Agent-based Modeling and Simulation for Advancing Child Maltreatment Prevention

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NIH Campus, 2/25/2014
Outline

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Background – CM as a Public Health Problem and CM Prevention

• Child maltreatment (CM) is a serious problem in the United States and around the world.
• Exposure to child maltreatment increases the risk for a broad range of emotional, behavioral, and physical health problems.
• Research suggests that progress in preventing the nation's worst health problems – such as obesity and diabetes – can be made by investing in programs that promote raising infants and young children in healthy, safe, stable, and nurturing surroundings.
• CM prevention/intervention is a challenging task.
  – Complexity nature of the problem.
  – Funding, safety, and ethical issues.
Background – The Social Ecological Model of CM and CM Prevention

- This model considers the complex interplay between individual, relationship, community, and societal factors.
  - Individual: age, education, income, substance use, or history of abuse.
  - Relationship: family relationship, closest social peers, partners
  - Community: community setting, such as schools, workplaces, and neighborhoods
  - Societal: social and cultural norms, health, economic, and social policies

- There has been growing recognition that to truly prevent CM requires the adoption of holistic prevention strategies with a focus on ‘whole of community’ approaches.
The Agent-Based Model

- Intervention/prevention programs influence agents and their connections.
- Agents are connected with each other through social network.
- Behavioral/cognitive modeling of individual agents.

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Overview of the Agent-based Model

• The model incorporates various factors across the social ecology of CM.

• Each agent is a family unit.

• The model adopts a resource-based conceptual view.
  – Child maltreatment occurs when parents do not or cannot meet their children’s need.

• Each agent includes a cognitive model that is inspired from the theory of planned behavior, self-efficacy theory, and parenting stress model.
  – “The occurrence of CM is a result of a cognitive process that impacts parents’ decision to engage in aggression toward children.”

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A Single Family Agent

child need

resources

family resource

perceived community resource

community

resource-based efficacy

parental efficacy

experience-based efficacy

stress level

social normative beliefs/social norm

perceived behavioral control

intention

w1

w2

w3

attitude

responsive to child need?

enough resource?

unmet child need >0

unmet child need =0

feedback

parenting stress

contextual stress

unmet child need =0

yes

no

yes

no

no

yes

yes

no
Modeling CM Prevention/Intervention

• Different CM preventions/interventions influence agents and their connections in different ways.

• Several prevention/intervention strategies are modeled, targeting on different aspects of the system.
  – Resource: Community resource center
  – Stress level: Neighborhood development to reduce community stress
  – Social connections: Building social connections
  – Note: These prevention/intervention strategies are modeled in a general way in the current model. They need to be tailored for specific programs.

• A specific prevention/intervention program (e.g., home visiting) may combine multiple strategies together.
Simulation-based Experiments

- Configuring an “artificial community” of family agents.
- Collecting results based on Monte Carlo simulations.

Statistical results generated from simulations showing the nonlinear relationship between family stress level and percentage of families with child maltreatment. Each data point is averaged from 10 different simulations.
Heterogeneity within a Community

- Each family is unique.
- Families can be categorized based on their properties, e.g., family resource, social connection.
- The ABM allows studying the impact of a given prevention/intervention strategy on different family categories.
Heterogeneity within a Community (cont.)

- Different families “benefit” differently from prevention/intervention programs.
- Example: *Neighborhood development to reduce community stress by 70% in one year*
- In this example, families with more social connections “benefit” more from the program of reducing community stress.
- Why?

### Percentage of HRF

- No CM Prevention
  - Families with no social connection: 40
  - Families with 1 or 2 social connections: 29.4
  - Families with 3 or more social connections: 43.5

- CM Prevention by Reducing Community Stress
  - Families with no social connection: 40
  - Families with 1 or 2 social connections: 23.5
  - Families with 3 or more social connections: 13
The simulated community has high level of community stress, which cause families to have high stress levels.

Based on the model, families with high stress levels tend not to fully exploit their family resources and/or social connections.

When the community stress is reduced, families with more social connections or more family resources benefit more because they begin to exploit these resources. Families with less resource/social connections “benefit” in a limited way because they have limited resources to exploit.

What if a different type of community?
What if a different CM prevention/intervention strategy?
What are the policy implications?
Is this true in the real world?
Data and Model

- Model validation from empirical data is essential in order for practitioners to trust and to use the model.
- The current model focuses on exploring the possible dynamics of CM without a serious attempt to have fidelity to real world observations.
- Model validation of the developed ABM remains to be an open issue.
- Knowledge-driven modeling vs. data-driven modeling.
The Online ABM Tool

http://www.cs.gsu.edu/sims/CMSimulation/applet/

• Allow one to set up an “artificial community” and run simulations.

• Allow one to easily compare the impact of different factors on the quality of child care and other related outcomes (e.g., parenting stress, parental efficacy, social support).

• Provide statistical results (e.g., number of high risk families, average parental efficacy) for the community and sub-categories of the community.

• Allow one to configure CM prevention/intervention strategies and simulate their impacts.
  – Community Resource Center
  – Home Visiting
  – Neighborhood Development to Reduce Community Stress
  – Building Social Connections
Agent Based Simulation of Child Maltreatment (CM) and CM Prevention

Questions/Comments? Please email to Dr. Xiaolin Hu (xhu@cs.gsu.edu)

Community Configuration

Average Number of Children Per Household: 1.8
Average Number of Parents Per Household: 1.3
Average Stress Level of Families (0-10): 7
Parental Skill (0-10): 5
Community Condition (0-10): 7

Prevention/Intervention Configuration

Community Resource Center Capacity: 3%
Conclusions

• CM is a public health problem and the complexity of CM and CM prevention.
• An agent-based model is developed.
• Heterogeneity within a community should not be ignored.
• The online ABM tool.
• We are open for potential collaborations and supports.
Acknowledgement

• Dr. Richard Puddy from CDC
• Dr. Charlyn Harper Browne from Center for the Study for Social Policy (CSSP)

• Georgia State University Resource Foundation
• Centers for Disease Control and Prevention (CDC)
For More Information

- http://www.cs.gsu.edu/sims/research/AdvancingChild.html
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- Thank you!
- Questions & Comments