Process Insights from Using Group Model Building to Address Emergency Department Use for Pediatric Asthma Treatment *

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Abstract

The rate of emergency department (ED) use for the treatment of pediatric asthma in St. Louis has been four times higher than the rates in surrounding counties for over two decades. ED use for conditions that can be better managed in primary care facilities drains hospital resources, and creates significant stress and strain on families whose children need treatment. Several policies to address this complex problem involving social, health and health care system factors have failed to produce any long-term results. Insights into effective intervention require a deep understanding of the complex system in which the problem is situated. Thus, to address the problem, we organized group model building (GMB) sessions to bring stakeholders involved with various aspects of pediatric asthma treatment, care, and prevention to create a qualitative map of the structure driving persistently high ED use. Insights from the process include a shared understanding of the system boundaries, elements and feedback structures involved in pediatric asthma exacerbations and care, as well as an understanding of feedback and focus on endogenous drivers of system behavior among participants. Using the desired insights to drive the design of the sessions along with frequent reflection kept the GMB process productive and responsive.

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Introduction

Nearly 20% of all children in St. Louis City have asthma. Asthma exacerbations can be life-threatening when not controlled, and data show that over the past two decades, children in St. Louis go to the emergency department (ED) for acute asthma treatment three times more than children in surrounding counties and the rest of the state (Missouri Department of Health and Human Services, 2010). ED visits for asthma place a burden on the hospital resources and create stress for families whose children suffer from these asthma crises. Realizing the scope of the problem, stakeholders from the St. Louis City Department of Health, hospitals, local health clinics, universities, school districts, and other non-profit organizations have worked to address this persistently high ED utilization rate for the treatment of pediatric asthma, however their efforts have been met with considerable policy resistance, as rates remain high (Sterman, 2000).

With public health problems like ED use for pediatric asthma treatment in St. Louis that are complex and dynamic, involve several inter-related factors from social, health and health care systems, and show strong policy resistance, using a system dynamics (SD) approach could generate insights into the structures driving the problem and potential solutions (Homer and Hirsch, 2006; Hovmand et al., 2012b; Sterman, 2006). More specifically, a group model building (GMB) approach involving participants who live and work in the systems driving ED use is necessary for the model and any of its to be accepted by the stakeholders and the community (Hovmand et al., 2012b). Where the current strategy in asthma research has been to collect more numerical data, the real progress can be made with a deeper understanding of the structure, which lies in mental databases of those embedded in the systems where these problems are (Forrester, 1980). Using GMB can not only help modelers tap into the mental databases of stakeholders, but can also enable changes in the mental models of participating stakeholders (Vennix, 1996).

This paper presents the process and insights from a community initiated and led GMB project organized to address persistently high rates of ED use for pediatric asthma exacerbations in St. Louis with stakeholders from local departments of health, school districts, federally qualified health clinics, hospitals and other stakeholders involved in asthma treatment and prevention. In the first section we will provide some background on the ED use and asthma problem in St. Louis. Next, we will describe the core modeling team (CMT) activities and the group model building session design process. Then, we will present the outcomes from the GMB sessions and insights from those sessions, and lastly close with comments about how the process has guided the St. Louis Regional Asthma Consortiums next steps in addressing ED use for pediatric asthma treatment.

Problem

The ED utilization for pediatric asthma is situated in a complex system where social, health and the health care system are intertwined. The physiological event of an asthma exacerbation, where the airways to the lungs become swollen, restricting breathing, can be life threatening, and extensive research and data have been collected on its triggers and correlates. Environmental triggers for pediatric asthma include pet hair, insects, second-hand smoke, mold, and perfume among others (Missouri Department of Health and Human Services, 2010). Sociodemographic factors including race/ethnicity and income are frequently cited in asthma research. St. Louis data shows a disparity between racial/ethnic groups in the prevalence of asthma in children with more African American children diagnosed with asthma as compared to white children, and a similar disparity in terms of visits to the ED for treatment– over 90% of the children making ED visits in 2008 for treatment were African American (Missouri Department of Health and Human Services, 2010). Children who live in low-income communities have also been found to be at a higher-risk of developing asthma that those in higher income communities (Miller, 1999).

Several of these factors related to asthma prevalence in children are also related to ED use and hospitalization for asthma exacerbations (Miller, 1999). However, studies show that prevalence only explains a small piece of ED use and hospitalization. The causal mechanisms driving ED use for pediatric asthma exacerbations are not fully understood (Claudio et al., 2006). In the meantime, the current strategy appears to be to collect more and more surveillance data, however, these data collected by the health care systems, public health departments, and other public and private entities have yet to provide insights that have made change in the ED use and childhood asthma prevalence in St. Louis.

Several programs and policies have been implemented to address ED use in St. Louis by various stakeholders from the health department and hospitals to schools and other non-profits. Awareness campaigns about the severity of asthma as a chronic disease, asthma management plan promotion, and distributing information of about asthma triggers are all strategies that have been tried but resulted in little or no impact on reducing ED use.

From a SD perspective, this dynamic problem of ED use exhibits a strong policy resistance, as its multiple interwoven parts are interacting to compensate for any of the shocks that concerned stakeholders are introducing into the system to create changes (Forrester, 1987; Sterman, 2000). And, while the focus has been to gain a better understanding of the problem by augmenting the numerical database about ED use and related factors, a deeper understanding of the structure driving ED use is more likely to come from the stories of those embedded in the system itself (Forrester, 1980). By tapping into the mental databases of stakeholders working in asthma treatment, prevention and related fields using group model building, we can begin to unpack some of the causal mechanisms behind the correlation-based research efforts , create a shared vision of the problem across the diverse stakeholders involved,

and and moved towards effective intervention.

Project description

Core Modeling Team Formation

The initial idea to use an SD approach to pediatric asthma utilization came out of one core modeling team member's work in the health department and a week long exposure to systems thinking in public health training, where she developed a causal loop diagram that showed a counter-intuitive system archetype, "shifting the burden," to characterize the problem (Senge, 1990; Lane, 1998) (Figure 1). After enrolling in an SD course, followed by a GMB course at a local university, she had conversations with the St. Louis Regional Asthma Consortium (STLRAC) about using GMB to address the persistently high ED use for pediatric asthma exacerbations– one of the city's most pressing and complex public health problems. The goal was to go into deeper detail into the causal mechanisms underlying the general structure with community stakeholders (Vennix, 1996). She approached the Social System Design Lab (SSDL) at the George Warren Brown School of Social Work at Washington University and after several conversations, decided that GMB would be both a an appropriate and useful approach to addressing pediatric asthma treatment in emergency departments.

The grant mechanism that supported this project (through the St. Louis Institute for Medical Education) emphasized the participation of students and the provision of practice with methods useful for studying and understanding public health problems. This unique focus allowed the core modeling team, which was assembled after the support was secured, to build in and spend considerable time reflecting on the GMB process and learning, giving many CMT members the opportunity to participate in the various roles during GMB sessions.

The CMT was comprised of eight diverse stakeholders interested in asthma, public health and/or GMB and SD. The team's experience in SD and substantive area of pediatric asthma ranged from some with extensive knowledge about asthma and new to SD and GMB, to others with experience in SD and GMB and little knowledge about pediatric asthma, and one member (the project's community leader) falling in the middle of those extremes. Members also had a diversity of work experience, with one member being a trained physician with extensive experience working with asthma patients and research in St. Louis, another from the division of Children's Environmental Health at the St. Louis City Department of Health, three doctoral students (one in each social work, public health, and educational technology), and three master's level students (one from public health, one in social work, and one dual degree social work with public health). Although some core-modeling team members had previously worked together on other projects, the entire group assembled to work as a team for the first time on this particular GMB project.

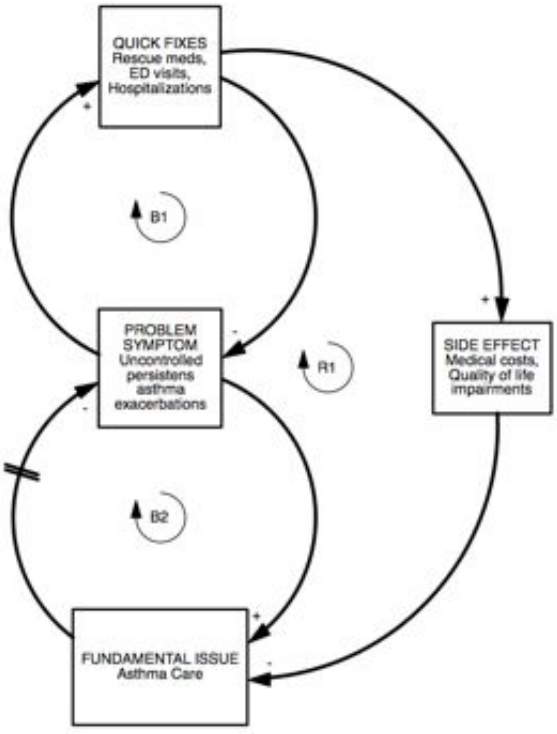

Figure 1: Initial "30,000 ft view" CLD of the ED use for pediatric asthma problem in St. Louis. B1: Children go to the ED for treatment when they have an exacerbation in a crisis. B2: Children can also have management plans that can reduce exacerbations, but these take time to develop. R1: The more children use the ED for asthma exacerbation treatment, the less resources are available for longer-term asthma care programs, the more exacerbations there are being treated in the ED.

Either the CMT held a meeting or a GMB session every two weeks beginning in September 2012 through mid-December 2012. The CMT met for three sessions before the GMB sessions with community stakeholders were scheduled. During these sessions CMT members shared information with each other about the problem of ED use and childhood asthma, GMB and SD. Scripts like "Hopes and Fears" allowed CMT members to share feelings and expectations about the project and their involvement. With such a diverse group on the core modeling team, this script proved to be very helpful in normalizing fears, as well in understanding what each member hoped to gain from the project.

The scope and goals for the project were also defined by the group in these first sessions. Several potential options were discussed that varied in terms of types of insights we were hoping to generate, types of models produced (e.g., simulation or qualitative models), types of stakeholders to include, and number of sessions to hold. Based on the projects timeline, expertise of the core modeling team members, and

previous work on the problem, the core modeling team aimed to produce a qualitative map of the structure driving ED use for pediatric asthma from the perspective of the stakeholders working in the communities in hospitals, clinics, schools, and other programs. The insights sought were: 1) to engage participants in understanding that the ED use problem was embedded in a system, 2) to have stakeholders identify what parts in the system are relevant to include in a model targeting the reduction of ED use, 3) to create a shared vision of the structure (i.e., causal links between the relevant variables) between participants in several participant stakeholder groups. Although the CMT understood that that SD simulation modeling can provide some deeper insights into system behavior (Homer and Oliva, 2001), and that qualitative models can often misrepresent feedback (Richardson, 1996), for the types of insights that they hoped the project could gain, qualitative diagrams that could reflect the mental models of diverse community stakeholders was central to values of the CMT and the project goals. Future work towards a simulation model could come following this first phase of the project, however the scope of the activities planned for this project were agreed to be in line with the insights sought.

The CMT decided on using a scripted approach to the GMB process (Hovmand et al., 2012a), and decided on a total of four GMB sessions. During a planning meeting, the CMT created a process map to organize how the potential sessions and project would unfold, including the number and types of participants, and session outputs (for an example of an early version of a process map see: Figure 2). The following section will describe in more detail the structure and activities of the GMB sessions.

Few case studies exist that describe how GMB sessions are organized and undertaken, and none that the authors could find described in-detail this process on a community initiated *and* led GMB project. Luna-Reyes and colleagues (2006) describe their process of designing GMB sessions by describing the scripts they developed and used. The objective for each script was detailed, followed by a summary of how the script was carried out (process), and was followed by a critical assessment of the script in addressing the desired objective. Following this framework, we will describe our GMB sessions script-by-script, including discussion of objectives, process and assessment.

GMB Session 1: Professionals from a Patient Referral Task Force and Managed Care

The first GMB session included 21 participants (plus the eight core modeling team members), who were professionals working in health clinics, hospitals, managed care, and emergency departments in St. Louis. Inviting professionals from the along the continuum of childhood asthma care was the plan for this first session to take a first pass at some of the relationships driving ED use. During this session, a short verbal introduction to the problem was given, and a reference mode showing the desired and feared trajectories of ED use for pediatric asthma exacerbations drawn on a whiteboard. Two scripts, "Behavior Over Time Graphs" (BOTGs) and "Structural

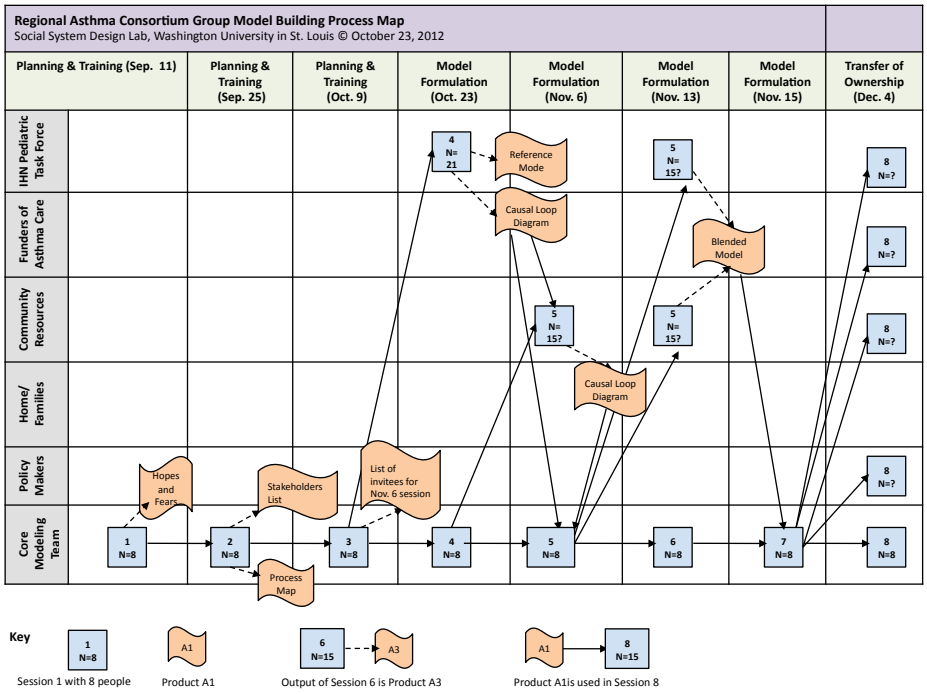

Figure 2: Example of a process map created at CMT meeting, outlining the GMB sessions, participants, and outputs.

Elicitation", were used to structure the rest of the session.

Script 1: Behavior Over Time Graphs

Objective This script has several objectives: 1) orient participants to the dynamic problem that is the focus of the session, 2) elicit variables related to the problem, and 3) encourage participants to think about the problem of ED use for pediatric asthma exacerbations as a dynamic problem and in the process, understand some of the key variables and relationships related to problem. This exercise has an important role in giving all participants an opportunity to speak or (when working in pairs on the task) have their voice heard at least once in front of the entire group.

Process The facilitator encouraged participants to hand-draw "behavior over time graphs" (BOTGs) of variables that "cause or are affected by ED use for pediatric asthma exacerbations." The facilitator drew one herself in real-time, talking out loud as she describes the components each graph should include: the x-axis for time (any time scale and horizon the participant chooses), the y-axis for the variable chosen (percent of children hospitalized, number of trips to the hospital per month, etc.), a

trend line that shows past behavior as the participant understands it to be, a dotted line indicating the present time, and desired and feared trajectories. Drawing this in real-time instead of having one example that had been pre-made has increased the success of participants' creating their own graphs with all of the useful elements clearly included.

The example the facilitator drew had nothing to do with the topic of the GMB session so as not to influence the participants, and was on a time scale that was probably also not one that the participants would choose (the particular example had something to do with stray dogs beginning in the year 1713 and going until 2080). Our experience is that the example the facilitator chooses can heavily shape the participants' graphs. If the example shows an upward trend in a variable in the past, and an increasing upward trend as something feared, and a negative trend as desired, many participants will follow suit framing all of their variables that way. We have thus, created graphs that have unrealistic oscillations (sometimes with curly loops), have time horizons that go centuries into the past and future, and use variables like stray dogs in the city and price of gold.

After walking through the example, the facilitator gave the participants fifteen minutes to create as many graphs as they could. Since the group was large (more than 10), we asked participants to pair up and create graphs together. As things slowed down, the facilitator asked the participants to order their graphs with the one they liked/felt most strongly about on the top. Then each pair shared their graph with the facilitator and group, telling the story behind it. The facilitator began with a graph that was especially clear and included all the elements the example graph included. A "wall-builder" then taped the graphs to the wall as they were shared, organizing them into thematic groups as they emerged.

Participants shared until there are no graphs left with new stories. Many participants continued making graphs if something came to mind while others were presenting, and were encouraged to do so quietly. The wall-builder then shared the groups she constructed and asked for feedback from the group on the groupings, asking if any categories need to be changed or any graphs needed to be moved.

Assessment The participants who work in several sectors associated with pediatric asthma in St. Louis agreed that focusing on ED use for pediatric asthma exacerbations was an important problem to come together to address. Ten pairs and one group of three generated 25 unique BOTGs, that the wall builder grouped into four groups: environment, issues related to parents, access to medications and insurance, and quality medical care. The participants seemed engaged in the creating the graphs (many drawing more even as the sharing started), and commented both on how both they had not thought of some of the variables others had, and how others were"exactly what we had drawn."

Professionals in the health and social service fields are bombarded by statistics that stratify individuals by race/ethnicity, gender, socioeconomic status and several other "status" variables. Correlation-based thinking is not what is needed to create

Figure 3: Photos from first GMB session. *(Clockwise from top right:)* Participants creating BOTGs, Wall builder grouping graphs, participants choosing important variables, modeler during structural elicitation script.

CLDs or SD models, and the BOTG script helped to shift participants away from thinking in terms of correlations and "sociodemographic predictor variables" and towards variables that demonstrate change over time. The group seemed comfortable thinking about the operational causes and effects of the ER use, and no one questioned the use of the word "cause" or "effect" (as can happen when participants are used to using the word cause with much caution), or asked "What about race?" during the script.

Script 2: Dots

Objective The objectives of this simple script are to get an idea of the variables the participants find to be the most essential to understanding the ED use problem and to reduce the number of variables from generated in the BOTG script to a more manageable number (five or six) before moving into the structural elicitation script that follows.

Process Using small sticker dots (three for each participant), the group voted for which BOTGs they think were the most essential to consider when thinking about ER use for pediatric asthma. They could place their sticker dots on any of graphs,

and could have even given multiple sticker dots to graphs they found to be especially important. The facilitator assured the group that these variables were just a starting point, and that more will surely emerge from the conversations in the next part of the session. Participants were invited to walk up to the wall to place their stickers before taking a small refreshment break.

The facilitator for the structural elicitation script, modeler, wall builder and process coach (in charge of things related to time management and making observations about interactions and dynamics within the session) met to discuss graphs that were receiving the most votes. After all the participants had cast their stickers, the modeler for the next script writes the names of the top four variables scattered on the white board, along with a variable of ED visits. The dots script took about 6 minutes, and was included in a ten-minute break for the group.

Assessment This short script ran smoothly and maintained a positive environment in the convening room. Participants discussed the process with others at their table and at the wall while making their choices. These conversations continued throughout the break and the general energy in the room was buzzing and positive. Sixteen of the twenty-five BOTGs received at least one sticker vote, and four had more than six stickers attached to them: referrals to primary care providers after ED visits, improper use of inhalers, ED discharges with no prescription or plans for asthma control, access to primary care providers office, and relationship between patients and their primary care providers. These were used to start the structural elicitation following the break.

Script 3: Structural elicitation

Objective In the structural elicitation exercise the objectives are to make a first cut at the causal mechanisms driving the dynamic problem. One insight the script aims to foster is that there is complex system driving the problem, with many components, all moving together. At a deeper level, the idea is to move participants from a creating a"dead buffalo" diagram where several variables are directly causing one outcome, to one that shows operational causal linkages and feedback loops that could be driving the problem (Sterman, 2000).

Another important objective in the script is accommodating the inclusion of several perspectives in the CLD. Especially at the beginning of a GMB project, where stakeholders are from several different sectors, and have different power in their professional life, accommodating these diverse perspectives is important in team and trust building in the GMB process.

Process During this script the facilitator, first gave an example of how the group would show how causal linkages would be depicted on the whiteboard, and gave an example of a balancing and reinforcing loop using an example based on the stray dogs variable (used as the example in the BOTG script).

The facilitator then explained that the group would draw the same types of causal linkages between the variables they had identified in the BOTGs and that they were free to include other variables as they went along. The first link drawn described that as the quality of the relationship patients have with their primary care providers (PCPs) increases, their use of the ED decreases. Others discussed how discharge plans for patients could also decrease their use of the ED in the future, especially when there is communication between the ED and the patients PCPs. Both of these linkages were influenced patients use of controller medication. Participants told stories about how patients knowledge of how and when to use controller medications can and appointment availability at PCPs affect their decisions to go to the ED for treatment.

Conversations and links were rapidly being suggested from the participants and the facilitator and modeler worked together to ensure that the stories told were reflected in the structure drawn on the board, which proved challenging (as the modeler was having to draw variables and links as they were quickly being suggested for all to see on a wall of dry-erase boards). Participants included variables that discussed in the earlier BOTG script and integrated others not previously mentioned easily. Some variables that seemed to be outside of the model boundaries like poverty were suggested, and while the group acknowledged that addressing poverty was beyond the scope of the model, for the time being, participants felt more comfortable including it and "social determinants of health", as long as the model was going to be a "rough cut" and "first draft".

The balancing loop between ED use and asthma exacerbation was identified and discussed in the group, but the early stories shared did not describe any other feedback loops (Figure 4). The facilitator guided the participants attention to the"dead buffalo" nature of the emerging diagram, and asked participants to focus on relationships between variables that were already on the board. The participants stories began linking more variables, but no one was describing how ED use affected anything in the model. The facilitator asked the participants to consider what variables it affected, but time was running out and while the interest in CLD building appeared to be in full swing the session had to end. The CMT met following the session to debrief.

Assessment While this session did produce a preliminary causal map, participants wanted more time to add more of their experiences to the diagram. This was addressed by discussing that nothing about this diagram had to be final or perfect and that the model building is an iterative process. However, the CMT reflected on these reactions from the participants and the lack of time to focus on identifying feedback loops in the planning for the next sessions, both in terms of time and agenda setting and in the way the Structural Elicitation script was carried out. The CMT entered the diagram created in the first session into Vensim and redistributed it to all the participants of that week along with some photographs from the session, both so they could think about the diagram and other relationships they might want to discuss

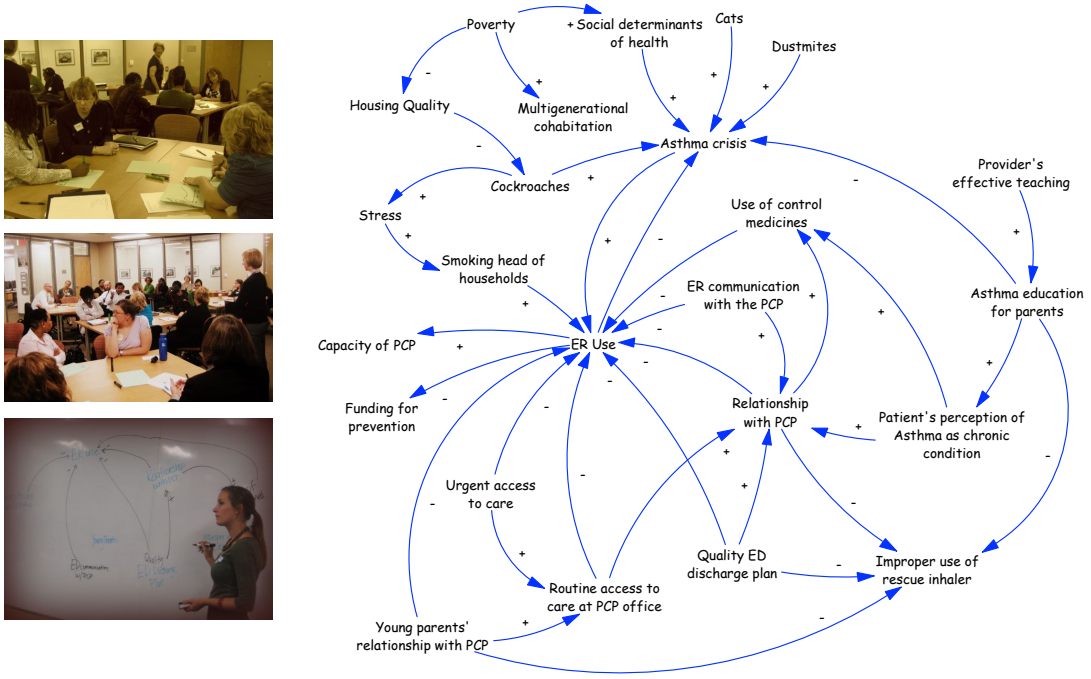

Figure 4: Handout created for participants from the Integrated Health Network.

and to remind them that they were invited to future GMB sessions (Figure 4).

GMB Session 2: Community health workers

This second GMB session included 16 stakeholders the core modeling team characterized as community health workers. These participants were professionals including school nurses, managed care providers, wellness and tobacco cessation coaches.

Script 4: Structural elicitation

Objective The objectives for the structural elicitation script are the same as in the previous section.

Process Learning from the timing problems in the first session, this session began with the structural elicitation, with the same variables the first session stakeholders had chosen (cutting out the BOTGs and Dots scripts that were included in the previous session). Also in this session, instead of drawing the CLD on the board, a

modeler created the diagram in real-time in Vensim, the modeler-facilitator led the conversations informing the structure for approximately 90 minutes. Participants drew causal links between the initial variables, quickly nominating other relevant variables.

Since time seemed to constrain the identification of feedback in the previous session, the process coach gave a signal to the modeler-facilitator to begin a shift in identifying feedback loops with 30 minutes remaining for the script in this session. As the nomination of links began to slow, the modeler-facilitator asked for any additional variables that participants felt needed to be represented that were not already included before handing the facilitation to the process coach. The day's accomplishments were then reviewed and situated within the context of the modeling project scope, and participants were given a chance to reflect on their experience in the process and share their observations. CMT members debriefed following.

Assessment Participants seemed much more satisfied with the modeling process during this session. Their contributions to diagram were rapid at first and seemed to slow down towards the end of the time allotted for the script, instead of being cut off by time restraints as in the previous session. Still, feedback relationships were not drawn.

The CLD was cleaned in Vensim and sent to participants the following week (Figure 5). Core modeling team members worked to integrate the CLDs and clean them for presentation in the following GMB session. Emphasizing and identifying feedback in the diagram was set as the goal for the third session as both CLDs had several links leading directly to"asthma crisis" and "ED use".

GMB Session 3: Combined Stakeholder Groups

This third session had thirteen participants. Stakeholders from the first two sessions were invited to attend if their schedule allowed, and two participants attended for their first time. The session lasted 90 minutes, and the script for the session was used as a result of the observations and CMT reflection that time needed to be taken to pull out more feedback from the stories of the participants.

Script 5: Merging maps and closing loops

Objective The objective of this script, was two-fold: 1) bring diverse groups of stakeholders together to make steps towards a qualitative diagram that reflects the experiences of all those who worked to create it, and 2) work with the participants to identify and capture relevant feedback loops in the structure. Special time was taken to ensure that variables with the same name in different diagrams had the same meaning in the shared diagram.

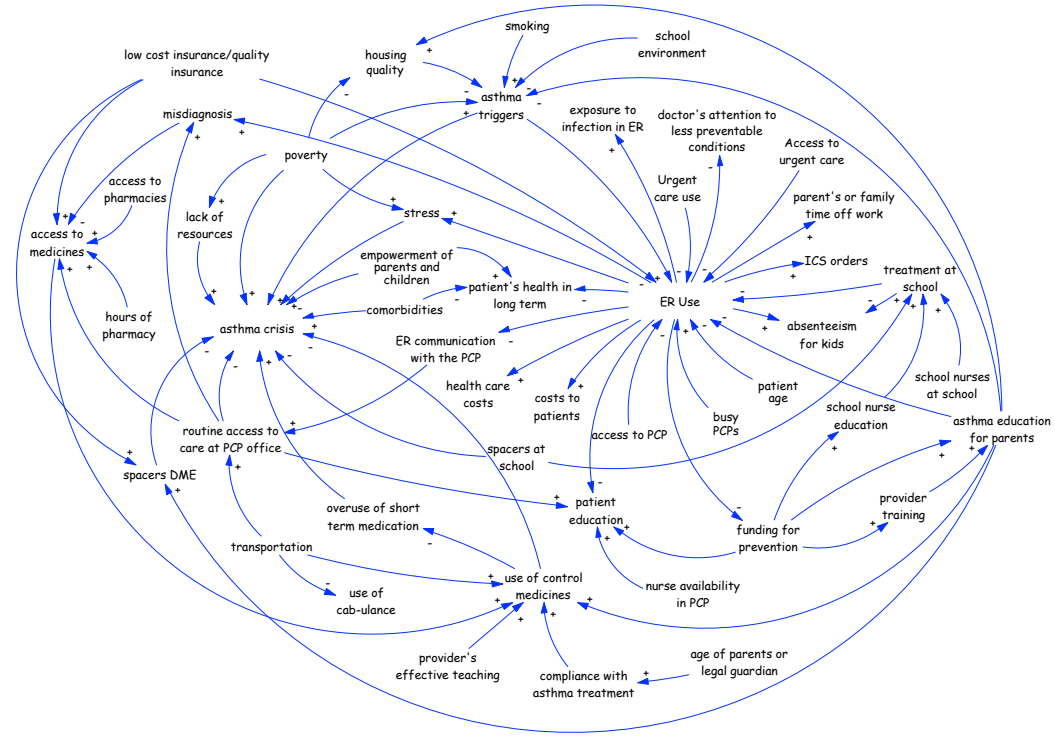

Figure 5: Handout created for participants from the second GMB session with community health workers.

Process The modeler facilitator reviewed the process from the last two sessions and explained the tasks at hand for the current session. As the two CLDs had been integrated off-line by the CMT, some time was spent explaining that process and any questions or initial reactions were discussed before the work on the model began.

Then, the participants worked in pairs to identify links that they believed exist between variables already in the diagram, but that might not have been discussed in the previous sessions. Each participant had a paper copy of the current version of the CLD and a blank paper to note the variables, relationships, and polarities that they considered relevant but missing from the diagram. The modeler facilitator asked them to make note if the links they were making closed any loops. After about 10 minutes of working independently, the partners began to share the links they wanted to add, and the stories that accompanied them. While participants shared the stories, a modeler added the links in realtime in Vensim, projected on a large screen, in a similar way as had been done in the Structural Elicitation script in the second session. The facilitator highlighted feedback and delays when possible.

Assessment This session made steps in moving the diagram from one of correlations and linear thinking to one of operational mechanisms and feedback. Participants were able to remove some variables that no longer seemed relevant, and add in intermediary variables that made up the causal structure of the system. Those who had not seen Vensim before reacted very positively to the real-time modeling. At the end of the session, participants appeared energized after having made another "cut" at the model and were anxious to see what it would look like cleaned up with fewer crossing lines and the removal any unnoticed redundancies. They trusted the CMT to do this offline after understanding and seeing the output of this process several times by this time in the process, which showed a high level of trust between the stakeholders and CMT members. The session ended as the previous sessions did, with a review of the session and discussion of what to expect in the following meeting. The CMT met following the sessions to debrief and discuss preparations for the final meeting.

An additional core modeling team meeting was planned to go over the notes from the previous sessions to clean up and simplify the CLD, and identify any thematic subsystems in the model. Revisiting the stories of the participants and using the knowledge of the core-modeling team members with experience in asthma treatment, the CMT was able to remove several direct links from variables to ED use that had previous versions looking like "dead buffalo diagrams", and reflect them more appropriately through intermediary links (Sterman, 2000). The model refining was done as a group, and creating a cleaner visual representation was then done outside of the meeting between two core modeling team members.

GMB Session 4 (Integrated CLD Presentation): Combined Stakeholder Groups

Script 6: Transferring Ownership

Objective The objective of the Transferring of Ownership script is to review the GMB project goals and the work accomplished through the GMB sessions, go over the current version of the model, and discuss the next steps for the project. Both the facilitators and participants discuss how they might use the model moving forward.

Process The community facilitator opened the session with a presentation reviewing the motivation for the use of GMB to address pediatric asthma treatment in EDs in St. Louis, which began with a brief overview of numeric data available on rates of ED use and hospitalizations over time, the initial "shifting the burden" qualitative model, and discussion of how coordination across several organizations and individuals was needed to make any headway on reducing the rates. The review of the background and motivation for the project was followed by a review of the work of the previous GMB sessions and work done by the CMT between sessions, these included pictures of the models at various stages, and photos of the participants at work during the sessions and CMT meetings.

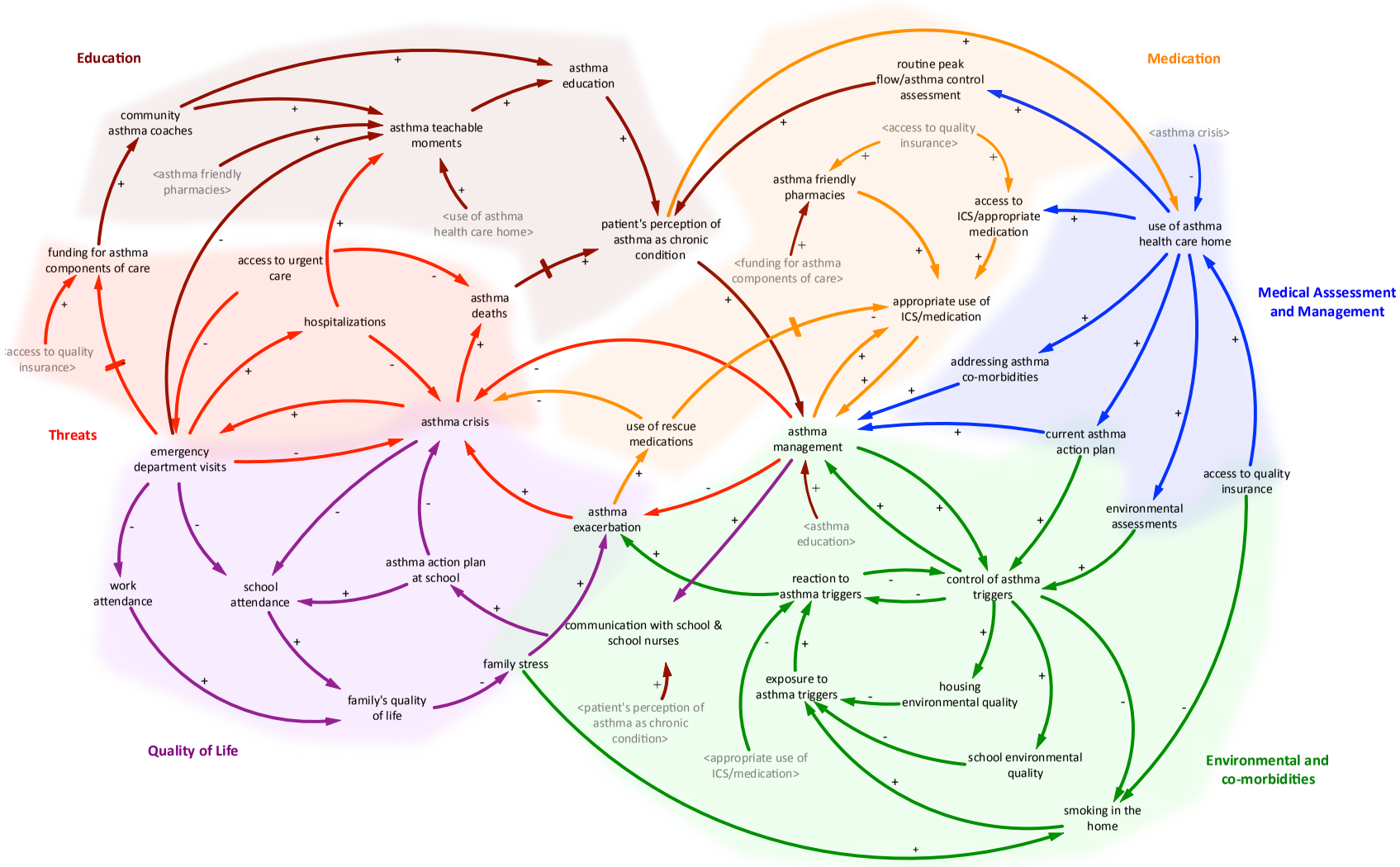

Figure 6: CLD presented at the final GMB session with community stakeholders.

The presentation part of the script closed with a discussion of the current version of the CLD (Figure 6), which had been cleaned up between the previous GMB session by the CMT as a group. Six sectors of the model came out in the cleaning process, and those were highlighted in the presentation: education, threats to asthma exacerbations, quality of life, environmental triggers and co-morbidities, medical assessment and management, and medication. These sectors and corresponding color-shadings came out of the model cleaning process and thus some time was gone over discussing that process with the participants.

The community facilitator went over feedback stories and loops that had been told in previous sessions and some new feedback loops had been identified in the model cleaning process. While going over these sectors of the model, the community facilitator asked the participants if the diagram reflected what they experienced or had told in previous sessions so as to ensure the cleaning process did not miss or mis-represent stories or relationships shared throughout the project. Participants, particularly those for whom it had been their first session had questions about the relationships that others who had been in the sessions answered.

Ideas about how the CLD could be used in the participants' work and how it might be used in the future by continuing the modeling process were shared. Participants were asked to think about and share where their organization's work or their own position's fits into the diagram, guided by prompts such as: what if any gaps were evident that could be filled, what new links needed to be created or removed, and how could participants (and their organizations and programs) use the CLD in their work. The session ended with these conversations in a large group with participants also adding what they had taken away from the process. As with the previous GMB sessions, the CMT debriefed following the session.

Assessment The tone of the room was positive during this final session. Although the majority of the participants had participated in at least one of the previous sessions, for some it was their first meeting. Having new participants at a session where the majority of the work has been completed (at least for this phase of the project) can be challenging as they are not familiar with the GMB process and SD and can come with questions that come from that unfamiliarity. In one case, a new participant was eager to find which "one thing" could be changed to fix the problem, and in this instance participants were able to explain that finding that "one thing" was not the purpose of these sessions, and that maybe there was not any one solution. The CMT reflected that the participants' ability to explain this showed a strong understanding and engagement in the project.

It was also considered positive that stakeholders were eager to continue in upcoming GMB processes. The community facilitator explained that possible next steps for the project as organized by the Regional Asthma Consortium and St. Louis City Department of Health included working on building a simulation model in additional GMB sessions, involving other groups of stakeholders in adding to the qualitative model, and/or taking the model "on tour" to several asthma focused task forces and

interest groups to get more feedback and interest in participating in future modeling efforts. Many participants reiterated that it would be extremely useful to understand the experiences of the children with asthma and their families using GMB that they felt uneasy trying to include in the CLD they had worked to create.

Insights from the GMB Sessions

The goals of the project as defined by the core modeling team were to develop certain levels of system insights with stakeholders through GMB. Through GMB, stakeholders and CMT members developed insights about the system boundary, structure, operational mechanisms, and feedback. The core modeling team also learned from the process of GMB especially about the importance of insight and project goal-driven design of the sessions and process oriented reflection amongst CMT members.

Complex System Insights

One of the defined goals of the project was to develop the insight that the ED use for pediatric asthma exacerbations problem was embedded in a complex system. And while this seems intuitive to system dynamicist, mental models of participants early on often focused on one variable being a "the main cause" (i.e.,"parents dont see asthma as a chronic condition","primary care doctors cant schedule patients when they need it","medications are too expensive"). Very quickly participants began to see that it was "just" any of these causes but the interaction of all of these things. Participants found the value in mapping the structure and seeing the complexity represented visually.

Boundary Insights

Stakeholders spent time discussing the model boundary, especially as it pertained to the inclusion of poverty and insurance. The discussion of how the model boundary and the scope of the modeling project would change in order to make poverty endogenous to the model was a helpful one in that it appeared to be empowering to participants since the focus was "on things what we have control changing" and not feeling overwhelmed by one variable that seemed to have relationships to everything. This was also a key variable in conversations about causal vs. correlation-based relationships in SD. In the end, certain aspects of poverty like available income were included in the model, whose meaning was negotiated by participants, and which seemed to be more on the level of aggregation of other aspects of the CLD and within the boundary.

The boundary of the model was questioned frequently when participants had conversations about the inclusion of the child patient/family perspectives. Participants felt uncomfortable about making assumptions about patients and their families, and

so the participants were reassured that these sessions were preliminary sessions to start to understand the issues, and that they were not responsible for expanding the boundary to include every aspect of the problem. The participants and the CMT did express that future modeling processes must involve patients and families.

Structural Insights

Creating the space for several stakeholders to share their mental models about the causal linkages between several factors in GMB sessions did not come without disagreements amongst participants. In every session, several causal links were debated, and in come cases, quite heatedly. In these cases, where the participants mental models were not the same, structure was agreed upon that could show several points of view (often by adding intermediary variables) or a structure was agreed upon that reflected a consensus opinion of the situation. Having the CLD as a focus of attention shifted the discussions from having a blaming tone or alienating the voices of participants offering alternative perspectives.

Insights Moving Toward Operational Thinking

The "Behavior Over Time Graphs" script in the first session was useful in setting the tone for participants to think about variables that explicitly cause or are affected by ED use for pediatric asthma exacerbations, away from variables used frequently in correlation-based research like race/ethnicity and gender. During structural elicitation scripts in both sessions, when variables like these were brought up, participants were pushed to describe what they thought were the causal mechanisms under that named correlation. In the first two sessions, a variable concerning the age of the parents of children with asthma was explained by different participants as being related to developing and sticking to asthma treatment plans.

This one variable had several stories beneath it, including ones that described younger parents lack of time, shorter attention spans, different understandings of responsibility, lack of knowledge about the gravity of asthma as a health concern, among others. Participants appeared to be challenged when asked to present these mental models, but normalizing the experience by sharing that these CLDs require this operational perspective created space for participants to explore their own mental models and question and compare theirs to those of others.

Feedback Insights

The importance of the feedback was emphasized throughout the GMB sessions and participants had no trouble relating to reinforcing loops and balancing loops as they were presented, placing them in the context of asthma treatment. Although feedback loops were identified as they were made in all three working group model building sessions, an important insight came at the third session when a new participant provided new information about a hospital program designed to give more information

to patients about asthma management. If the goal was to shift the burden away from the EDs and hospitals, creating a program that addressed more of the patients needs at the hospital or ED, might only strengthen the loop of families taking their children to hospitals for treatment. The relationship of feedback to unintended consequences of policies became very real to participants and CMT members.

Complex Problem Solving Insights

In the final session, where the integrated and simplified CLD was presented to stakeholders, some newcomers were struck by the complexity of the diagram, and were anxious to know where to intervene. The city had in past years reduced a major problem with lead poisoning, and one participant wanted to know where in his words "removing lead paint in the windows was in this diagram". Using the model, the facilitator could explain how although lead poisoning and asthma are both public health problems and both most likely to occur in low-income communities of color in the city, the mechanisms are quite different. Although lead poisoning was a complicated problem, childhood asthma and ED use are more complex. Just as lead poisoning required a coordination of efforts to address, these ED use for asthma problem requires that as well, but after the complexity of the problem and important feedback loops are understood. The participants involved in the modeling sessions seemed to understand that there was no solution, like "removing windows" for the asthma problem.

Process Insights from the Group Model Building Project

A core component of group model building is co-creation with stakeholders not just of models or qualitative diagrams but also of the insights throughout the process. This was certainly apparent in the current GMB project. Members of the CMT, with their combined domains and levels of expertise, might have just as easily created a model that looked in the end very similar to the one created by participants in modeling sessions, however, the insights would have remained with just them. For complex problems like ED use for pediatric asthma exacerbations, intervention strategies will require the coordination of several stakeholders, and that requires a shared vision of the problem, its drive, how certain goals can be achieved and why others might fail. Steps towards intervention, thus, are facilitated through GMB more than through other model building strategies that do not include community stakeholders from the beginning.

The design of GMB sessions should be driven by the project goals and insights, but should also be flexible. Process maps like an early one from this project shown in Figure 2, are invaluable tools for organizing and viewing the scope of a project and how components work towards the project goals. In designing these sessions, practical constraints like the availability of participants in terms of time and available meeting spaces to adequately accommodate participants and goals for the session

influence the kinds of scripts that you can use to meet session goals. While process maps for the entire project are helpful to make in the planning phases, adjustments can be made as needed as goals evolve, things can be scaled up or down, or change in other ways. Our process map changed several times responding to changes in varying scope. Our earlier stages of planning had more stakeholder groups and then reduced in scope, went between separate meetings for different stakeholder groups to careful mixing of stakeholder groups, planned for using the same scripts in initial sessions with stakeholders and based on session reflection changed things for subsequent sessions. However, despite changes in the process, the idea of designing these sessions with a common goal in mind kept the project on track and sessions productive.

Reflection or debriefing after GMB sessions serves many important purposes. Through group reflection the CMT could give each other feedback and discuss what went well and what needs work both on the modeling team member level and the session level. These post-session discussions helped to inform adjustments in the process map, CMT roles in subsequent sessions, and helped members improve their GMB practice, which was especially useful as there was an expressed interest in CMT members to build their own capacity in group modeling building and system dynamics.

Conclusions and Next Steps

The persistently high rate of emergency department use for the treatment of pediatric asthma in St. Louis is a complex problem caused by the interaction of social, health, and health care system factors. Although several organizations have implemented programs aimed to reduce the use of the emergency departments for conditions that could be managed by the patients and families, they have not seen their desired results. This project, using GMB with stakeholders who work in the community, hospitals, clinics, schools and non-profits was a first step in understanding the drivers of this problem and developing a shared vision amongst stakeholders for what the problem is and how what they do at their organizations affects other parts of the system and the problem. This project was was uniquely both community-initiated and community-organized. Even with no experts in GMB or SD on the CMT and no simulation model, several important insights were gained in the process of creating this iteration of a CLD that were shared amongst CMT members and stakeholder participants.

The St. Louis Regional Asthma Consortium, St. Louis City Department of Health, and other core modeling team members have taken this initial causal loop diagram "on tour" to highlight the productive work towards understanding the problem accomplished in the sessions in a short amount of time and to receive feedback on what was done and engage more stakeholders. In the spring of 2013, CMT members worked with students from a GMB course to organize sessions with children who have

asthma and their families– the next step that was most strongly advocated for by the stakeholder participants themselves. These sessions kept with insight-driven design process and continued with the work started in these first sessions by reflecting the patient stories in a CLD. Work is now being done to integrate these CLDs and begin planning sessions that work towards producing insights that can be gained through simulation.

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