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Reframing Survival: It's about Systems not a Chain

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Abstract

The medical standard of care when confronted with sudden cardiac arrest (SCA) is to follow the "Chain of Survival" by engaging in early access, early CPR, early defibrillation and early advanced life support (ALS). Particularly in the occupational setting, each of these actions has been identified as critical to support the patient while awaiting assistance and transportation from the community Emergency Medical Service (EMS). However, I present here a broader argument that restricting one's thinking to a conception that the "likelihood that a victim will survive cardiac arrest increases if each of the elements is addressed" is inadequate and misleading. Moreover, continuing to focus *primarily* on these *individual elements* is unlikely to solve to any significant degree the complex problem of our vulnerability to death from SCA. This paper presents an overview of this argument, offers an alternative conceptualization, and proposes ideas and actions that follow from its logic. While specifically directed at the problem of survival following SCA, the argument presented also addresses wider problems associated with major medical emergencies and other disasters.

Comments

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CENTER FOR ORGANIZATIONAL DYNAMICS

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Reframing Survival: It's about Systems not a Chain[1]

Larry M. Starr, PhD[2]

> The term "Chain of Survival" was coined in 1987 to … capture the essence of today's ideal system of emergency cardiac care. The critical elements of this system: early access, early CPR, early defibrillation and early advanced life support, were conceptualized as interdependent links in the Chain of Survival.
>
> According to the Chain of Survival model of emergency cardiac care, the likelihood that a victim will survive cardiac arrest increases if each of the elements is addressed.
>
> It is the timely occurrence of each of these key variables in the continuum of care that determines who will live and who will die.
>
> Citizen CPR Foundation
> www.citizencpr.org/chain.html

The medical standard of care when confronted with sudden cardiac arrest (SCA) is to follow the "Chain of Survival" by engaging in early access, early CPR, early defibrillation and early advanced life support (ALS). Particularly in the occupational setting, each of these actions has been identified as critical to support the patient while awaiting assistance and transportation from the community Emergency Medical Service (EMS). However, I present here a broader argument that restricting one's thinking to a conception that the "likelihood that a victim will survive cardiac arrest increases if each of the elements is addressed" is inadequate and misleading. Moreover, continuing to focus <u>primarily</u> on these <u>individual elements</u> is unlikely to solve to any significant degree

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the complex problem of our vulnerability to death from SCA. This paper presents an overview of this argument, offers an alternative conceptualization, and proposes ideas and actions that follow from its logic. While specifically directed at the problem of survival following SCA, the argument presented also addresses wider problems associated with major medical emergencies and other disasters.

Over the past 50 years, from the perspective of organizational and management science, two paradigm[3] shifts have occurred. **Part I** of this paper describes the first, the nature of how we think about organizations and their activities. **Part II** presents the second, how we inquire into and think about information. Appreciating this dual change is critical to efforts to cope with and manage the chaos and complexity in our environment including how we prepare for and respond to our vulnerability to sudden cardiac arrest. Failing to integrate these shifts into plans, policies and procedures contributes to structural conflicts, perceptions of helplessness or impotency, and limits, resists or prevents efforts to change. **Part III** applies the outcome of these paradigms to better understand, plan for and manage the problem of our vulnerability to sudden cardiac arrest.

I. Nature of Organizations

When signals of possible SCA (ranging from chain pain to collapse) occur, it demands responses by those at the scene who recognize the presence of an emergency. When the scene is a formal organization, potential responders include bystanders, members of departments (such as safety, security, healthcare, and human resources) and

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[3] Paradigm was the word introduced by Kuhn to describe a pattern of knowledge, rules, assumptions, or thinking. Kuhn, TS. *The structure of scientific revolutions*. Chicago, IL: University of Chicago Press, 1962.

others who may be alerted or become engaged to voluntarily or by designated role provide support or care. Since each organization is an independent enterprise, each has its own organizational structures, governance, history, culture, and sets of policies and procedures which inform or control the nature of planning and responses.

When someone telephones "911," a second organizational entity consisting of police, fire, and/or other designated EMS responders is summoned. Each new person who arrives to help the SCA patient brings into the organizational space the structures, governance, history, culture, and policies and procedures of their own organization. This intersection contains its own organizational dynamics.

When EMS responders determine that advanced life support (ALS) is required, they provide support while transporting the patient to a third organization, the community medical institution. At this facility the patient is delivered into the hands of medical and allied medical personnel with their own structures, governance, history, culture, policies and procedures. At this intersection there may be dynamics informed by all three organizations plus the social forces from the community support system (e.g., relatives and friends) of which the patient's family is a part.

Therefore, from an organizational perspective, while SCA may occur at a single organization, its treatment and management involves forces from multiple organizations, each of which is likely to have its own structures, governance, history, culture, policies and procedures.

Mechanical Metaphor

It is common to use metaphors to think about complex structures such as organizations. From the time of the Industrial Revolution until World War II, for example, the prevailing metaphor for organizations was a *machine* with an internal structure that performed with regularity and with actions that followed causal laws of physical order. Just as one could assemble parts to build a locomotive engine, so could an organization be created. Just as each engine part performed a simple and specific function, so could the organization effectively operate if each person performed a simple task. This generalization from the construction and operation of a mechanical device to the coordination and behavior of people transformed much of society from agricultural to industrial.

At the core of the mechanistic organizational metaphor is simple premise: the parts (people) are "mindless," i.e., they have no purposes of their own. Once selected (hired and trained if necessary) it is assumed that each employee will function as designed by the user which was generally to achieve (for owners or leaders) either wealth or a comparable index of power. The important attributes of this "person-as-tool" approach are reliability, efficiency, controllability and predictability. As long as the environment remains stable (or did not interfere), the parts (all mindless) have no choice other than to work as assigned. Indeed, it would be inconceivable to assume a tractor's ignition would "decide" not to transmit power when activated. The mindset of the mechanistic organizational metaphor is that an employee would never question whether or not to do the assigned job.

Biological Metaphor

Following the end of World War II, in Europe and in the United States a second organization model emerged that used a *biological* metaphor. The assumptions of this mode of thinking are that organizations are similar to human beings with organic parts (people) that are more difficult to replace than those in a tractor engine but are yet "unminded." The purpose of the organization, like all living organisms, is to survive often by growing, adapting, developing, and exploiting the environment. In contrast to a mechanistic model in which profit is the end state or goal, the biological model suggests that profit is the means to its survival thus allowing corporate wealth to be appreciated as a social good and an acceptable argument supporting the American Way of Life. Indeed, most agreed with the chairman of General Motors Corporation when he proclaimed, in the 1960's, that "what's good for GM is good for America."

While a higher biological entity has choices about its means and ends, the parts do not. They react to stimuli from the outside and from other internal parts similar to a thermostat. For example, the heart cannot decide on its own not to pump blood, and the stomach cannot decide not to hold or digest food. There is no independent consciousness, conflict, or choice among any organ or body part. An important difference with a machine, however, is the presence of the single brain, operating with executive function (through a communication network) that can autonomously issue directives to activate the parts.

Since the existence of a brain makes it plausible for some parts (people) within a biological organism (organization) to decide to act on their own, an outcome that would be considered disastrous for the executives of an organization, many biological organizations tend to operate with a paternalistic, top-down, "command-and-control" structural framework. This supports the one-brain-in-charge metaphor in which a corporation ("corpus") is directed by the chief executive who is the "head" of the company. Indeed, this model rarely considers or uses psychological characteristics of the people who work in organizations as relevant to operational or management activities.

Socio-Cultural Metaphor

Within the past 30 years, a third framework has been conceptualized, the *socio-cultural* metaphor. A socio-cultural view considers the organization to be a voluntary association of multi-minded purposeful members each of whom has a choice of individual means and ends (goals). When the parts of a system display choice, neither a mechanistic or biological model can effectively explain, predict or effectively control activity except on a temporary basis. As a purposeful entity, an organization has individually purposeful parts (employees at all levels); the organization itself has multiple and sometimes conflicting purposes; and everyone is part of larger purposeful whole, the society in which many organizations and individuals co-exist. This inherent hierarchy – individual, organization, society – is so interconnected that addressing threats and challenges within any one level often may not be accomplished by operating within that same level. Only by aligning the interests of the purposeful parts between each other, each level, and that of the whole can the system function optimally. Also essential to this modern socio-cultural metaphor is that attention must be given to personality differences, personal, political and social needs, the meaning of organization change to participants, and other components of human nature, growth, or change.

II. Nature of Thinking about Information

For approximately 400 years, classical science including medical science has been preoccupied with independent variables. This type of thinking is rooted in analytic geometry where one basic axiom is that the whole is equal to the sum of its parts. To understand the behavior of a mathematical whole, ***analysis*** addresses through reduction and summation how each individual part (independent variable) affects the whole. ***Analytic thinking*** is the method of inquiry used in most science – physical, biological and social - and promotes rigorous, controlled experimentation and evaluation. Indeed to deviate from analytic methods often suggests weakness, lack of statistical power, and absence of scientific "evidence-based" validity.

The steps of analytic thinking are these: (1) Take apart that which one seeks to understand; (2) Try to explain the behavior of the parts taken separately; (3) Reassemble the parts to provide an understanding of the whole.

Analytic thinking has been commonly used to understand organizational activities. For example, it is assumed that analysis can be used to improve an organization's efficiency or productivity. The approach is to divide/reduce the components (structures, procedures, products, services, etc.) into small parts and to optimize each. It is similarly assumed that organizational distress or failure can be sought by searching for a failure within individual components, and that overall enhancement will follow when the performance of one or more causal parts are improved independently until the slack between them is used up. Analytic thinking results in the belief that one person can be the primary cause of overall organizational success. Analytic thinking also can result in the attribution that the cause for organizational inefficiency or poor productivity lies with a specific department such as safety, sales, marketing, and/or finance, or, unfortunately, to a specific person. The preferred method of solving an analytic problem is to "restructure," i.e., to eliminate, outsource, replace or combine the (independent) functions or parts.

Analytic thinking is ***linear*** in that it assumes that the parts will add up to the whole. For example, this premise makes it reasonable to assume that if company sales are inadequate, one could intervene by addressing one or more of the components that cause sales, as is presented in the following relationship and diagrammed in Figure 1.

Sales = Economy + Performance and Quality + Competition + Price + Interest Rates

Figure 1. Linear Contributors of Organizational Sales

Chain of Survival Metaphor

The Chain of Survival is described as an ideal system of emergency cardiac care. Using a metaphoric chain of response links (i.e., early access, early CPR, early defibrillation and early advanced life support), it proposes that if each element is appropriate addressed, i.e., optimized, the likelihood that a victim will survive cardiac arrest increases. The Chain of Survival presented below and diagrammed in Figure 2 is another example assumed to be an analytic linear sequence.

Survival Rate = Early Access + Early CPR + Early AED + Early ALS

Figure 2. Linear Contributors to SCA Survival

In line with this analytic approach and based on data collected between 1976 and 1991 in Seattle, a predictive model of survival[4] calculated the relative contribution of each independent link. This was written as a linear regression equation,

[4] Larsen, MP, Eisenberg MS, Cummins RO, Hallstrom AP. Predicting survival from out-of-hospital cardiac arrest: A graphic model. *Annals of Emergency Medicine.* 1993;22(11):1652-1658.

Survival Rate	=	67% at collapse – 2.3% per minute to CPR – 1.1% per minute to defibrillation – 2.1% per minute to ACLS

As noted by the authors (p. 1656),

> The regression constant, 67%, represents the probability of survival in the hypothetical situation in which all treatments are delivered immediately on collapse to patients with prehospital cardiac arrest … With delays in CPR, defibrillatory shock, and definitive care, the magnitude of the decline in survival rate per minute is the sum of the three coefficients (-2.2%, -1.1%, -2.1%), or –5.5%.

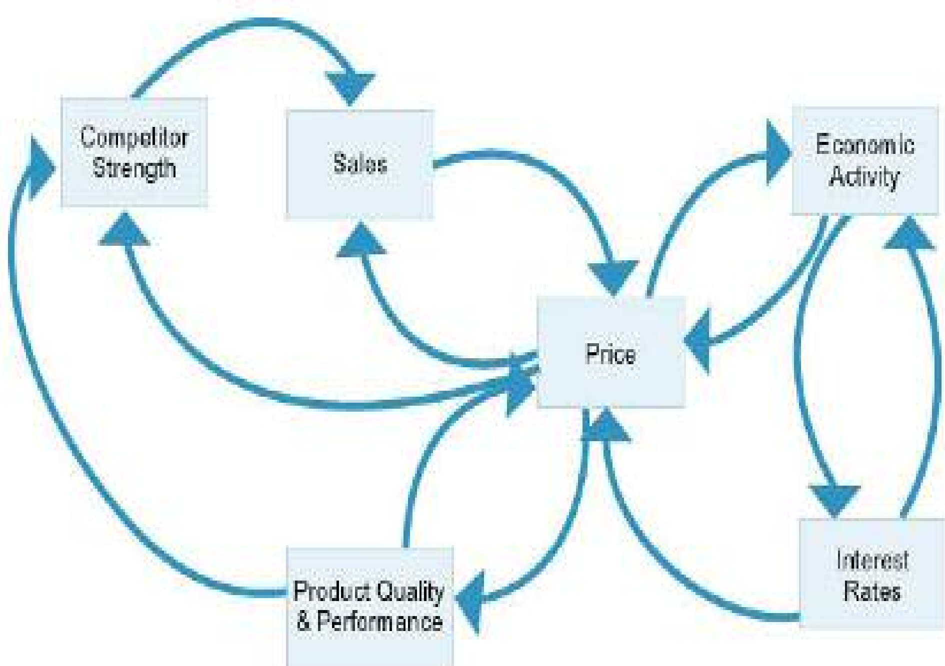
While analytic thinking can help one understand the nature of inanimate objects, it often fails to capture the complete nature of dynamic, homeostatic, cybernetic[5] or organizational systems where human beings have roles. This is because the underlying assumption that all the parts (i.e., people, teams, departments) are independent of one another does not apply to organizations particularly when the activity is ***socio-cultural***. Thus, the linear regression equation offered by Larsen, Eisenberg, et al is of little prescriptive help because it only considers characteristics of independent components rather than the interaction between the parts. To address the complexity of managing SCA which is often characterized by multi-minded purposeful members from multiple organizations requires a paradigm shift from analytic to systemic thinking.

When one makes inquiries systemically, a different process is used. A ***systems thinking*** approach considers each sub-system in the context of the larger whole of which it is a component and studies the roles played by all. Rather than examining or treating

[5] Athey, TH. *The systematic systems approach*. New Jersey: Prentice-Hall, 1982.

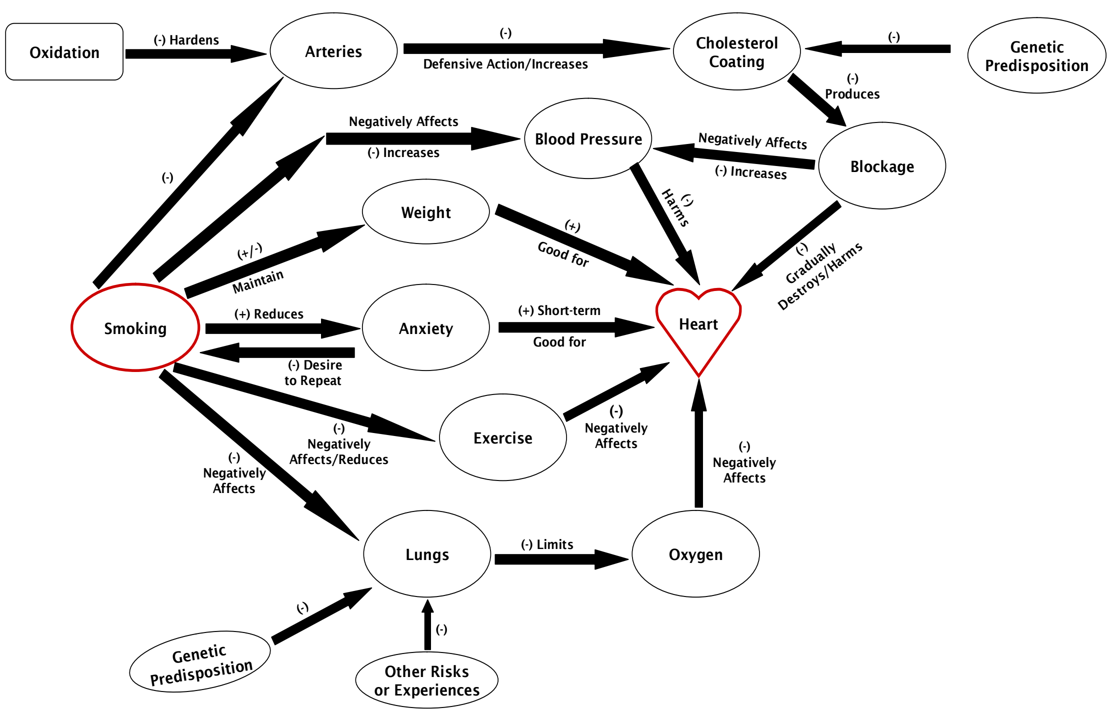
each independent part, a systems thinking approach examines the interdependencies between parts and considers ways to ***synthesize*** or combine parts to enhance the whole. For example, from a systems perspective, the relationship among sales and other organizational forces could be portrayed as in Figure 3. As shown, the interrelationships are non-linear and complex; it is not clear where to make intervention(s) in order to optimize sales. Organizational sales improvement is complex because sales are assumed to be both a cause and effect of other activities, many of which interact with other forces. The challenge in an organizational systems approach is to determine the best combination of forces necessary to ensure a desired level of sales.

Figure 3. Systemic Contributions of Organizational Sales



Also complex and non-linear are the risk factors associated with heart diseases in general and SCA in particular. While many understand that smoking is not the direct cause of a heart attack, from a systems framework, the relationship between smoking and the heart is complex (see Figure 4 based on Gharajedaghi, 1999[6]).

Figure 4. Systemic Relationship Between Smoking and the Heart



Complex organizational interactions are often difficult to understand and manage particularly if one is using an inappropriate thinking strategy. Flood and Jackson (1991)[7] suggest that a systems approach is essential when the conditions noted in Table 1 exist.

[6] Gharajedaghi, J. *Systems thinking: Managing chaos and complexity*. Boston, MA: Butterworth Heinemann, 1999.
[7] Flood, RL and Jackson, MC. *Creative problem solving: Total systems intervention*. Chichester, UK: John Wiley & Sons, 1991

Table 1. When Systems Thinking is Appropriate (Flood and Jackson, 1991)

1. There are a large number of elements (e.g., subsystems, departments, people)
2. There are many interactions among the elements
3. Attributes of the elements are not predetermined (e.g., the characteristics of people and what they do during an interaction are not completely known in advance)
4. Interaction among the elements is loosely organized (e.g., specific lines of authority, roles and responsibilities are not fixed)
5. The parts are probabilistic in their behavior (e.g., actions are based on probabilities rather than fixed physical laws)
6. The system evolves over time
7. "Sub-systems" are purposeful and generate their own goals (e.g., a person or group can change their mind or become distracted rather than adhere to set goals)
8. The system is subject to behavioral influences from within or outside (e.g., powerful others can alter the nature of what is done or how events unfold)
9. The system is largely open to environment

From a systems perspective, the problem of survival following SCA is influenced by the complex forces summarized in Figure 5 and presented in detail in Figures 5a, 5b, 5c and 5d. The four links of the Chain of Survival are highlighted in Figure 5 and can be seen as parts that rather than acting as independent predictors interact with many others in the overall system. To ensure an effective outcome (i.e., to increase the probability of survival from SCA) the whole system should be addressed rather than any of the parts.

Figure 5 presents the complete SCA system with four continuous cycles framed in terms of their ***function*** (what must be done), ***structure*** (the parts involved), ***process*** (how the functions are carried out) and ***purpose*** (why the functions are carried out by the parts). This allows one to understand how the intentions, plans, behaviors and outcomes of all components are interrelated within each subsystem and within the entire system of which each is a component.

Figure 5. System of Survival From SCA

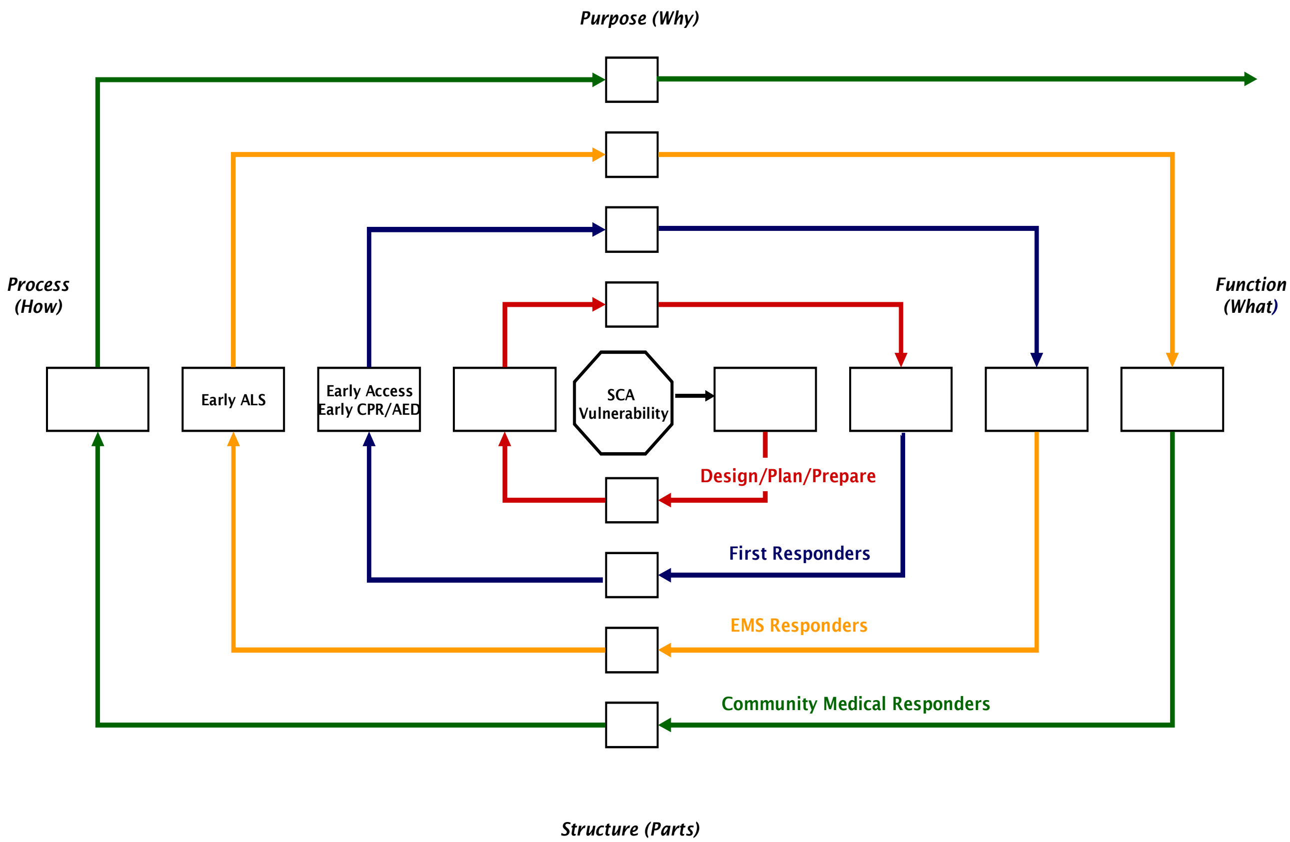


Figure 5a. Design/Plan/Prepare

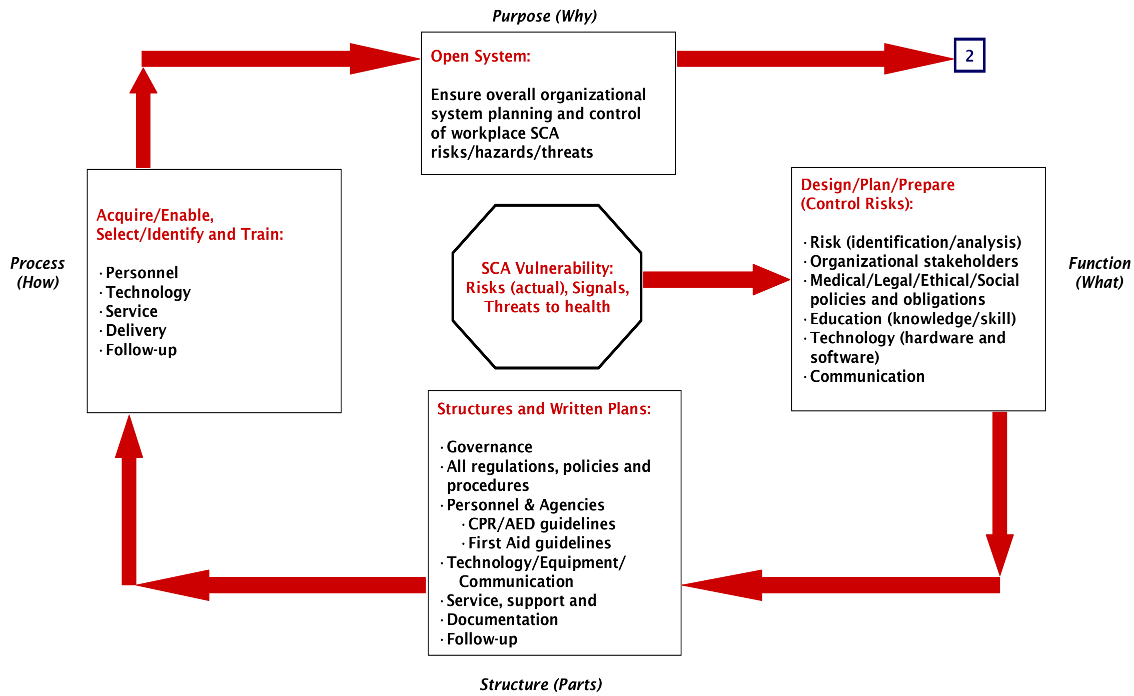


Figure 5b. Workplace First Responders

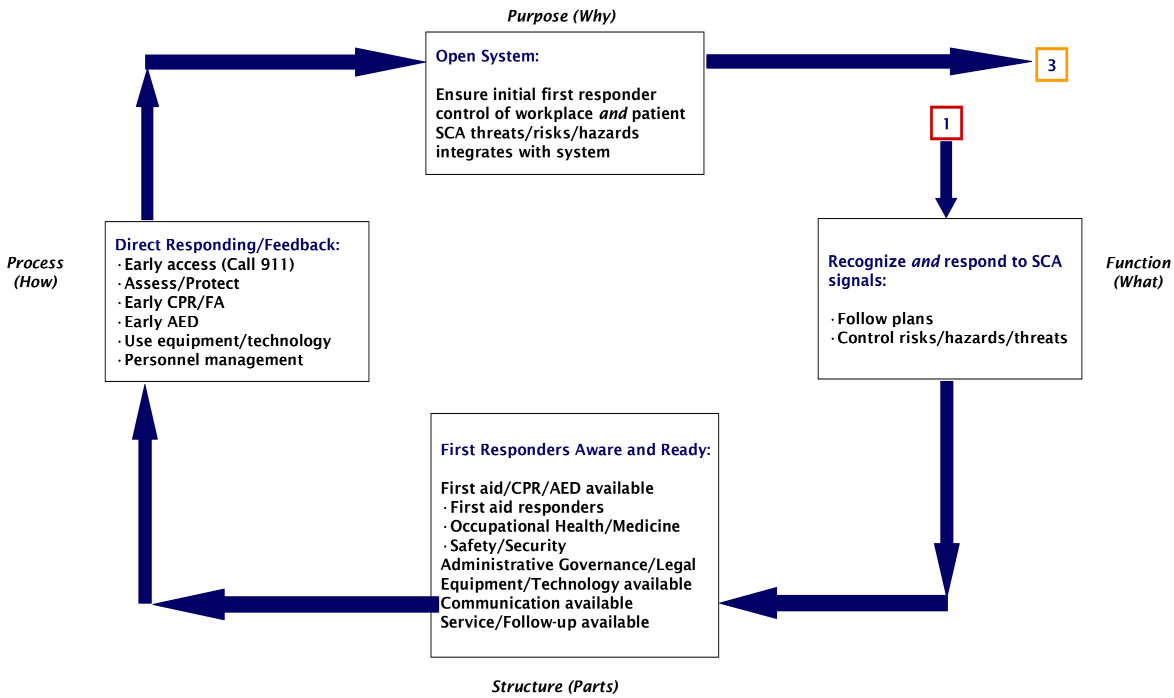


Figure 5c. EMS

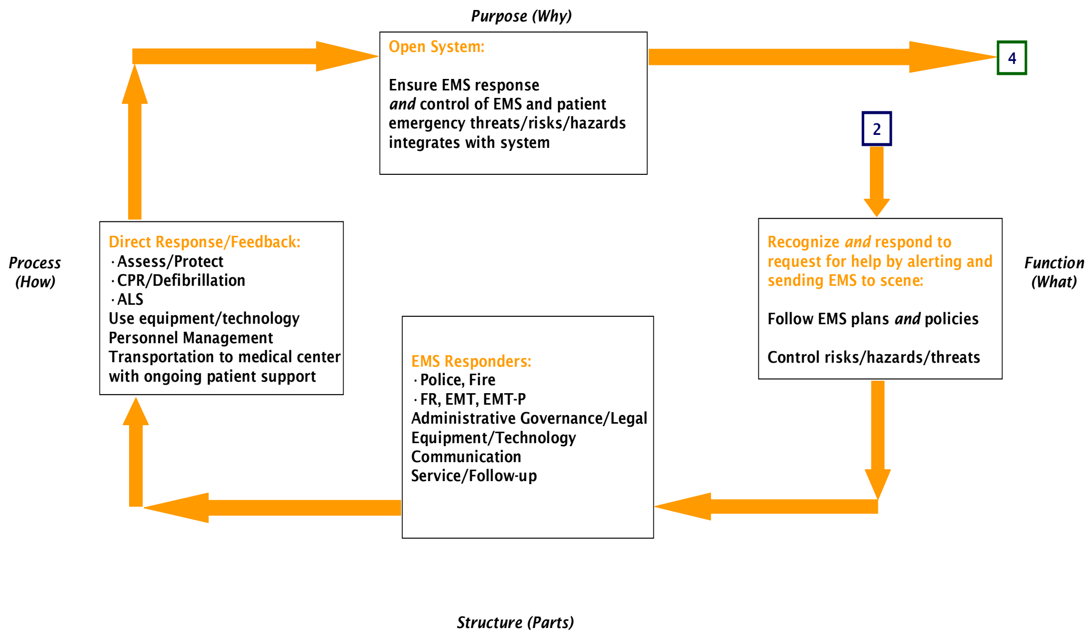
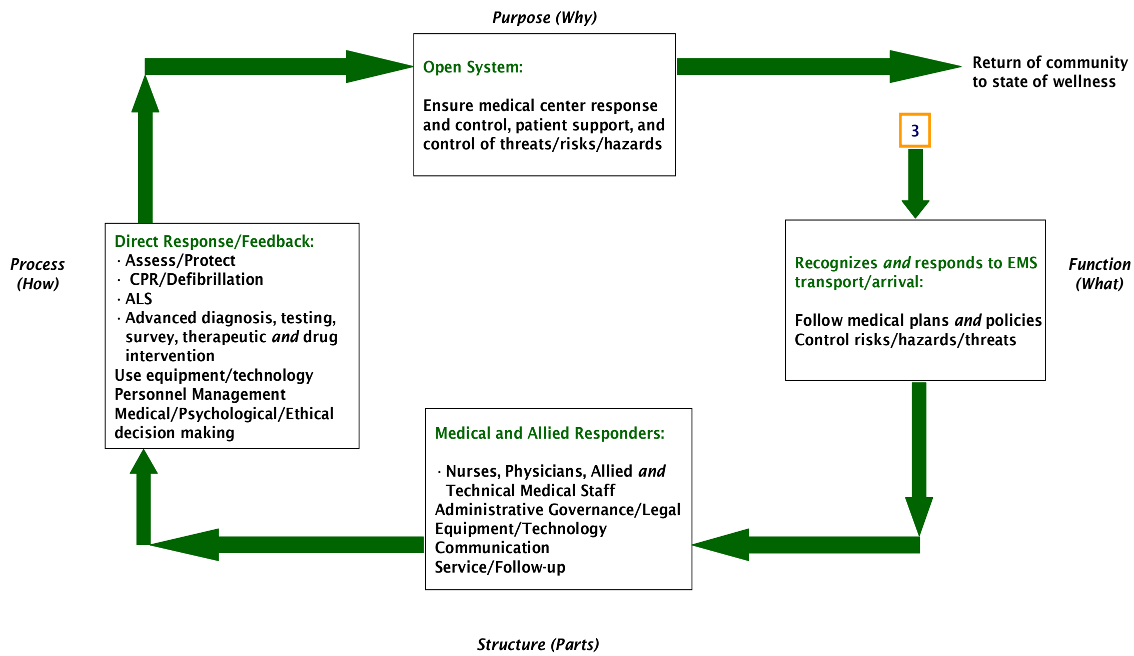


Figure 5d. Definitive Care in Medical Center



III. Reframing Survival and SCA

Thinking about SCA survival in a systemic framework offers a number of important recommendations. The following are some of the many examples that rather than optimizing any one part considers how to enhance the relationship between parts in order to ensure the integrity of the entire system.

<u>Functional Considerations</u>

When considering the overall ***function*** of the system, the ***design of plans to manage SCA*** should integrate the interests, obligations and needs of the entire system. Therefore, plans should have attributes and values agreed upon and understood by all and rather than three plans, each designed for others to understand and follow, there should be ***one plan that integrates everyone*** but with sections that apply to each subsystem. The plan should identify appropriate categories such as risks and hazards; stakeholders with relevant interests and competencies; required medical, legal, ethical and social policies and expectations; educational and technological resources; and the nature of how to ensure effective communication among all involved.

Since a single plan must account for all ***stakeholders***, the following groups should be included ***in its design***: management from the organization preparing for SCA, and representatives or designated responders from that organization; EMS administration that controls who will be sent to local organizations and all EMS responders who may be on duty when "911" requires a response; and management and responders in the medical center who are likely to interact with the patient and/or representatives from the patient's workplace, EMS responders and administration. If local organizations do not integrate with EMS the planning of how SCA will be managed when EMS arrive at their facility, or if they do not determine the nature of how the local emergency department integrates with EMS and their own workplace, the likelihood of smooth interface and communication are reduced. These and other aspects of coordinated planning are essential when SCA occurs.

Structural Considerations

The ***structural*** aspects of managing SCA concern ***integrating the parts identified in the written plan***. Structural parts include people (and groups), information (including policies, regulations and documentation), products (including technology) and services (including follow-up replacement). To ensure structural integration involves determining what the parts share, as well as what conflicts and absences exist among the subsystems. Since the written plan should address organizational stakeholders, policies, and procedures, one important structural part is the nature of the ***governance structure***, i.e., specifying who is in charge when subsystems come together. Integrating the structure of governance across the groups may be important if a workplace has personnel who are as qualified or more qualified than those from EMS, or if treatment is being directed by a qualified health care practitioner when EMS expects to "take charge." Governance should not be decided on the scene; it should be thought about carefully in advance, included in the system planning, and carried out as agreed by all involved.

Clearly specifying the ***technology*** or ***equipment*** that will be available for use during SCA is also a topic that should be integrated. If a workplace has lifesaving equipment that is likely to be used with a patient until EMS arrives or there are communication devices that could be helpful, this information should be known by EMS to ensure that they understand what resources are likely and so equipment can be matched or integrated, if needed. If there are special patient needs (patient history) or unique workplace threats/hazards (construction or other access barriers) these should be understood by EMS and the medical center which will receive the patient. Because ***communication*** among the subsystems should be integrated, technology should be available to ensure all participants have equal access and effectiveness.

Process Considerations

Process concerns ***how the plans will be carried out using the designated structural parts***. If the overall plan identified the need to provide resuscitation when SCA is recognized, one important item of equipment would be an automated external defibrillator (AED). A related structural part would be the resources to ensure that personnel were educated (and up-to-date) in how to perform CPR and use an AED. The process would concern – as an example – how to communicate that a person had collapsed and that EMS was needed; how to get the AED to the site of the emergency so trained people could use it; how other equipment (also brought to the scene) would be integrated with it; how information about its use would be communicated to others, if needed; how personnel would work cooperatively during resuscitation; and how the AED would be serviced after its use. Process requirements similar to these should be understood by all before EMS arrives, while EMS transitions then takes responsibility for the patient, and when EMS transitions with the medical center.

Since process among the subsystems should be integrated, it suggests that common rather than unique ***equipment and technology*** would be preferred. It may be possible, for example, to redesign the communication process so that a telephone call made to "911" would not only provide a request to send EMS responders, but would also ***open a communication channel*** with EMS and the hospital emergency department. This would make it possible for all subsystems to engage in information exchange while the first responders attended to the SCA victim (and thereby received support or advice) while waiting for the arrival of EMS. When EMS was in route to the patient, while at the scene then during their transport to the medical center, all groups would have continuous information access and update. A telephone line that made the connection as soon as the AED turned on would enable this.

Purpose Considerations

The ***purpose*** of the system addresses ***why the functions, structures, and processes are needed***. Within each subsystem the answer is similar: to increase the probability of survival following SCA and to protect the health and safety of the people engaged in response efforts, and the organizational structures of which all are a part. As survival from SCA is influenced by the integration of all subsystems, not the activities of one part, the value of working together should be understood and agreed upon.

When a person collapses due to SCA, I argue that "who will live and who will die" - is not determined by merely engaging in early access, early CPR, early AED and early ALS. Many more interrelated forces influence survival. Broadly, these involve the nature and expectations about people and their work within organizations, and how those involved in planning and responding think about reality and information. More specifically, survival involves the details of how preparation and response plans are designed, what components are specified, how the activities are carried out, and why those involved agree to participate. These translate into the degree of perceived threat, quality of planning, governance, structure, culture, education and resources allocated.

I argue that the Chain of Survival metaphor, in terms of organizational components and in its conception, is not a "system" because it does not address the degree to which organizations, EMS and community medical personnel are integrated. This is not a Workplace or EMS or Medical Center problem. Rather, it is the responsibility of every organization in the community system of which all are parts to accomplish this integration. Less important and of less value for patient survival are efforts that focus on any one part, as if the solution to the patient survival problem could be found by optimizing any one level. More important for patient survival is to understand and bring together the organizational system parts, all of which have purposes and interests, then align and interrelate the parts within the whole.

Appreciation is extended to Joyce Bryant who was able to convert my barely legible hand-written systems drawings into clear and complete graphics.

Larry M. Starr is the author of the American College of Occupational and Environmental Medicine Evidence-Based Policy and Position Statement on Use of AEDs in the Occupational Setting:

Starr, L.M. Automated External Defibrillation in the Occupational Setting. *Journal of Occupational and Environmental Medicine*. 44(1):2-7; http://www.acoem.org/guidelines/article.asp?ID=41