Together, case management aggressiveness and the severity of illness determine how much care case managers authorize.

The system dynamics modeling process used aimed at showing exactly how case management aggressiveness affects the program's cash position. The modeling process entailed creating a set of rough-cut maps, or influence diagrams (IDs), by analyzing the relationships among the program's membership, the care being authorized, and the resulting cash flow. Throughout the modeling process, we assumed that we cannot control directly neither the admission of patients from outpatient services to inpatient services nor the admission of patients members to inpatient or outpatient services. That is, when people from our membership population become sick, then we provide them with the appropriate service. How frequently our covered members use our services depends on their health, but we what we can control is their length of stay in the hospital.

Our model depicts the relationships among program enrollment, case management aggressiveness, behavioral care treatment, and cash flow. Because case management aggressiveness affects everything else in this program, we assess system performance by varying the aggressiveness of managed behavioral care.

Model Description

Figure 1 shows the system dynamics simulation model resulting from our modeling process. Although this is a rather small, four-level variable structure, it has captured enough of the feedback loops that produce the system's dynamic behavior patterns. The «Membership», «Inpatient Cases», and «Outpatient Cases» level variables, for example, are embedded in thirteen (13), twenty-two (22), and nine (9) feedback loops, respectively.

Being a performance variable, the «Cash» stock on top of Fig. 1 entails no feedback loops. This level variable is fed by daily revenue, which is the product of «Membership» times the program's flat «capitation» rate. The «inpatient cost» and «outpatient cost» are the two outflows that deplete *Cash*. The *impatient cost* per day is the sum of the inpatient variable cost (Inpatient Cases x cost per day) plus the fixed overhead component of the inpatient administrative cost or «inpatient adm cost» per day. Similarly, the outpatient cost is the sum of the outpatient variable cost ((Outpatient Cases / 7) x cost per session)) per day plus the fixed overhead component of the outpatient administrative cost or «outpatient adm cost» per day.

Fig. 1 Managed behavioral care model

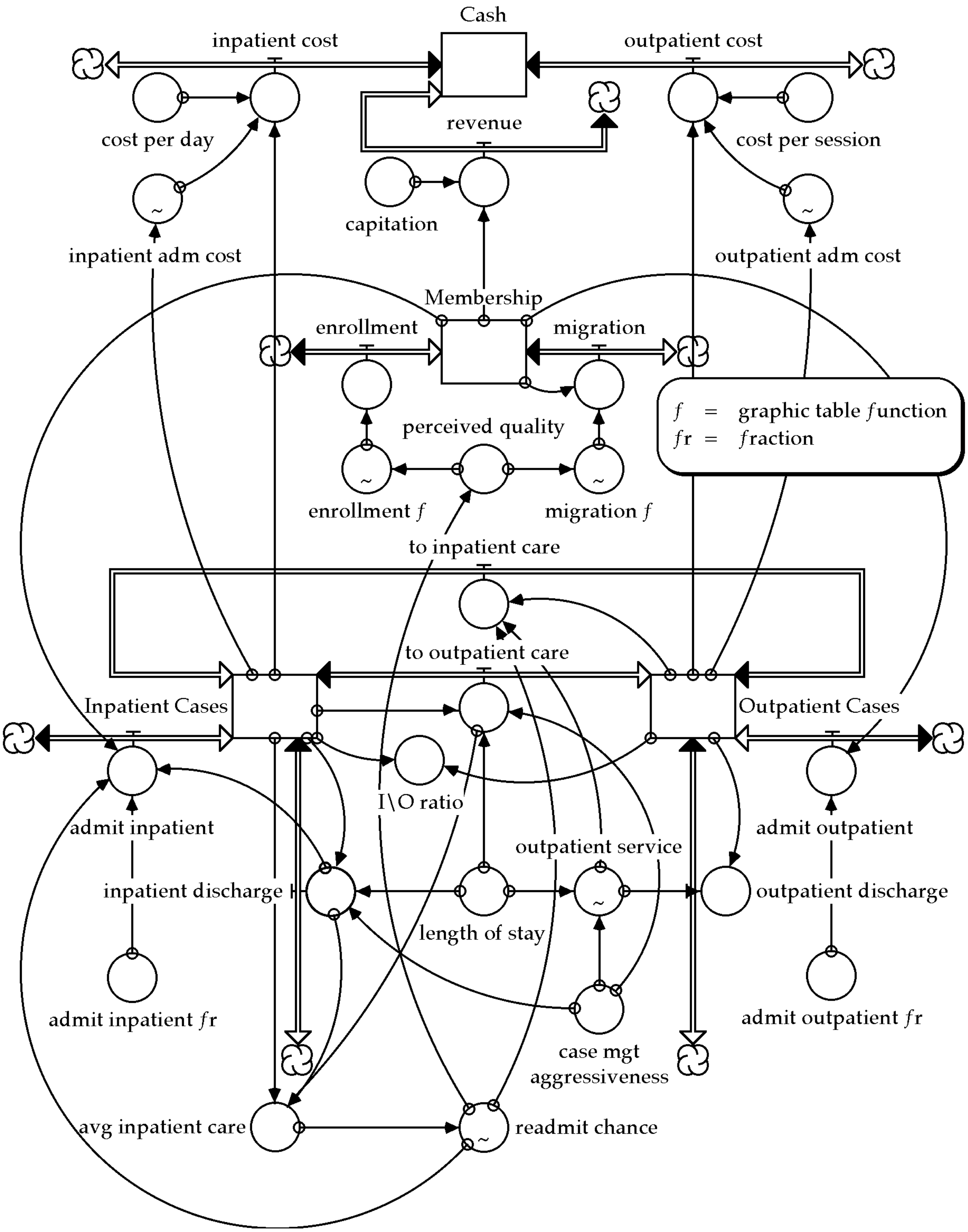
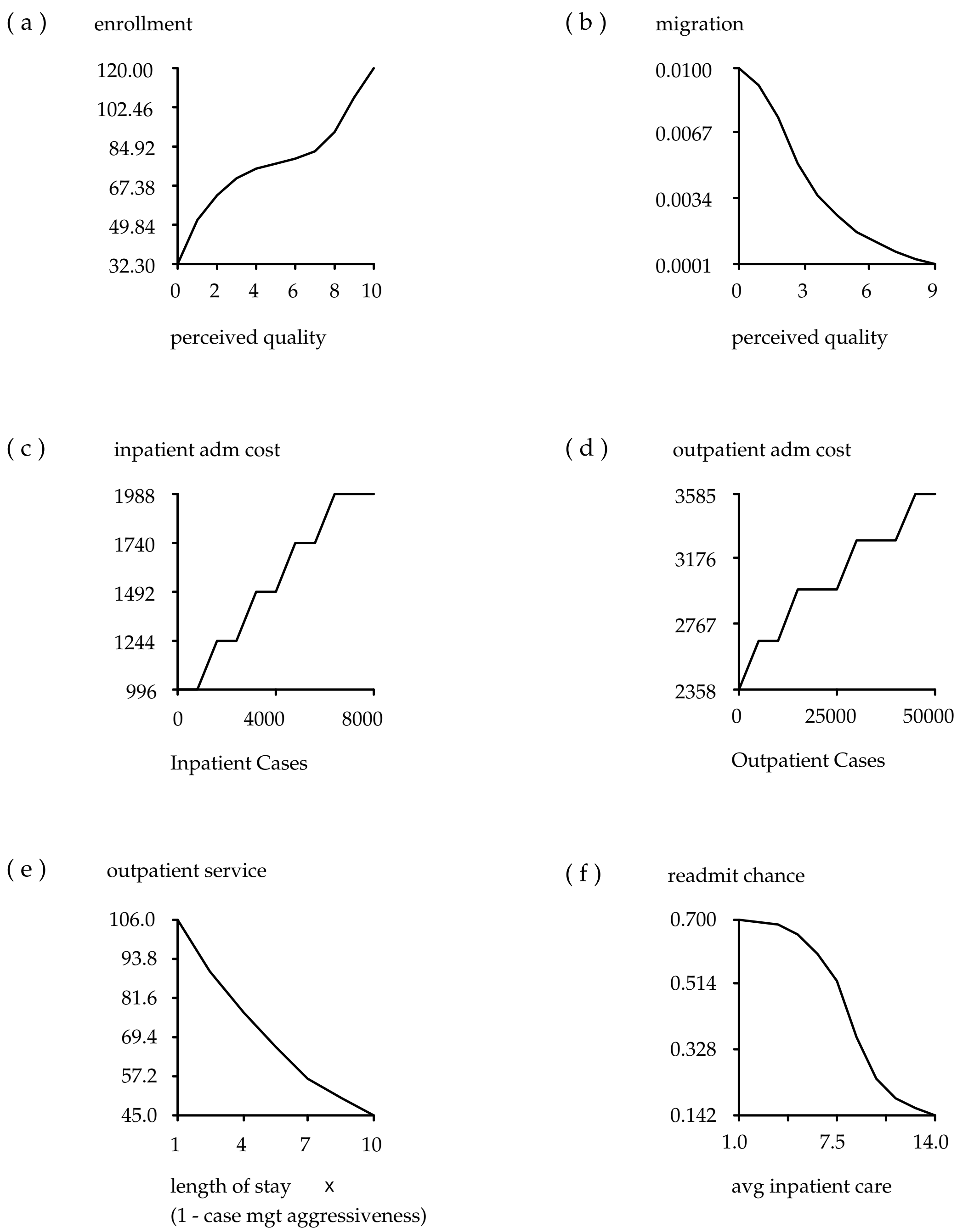


Figure 2 shows the model's *inpatient administrative cost* (c) and *outpatient administrative cost* (d) graphic table functions that contribute to the *inpatient*

Fig. 2 The model's graphic table functions (s)



cost and *outpatient cost*, respectively. The Appendix at the end of the essay shows the model equations along with the detailed data underlying Fig. 2.

The «enrollment» inflow feeds and the «migration» outflow depletes the program's *Membership* in the middle of Fig. 1. The *enrollment inflow* and the *migration outflow* depend on the «enrollment *f*» and «migration *f*» graphic table functions, respectively, both of which in turn depend on the program's «perceived quality» (computed by the same linear function the program administrators use to assess it). *Membership* growth is crucial to this mental health and substance abuse program because not only it contributes directly to *revenue*, but also determines the program's inpatient and outpatient service utilization through *Inpatient Cases* and *Outpatient Cases*. Among the thirteen (13) feedback loops than entail *Membership*, twelve (12) run through either *Inpatient Cases* or *Outpatient Cases* or both.

The lower part of Fig. 1 shows how program members use its services. First-stay *Inpatient Cases* are admitted to hospitals through the «admit inpatient» inflow on the left, while first-time *Outpatient Cases* utilize the service through the «admit outpatient» inflow on the right. How long inpatients and outpatients use the program's services depends on the average «length of stay» and «outpatient service», respectively, both measured in days.

The two outflows that deplete *Inpatient Cases* are: «inpatient discharge» and «to outpatient care». The two outflows that deplete *Outpatient Cases* are: «outpatient discharge» and «to inpatient care». This is where the policy parameter «case mgt aggressiveness» comes into play. It affects both *inpatient discharge* and *to outpatient care* outflows directly, and *outpatient discharge* and *to inpatient care* outflows indirectly via *outpatient service* (Fig. 2e and Appendix).

The program's *case mgt aggressiveness* reduces inpatient care either by discharging *Inpatient Cases* or by transferring them to outpatient clinics. As «avg inpatient care» declines, however, more patients get insufficient treatment and need to be re-admitted into hospitals, thereby becoming *Inpatient Cases*. This is what the «readmit chance» graph (Fig. 2f) shows.

Each case manager's objective is to reduce the rather costly *Inpatient Cases* by transforming them into *Outpatient Cases*. The rationale behind this motive is that: if *Inpatient Cases* decline, then not only the utilization of outpatient services will rise but, more importantly perhaps, the *Cash* position of the mental health and substance abuse program will also improve.

Inversely, by increasing *avg inpatient care*, the program's case managers expect to reduce their *Outpatient Cases*. Yet, when case managers increase *avg inpatient care*, their outpatient utilization converges toward a minimum value because no matter how long the inpatient treatment is, there is a minimum of outpatient care needed.

Similarly, if case managers reduce the average length of *outpatient service* (Fig. 2e), then the *Inpatient Cases* increase because there is an increasing number of patients getting worse who need hospitalization.

Simulation Results

Because of its potential impact on the mental health and substance abuse program's financial performance, system behavior is assessed by varying the *case mgt aggressiveness* policy parameter. The simulation output time-series graphs of Fig. 3 for (a) *Inpatient Cases*, (b) *Outpatient Cases*, and (c) *Cash* result from running the model from zero to ninety days, with a computation interval dt=0.125, using the *Runge-Kutta* 4 integration method. The four comparative runs of Fig. 3 show that as *case mgt aggressiveness* increases from zero to 10 percent (from 0.0 to 0.1), both *Inpatient Cases* (a) and *Outpatient Cases* (b) decrease, while the program's *Cash* (c) position improves—as the case managers expected.

Increasing *case mgt aggressiveness* more, however, from 10 to 20 percent (from 0.1 to 0.2), has an inverse effect both on *Inpatient Cases* and on *Cash*. Moreover, contrary to the case managers' expectations, further reducing *avg inpatient care*—either by discharging *Inpatient Cases* or by transferring them to outpatient clinics via *to outpatient care*—does not improve the program's outpatient service utilization: *Outpatient Cases* continue to decrease because there is an increasing number of patients getting worse who need hospitalization (run #3, Fig. 3b). *Impatient Cases* increase more drastically when *case mgt aggressiveness* reaches its 30 percent (0.3) mark (run #4, Fig. 3a). One can also see the behavioral care system's sensitivity to large increases in *case mgt aggressiveness* in the *Outpatient Cases* decrease (run #4, Fig. 3b), but this apparent sensitivity is most pronounced by the dire-straights decrease in the program's *Cash* position (run #4, Fig. 3c).

The dramatic increase in *Outpatient Cases* directly affects the *inpatient cost* outflow that depletes *Cash*. And the decline in *Outpatient Cases* does not seem sufficient enough to offset the large decrease in Cash. Recall the rationale behind the case managers' motive to increase *case mgt aggressiveness*: If *Inpatient Cases* decline, then not only the utilization of outpatient services will rise but also the *Cash* position of the mental health and substance abuse program should improve. Their intuition works when they increase *case mgt aggressiveness* from zero to 10 percent. Indeed, the *I\O ratio* of Fig. 4a reaches its lowest threshold value at the 0.1 mark of *case mgt aggressiveness*, where the program's *Cash* position is maximized (run #2, Fig. 3c and Fig. 4b), because the decrease in *revenue* caused by the decrease in *Membership* growth (run #2, Fig. 4c) is more than offset by the decrease in the *inpatient cost* outflow, which depletes *Cash*. The case managers' intuition breaks off, however, when they increase *case mgt aggressiveness* to 30 percent.

Fig. 3 Simulation output time-series graphs

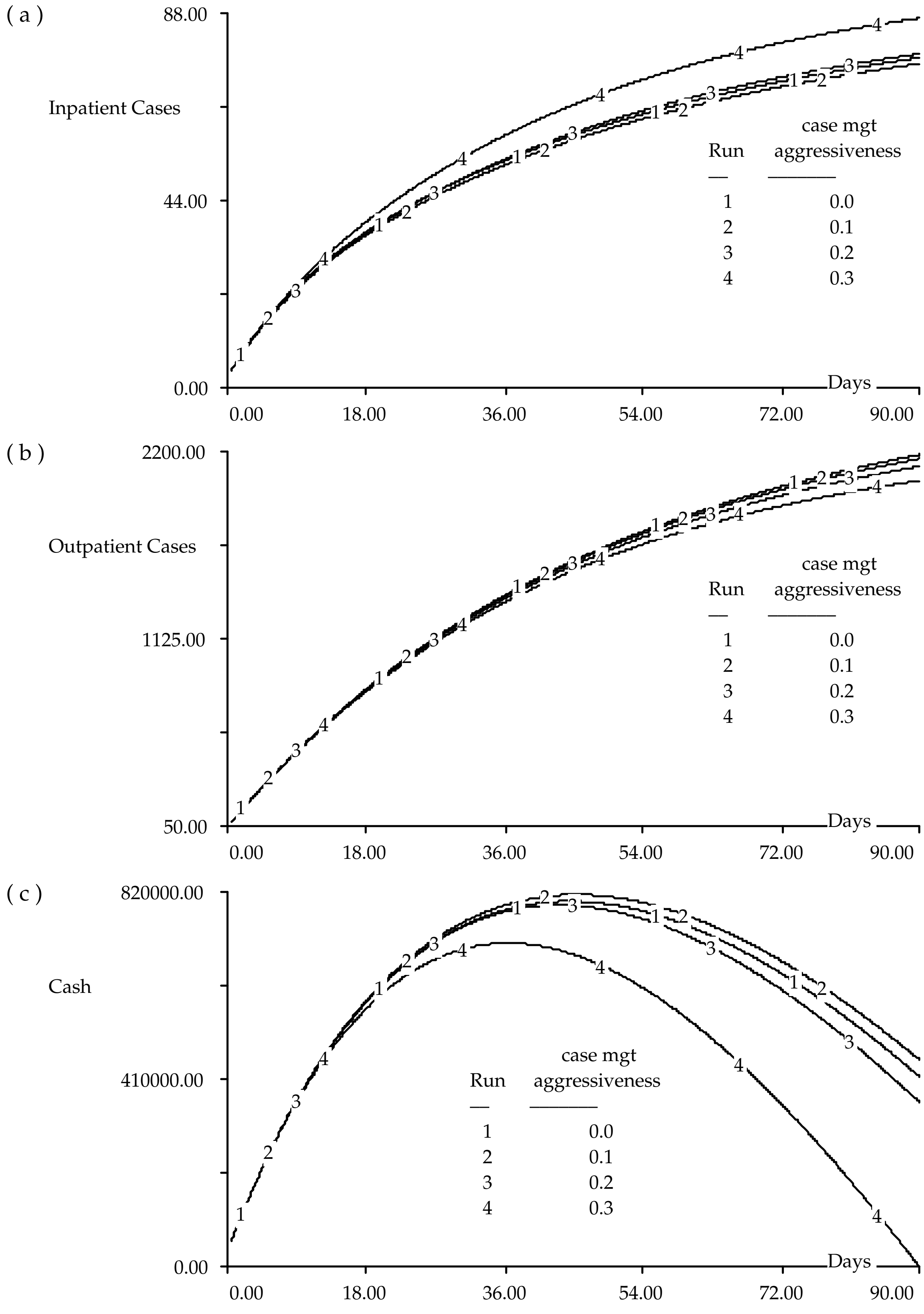
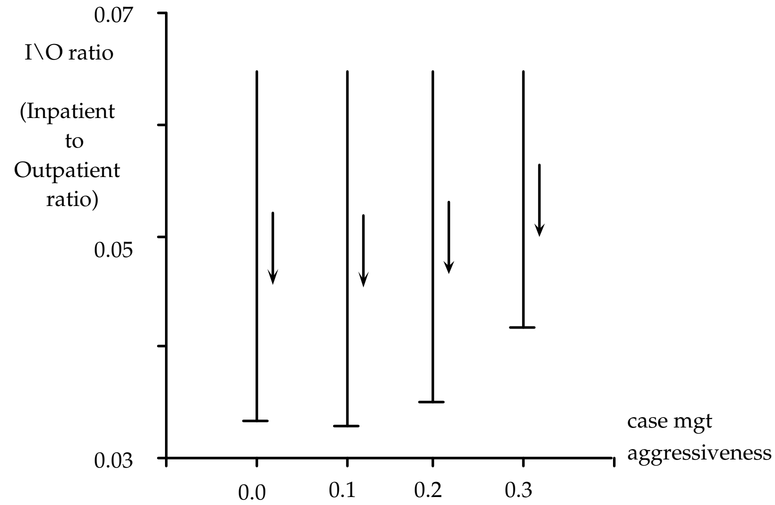
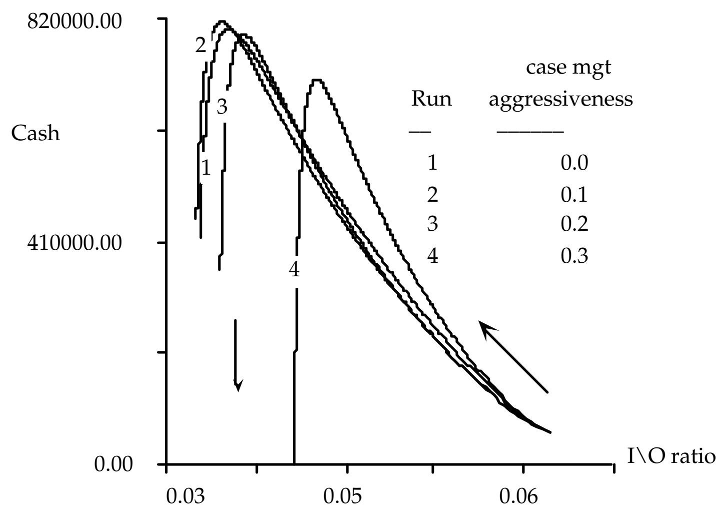


Fig. 4 Simulation output phase graphs

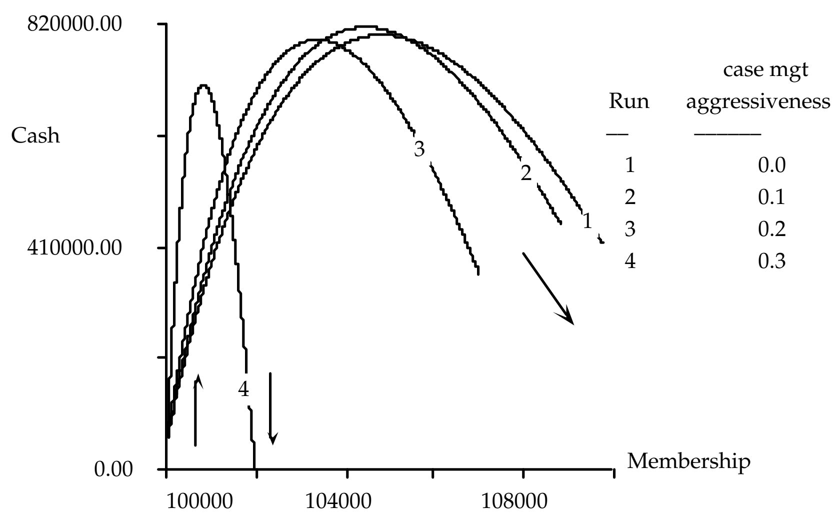
(a)



(b)



(c)



At the 0.3 mark of *case mgt aggressiveness* (Fig. 4a), the *I\O ratio* shows a high threshold limit, causing *Cash* to dive sharply (run #4, Fig. 4b) because of the *outpatient cost* increase, coupled with a sharp decrease in *Membership* growth (run #4, Fig. 4c). As *case mgt aggressiveness* increases, *avg inpatient care* decreases. *Outpatient Cases* increase temporarily but, since more patients are now getting worse and need hospitalization, the *readmit chance* also increases, causing not only more *Outpatient Cases* to move *to outpatient care*, but also *perceived quality* to decline. The decrease in *perceived quality* causes *Membership* growth to decrease sharply because its *enrollment* inflow decreases, while its *migration* out flow increases (middle of Fig. 1).

Conclusion

Indeed, it is crucial for case managers to see the important role that feedback loops play in this mental health and substance abuse program. The system dynamics modeling process we employed aimed at evaluating exactly how *case mgt aggressiveness* affects the program's effectiveness and efficiency. The simulation results show that for small values of the *case mgt aggressiveness* policy parameter (up to 0.1), the case managers' intuition becomes justified by the increase in the program's *Cash*. Case managers succeed in authorizing the least treatment while keeping the treatment effective. Above the 10 percent *case mgt aggressiveness* mark (0.1), however, the case managers' intuition breaks off. Because more patients get worse and need re-hospitalization when *case mgt aggressiveness* reaches values of 0.2 and 0.3, not only *Inpatient Cases* increase—thereby causing *Cash* to decrease—but, more importantly perhaps, the program's *Membership* growth also declines. Therefore, managed care is recommended, but only in small dosage.

Appendix: Model Equations

Level Variables

Cash(t) = Cash(t - dt) + (revenue - outpatient_cost - inpatient_cost) * dt
  INIT Cash = Membership * capitation {$}
Membership(t) = Membership(t - dt) + (enrollment - migration) * dt
  INIT Membership = 100000 {people}
Inpatient_Cases(t) = Inpatient_Cases(t - dt) + (admit_inpatient + to_inpatient_care - to_outpatient_care - inpatient_discharge) * dt
  INIT Inpatient_Cases = Membership * admit_inpatient_ƒr {people}

Outpatient_Cases(t) = Outpatient_Cases(t - dt) + (to_outpatient_care + admit_outpatient - to_inpatient_care - outpatient_discharge) * dt
INIT Outpatient_Cases = Membership * admit_outpatient_ƒr {people}

Rate Variables
admit_inpatient = admit_inpatient_ƒr * Membership + readmit_chance * inpatient_discharge {people per day}
admit_outpatient = admit_outpatient_ƒr * Membership {people per day}
enrollment = enrollment_ƒ {people per day}
inpatient_cost = (Inpatient_Cases * cost_per_day) + inpatient_adm_cost {$ per day}
inpatient_discharge = Inpatient_Cases / (length_of_stay * (1 - case_mgt_aggressiveness))
migration = migration_ƒ * Membership {people per day}
outpatient_cost = ((Outpatient_Cases / 7) * cost_per_session) + outpatient_adm_cost {$ per day; the division of Membership by seven (7) here reflects the program's extant policy to authorize only one (1) outpatient session per patient per week (7 days)}
outpatient_discharge = (Outpatient_Cases) / outpatient_service
revenue = capitation * Membership {$ per member per day}
to_inpatient_care = readmit_chance * Outpatient_Cases / outpatient_service {people per day}
to_outpatient_care = Inpatient_Cases / (length_of_stay * (1 - case_mgt_aggressiveness)) {people per day}

Auxiliary Variables
avg_inpatient_care = ((Inpatient_Cases / to_outpatient_care) + (Inpatient_Cases / inpatient_discharge)) / 2 {days}
I\O_ratio = Inpatient_Cases / Outpatient_Cases {dimensionless}
length_of_stay = NORMAL(14, 0, 123) {days (σ = 0 for smooth simulation output)}
perceived_quality = 10 - (10 * (readmit_chance - 0.142) / 0.7) {dimensionless}

Constant Parameters
admit_inpatient_ƒr = 1 / 30000
admit_outpatient_ƒr = 16 / 30000
capitation = 15/30 {$ per person per day}
case_mgt_aggressiveness = 0 {dimensionless}
cost_per_day = 550 {$ per person per day}
cost_per_session = 75 {$ per person per day}

Graphic Table Functions
enrollment_ƒ = GRAPH(perceived_quality)
(0.00, 32.3), (1.00, 52.0), (2.00, 62.9), (3.00, 70.5), (4.00, 75.0), (5.00, 77.3), (6.00, 79.1), (7.00, 82.7), (8.00, 90.8), (9.00, 107), (10.0, 120)
inpatient_adm_cost = GRAPH(Inpatient_Cases)

(0.00, 996), (800, 996), (1600, 1244), (2400, 1244), (3200, 1492), (4000, 1492), (4800, 1740), (5600, 1740), (6400, 1988), (7200, 1988), (8000, 1988)

migration_*f* = GRAPH(perceived_quality)

(0.00, 0.01), (1.00, 0.0091), (2.00, 0.0075), (3.00, 0.00515), (4.00, 0.0035), (5.00, 0.0025), (6.00, 0.00175), (7.00, 0.0012), (8.00, 0.00075), (9.00, 0.00035), (10.0, 0.0001)

outpatient_adm_cost = GRAPH(Outpatient_Cases)

(0.00, 2358), (5000, 2658), (10000, 2658), (15000, 2985), (20000, 2985), (25000, 2985), (30000, 3285), (35000, 3285), (40000, 3285), (45000, 3585), (50000, 3585)

outpatient_service = GRAPH(length_of_stay * (1 - case_mgt_aggressiveness))

(1.00, 106), (2.50, 90.1), (4.00, 76.8), (5.50, 66.0), (7.00, 56.3), (8.50, 50.0), (10.0, 45.0)

readmit_chance = GRAPH(avg_inpatient_care)

(1.00, 0.7), (2.30, 0.69), (3.60, 0.682), (4.90, 0.658), (6.20, 0.604), (7.50, 0.521), (8.80, 0.367), (10.1, 0.245), (11.4, 0.189), (12.7, 0.159), (14.0, 0.142)