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Using systems evaluation theory to improve points of dispensing planning, training, and evaluation

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ABSTRACT

Recurring throughput problems served as a catalyst to search for a better approach to planning, training, and evaluating points of dispensing (POD) exercises. The paper begins with a discussion of the potential of systems thinking and systems theory to improve exercise planning, training, and evaluation. The paper then illustrates how systems concepts guided a POD design team in improving their planning, training, and evaluation strategy. The paper concludes by suggesting the application of systems thinking and systems theory to other emergency response strategies (eg, incident command, emergency operating centers) shows great promise, warranting further investment in testing its efficacy.

Key words: evaluation, points of dispensing, systems

INTRODUCTION

The national preparedness goal (NPG) identifies the core capabilities, critical elements, and targets needed to effectively protect against, respond to, mitigate, and recover from all hazard events posing the greatest threat to our nation.[1] To help emergency personnel address the NPG priorities, the Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA) developed the Homeland Security Exercise and Evaluation Program (HSEEP). HSEEP uses a progressive objective-driven approach, where individual exercises build toward an increasing level of complexity over time. Agency policies, plans, and procedures are tested using discussion-based and operations-based exercises.[2]

When introduced nationally, the capability approach to planning, conducting, and evaluating exercises represented a significant step forward in improving the DHS program management exercise cycle.[2] Recent public health threats like SARS, H1N1, and EBOLA highlighted the need to tailor the capability approach for public health incidents. In response, the Centers for Disease Control (CDC) developed a new set of public health emergency preparedness capabilities (PHEP) to assist state, tribal, and local health departments with their strategic planning efforts.[3]

However, our findings from a series of point of dispensing (POD)* exercises suggested even the revised capability approach was limiting in detecting problems, their root causes, and providing meaningful corrective actions. For example, surge problems at some POD stations were not the result of capability inefficiencies at the station per se (eg, staff not understanding their tasks), rather resulted because of failures at preceding POD stations being passed down the line thereby significantly reducing overall throughput. During the exercise, the incident command (IC) focused on the station experiencing the surge, attempting to resolve the issue at the site where the symptoms of the problem manifested themselves. Not until the hotwash was it understood the root cause of the surge problem resided at a preceding, or upstream, station.

The POD exercise, after action report (AAR), made it clear the capability approach was leading to myopic problem solving: the focus of IC during the exercise was on resolving capability deficiencies at

*The purpose of a POD is to meet the public need for mass prophylaxis and/or immunization. A POD is usually set up with a series of stations depending on the context. Stations may include patient registration, forms distribution, briefing, triage, drug dispensing, and forms collection.

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the station being backed up; rather than recognizing the focus needed to be at earlier stations responsible for creating the surge. To be fair to the IC, observed surge problems at a POD station *could* have been capability related; however, another reasonable explanation is problems from earlier stations were the root cause. The challenge was how to shift IC and POD staff thinking so surge-type problems could be prevented or more quickly identified and mitigated.

These realties forced a deeper level of thinking about the best approach to conceptualize PODs so as to improve planning, training, and evaluation. We began by reviewing the National Incident Management System (NIMS) and the Incident Command System (ICS).[4-7] From this review, we deduced it was reasonable to posit FEMA operates from a system perspective, as both NIMS and ICS operate from the premise emergency response requires many parts (eg, agencies, equipment, people, policies) working together toward a common goal, which by definition is a system.[8,9] We also reasoned the POD structure is by definition a system, consisting of numerous interconnected subsystems (stations) working toward a common goal of maximizing throughput, safely.[10-15] Thus, an approach grounded in systems thinking and systems theory was sought to better structure POD planning, training, and evaluation.

The research literature is replete with articles devoted to systems thinking, theories, and methods.[8,10-19] We opted to examine the utility of system evaluation theory (SET) theory for several reasons.[20]

First, SET is grounded in systems thinking and system theory,[20] which is consistent with NIMS and the ICS frameworks upon which PODS are based (and for that matter any emergency response using an emergency operating center [EOC] and/or ICS). Further, SET specifically recognizes the importance of system actor capabilities as a key system principle in impacting all levels of a system's efficiency. That is, SET notes optimal system efficiency can only be achieved when all actors understand exactly how to execute the capabilities for which they are responsible. Therefore, the advantage of SET is its ability to integrate the NPG and PHEP core-capability approaches within a more robust system framework (ie, one that integrates additional, important system principles) to improve exercise planning, training, and evaluation.

Second, SET was developed in a multiagency multijurisdictional emergency response setting.[20-24] Thus, SET is likely applicable to other emergency functions requiring inter- and intra-agency coordination to meet a common goal.

Third, SET focuses on improving system efficiency and effectiveness. It also recognizes system effectiveness depends on system efficiency. These principles are consistent with the HSEEP focus on the improvement cycle and the NIMS to save lives and property, respectively, while being fiscally responsible (*https://www.fema.gov/national-incident-management-system*).

We begin by first providing a general overview of SET. We then present how SET and systems theory shaped design team thinking in improving POD planning, training, and evaluation.

SYSTEM EVALUATION THEORY

SET consists of three steps: (1) defining the system, (2) evaluating system efficiency, and (3) evaluating system effectiveness. Each step is purposively sequenced and interconnected; the success of subsequent steps depends on the implementation fidelity of previous steps.[20,24] Further, completing each step requires applying systems thinking and systems theory principles.

There are also three steps in defining a system. First, the common efficiency and effectiveness responses goal(s) must be defined. Optimal response efficiency and effectiveness occur when all system elements (command staff, responders, agencies, etc) share an understanding, and work toward, a common goal.[25] In short, if emergency personnel are on a different page, then the likelihood of working together seamlessly and being effective is reduced. Once the common response goals are made explicit, then the next step is to identify the subsystems working together toward meeting them. In the emergency response context, subsystems are often other agencies. The last step in defining the system is making the standard operating procedures (SOPs) of each subsystem explicit. The SOPs detail exactly how each subsystem is supposed to function, both within and between other subsystems. One method for detailing the SOPS is process flow mapping (PFM).[21] SOPs developed using PFM are preferred to job action sheets (JASs) because they detail what needs to be done, in what order, and various decision points. SOPs provide the detail needed to plan trainings and form the evaluation standard of acceptability.[26]

After defining the response system attention turns to completing step 2 of SET: understanding factors impacting its efficiency. SET identifies four general influences impacting system efficiency: system actor competence and capability, information technology (IT), leadership, and culture. How each of these factors influences system efficiency is now discussed.

System efficiency depends on actors having a clear understanding and being able to execute what, how, and when they are supposed to do. Indeed, this is the fundamental tenet underlying the NPG and PHEP core capability approaches. In the authors' experience, often AAR improvement plans recommend corrective actions relating to deficits caused by a failure of emergency personnel in understanding and/or executing their role.

IT is an important system-wide factor impacting system efficiency. In the authors' more than a decade of exercise experience, a lack of interoperability of communication and software platforms are recurring themes for the failure to provide credible, timely, and accurate information.[27,28]

Leadership is the third overarching factor influencing system efficiency. The recognition of leadership as critical to system functioning dovetails nicely with the ICS and the fact the success of almost every planning, response, mitigation, and recovery initiative is leadership dependent.[29,30]

Finally, SET notes of the importance of culture on system efficiency. When all emergency responders share the same culture, defined here as sharing the same goal(s), and are empowered by leadership, then they are more likely to work cohesively to optimize system efficiency and effectiveness.

SET also describes many system theory principles impacting response system efficiency. The principle of feedback recognizes a system must continually monitor the changing environment and make necessary corrective actions to maintain optimal efficiency. The principle of interconnectedness recognizes problems in one part of the system can be passed along to other parts of the system and lead to cascading failures. The principle of the reflex arc notes systems will strive to develop direct pathways to improve efficiency. These are just a few examples of system theory principles we introduced to a POD design team to make improvements in POD emergency response training, planning, and evaluation. We now present specific examples of how SET was applied and reshaped the planning, training, and evaluation of our POD exercises.

APPLYING SET TO PODS

Defining the POD system

To define the POD system, we first formed an exercise design team consisting of emergency managers, PHEP coordinators, and a small subset of POD subject matter experts (SMEs) from one of our tribal partners. Adding the responsibility of defining the system to the design team seemed prudent as members are often agency/exercise leaders. Leadership understanding and buy-in of the system perspective is key to reshaping POD planning, training, operations, and evaluation.[31] The systems understanding and buy-in is optimized by including design team members in this process.

The design team was responsible for defining the POD efficiency and effectiveness goals. The effectiveness goal was defined as maximizing the number of people safely vaccinated/immunized. The defined effectiveness goal is consistent with POD staffing standard 3.1 of the *Recommended Infrastructure Standards for Mass Antibiotic Dispensing* and was not altered by adopting systems thinking.[32]

On the other hand, systems thinking added significantly to the quality of the efficiency goal. With an understanding of the principles of system surge and connectedness, the design team understood meeting the goal of maximizing throughput depended on each station receiving and sending patients at the same *rate*.[33] Understanding this helped the design team engage in more thoughtful POD planning. The design team then worked backward, understanding it needed to first understand how long it takes each POD station to process a patient. It was further reasoned the rate at which a POD station can processes a patient depends on an understanding of what needed to happen at each POD station. In this regard, the JASs were deemed insufficient. Thus, the design team recognized the need to develop detailed SOPs for each POD station. Using these detailed steps, an accurate processing time could be established. Comparing the relative POD station processing times was then possible. POD stations requiring longer processing times would be staffed more heavily to compensate for the differential upstream processing rates so as to maintain a steady throughput.

Once the POD goals were defined, focus shifted to establishing the system boundaries. To do this, the exercise team began by defining POD patient registration as the initial boundary. Two-end boundaries were defined: one for patients needing emergency medical service (EMS) transport, the other for patients receiving prophylaxis/vaccinations.

With the initial POD system boundaries in place, the design team then defined the subsystems (ie, stations) connecting these boundaries. The validity of each system component was checked by asking design team members to reflect on whether each component contributes to the effectiveness goal. Upon reflection, the exercise design team felt it important to expand the upper boundary (ie, where the system started) to include both law enforcement traffic security control/safety as well as the POD public messaging (ie, Crisis and Emergency Risk Communications, CERC). Both were reasoned to directly impact POD system throughput. Further, the end boundary was expanded to include not simply the EMS patient transport, but the patient treatment at the hospital. Both these boundary expansions could be considered horizontal expansions, that is, adding to the front and back end of the initial system boundaries. However, the system boundary was also expanded vertically by the inclusion of the medical supplies from the Strategic National Stockpile (SNS). The final POD system is shown in Figure 1.

After defining the major subsystems, PFM interviews with POD station SMEs helped detail the SOPs.[21] As a result, each subsystem had SOPs detailing the steps to process patients at their station as well as communicating with upstream and downstream POD stations and the IC. Figure 2 shows the SOP derived from the PFM for the POD registration station.

Planning and evaluating for POD efficiency

The design team then considered how a systems perspective of leadership would impact POD efficiency. In the POD structure, leadership consists of the incident commander and staff, as well as POD station managers. Understanding the importance of having a shared understanding led the design team to understand the need for targeted leadership training. Just-in-time training (JITT) for incident command staff and job action sheets were deemed insufficient at conveying the importance of viewing PODs through a systems lens.[34] Thus, the design team insisted on developing supplemental training materials detailing the POD goals as well as how basic system principles—such as surge, connectedness, and feedback loops—impact overall POD efficiency.

Next, the design team considered the role of IT in impacting POD system efficiency. In so doing, systems thinking significantly altered the approach to two essential POD communication functions. First, a more deliberate approach was taken to understanding where IT could impact communication efficiency. To do this, the design team systematically reviewed each SOP step to determine IT dependencies and preemptively resolve them. For example, the design team was able to immediately pinpoint an interface problem between the county and tribal registration systems which needed to be resolved. Second, the design team recognized some of the target capability tasks, such as a regularly scheduled command briefing, were too vague. That is, when left to flow organically, communication is often crisis focused. To ensure optimal system efficiency, feedback had to be proactive, predictable (ie, timing and subject matter),

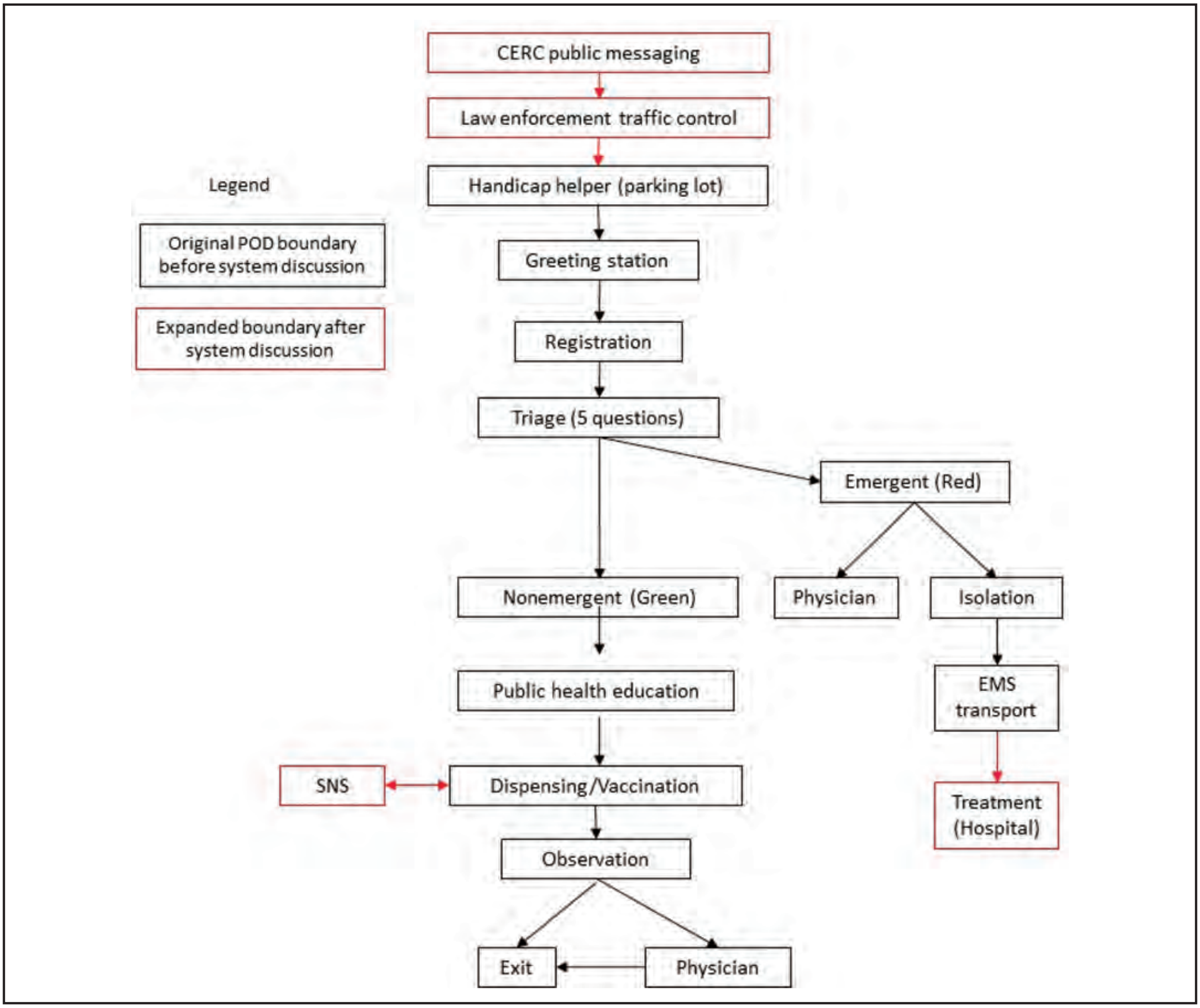

Figure 1. POD flow diagram before and after system discussion.

and continuous. The design team leaned on SET guidelines for establishing communication standards. Specially, five communication criteria were introduced into the POD setting. First, the information had to credible. In the POD environment, this means information about meeting efficiency goals must come from leadership positions. Thus, the importance of maintaining a chain of command to act on information is highlighted. Second, the information must be relevant. The design team defined relevant feedback as information pertaining to meeting the POD efficiency and effectiveness goals. Third, the communication must be timely. Thus, included in the leadership training was a discussion of the consequences of delayed action (eg, surges, cascading failures, and reducing POD efficiency). Finally, the information must be sufficiently frequent. The design team translated this to mean that a strategy was needed to have regularly scheduled information flow to all station leaders on throughput rate, rather than simply communicating when there was a throughput problem. This regular pulse on the goals was reasoned

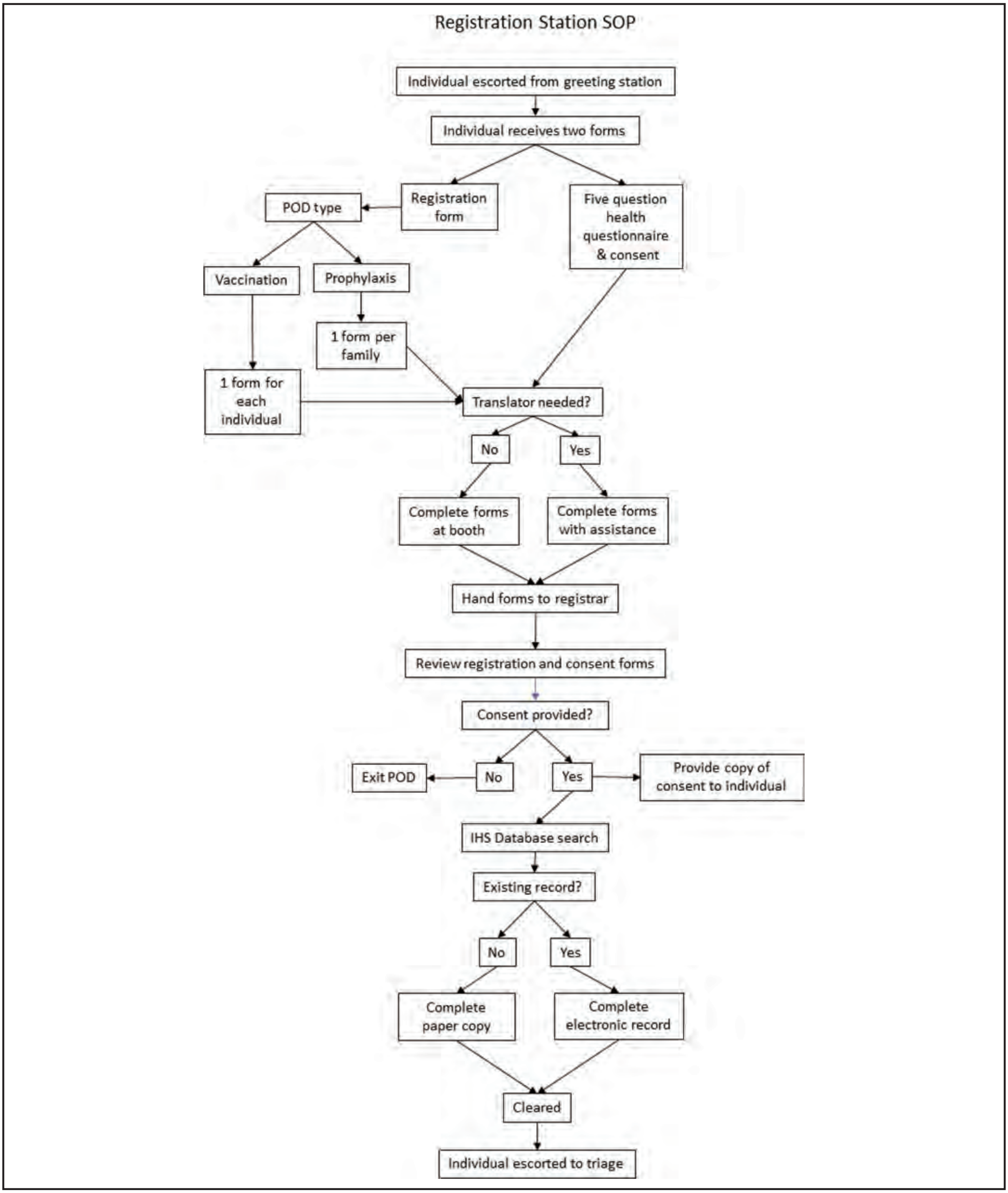

Figure 2. The POD registration station SOP.

to help detect potential problems sooner and mitigate factors impacting negatively on system efficiency. In retrospect these feedback, quality standards closely adhered to the CERC standards,[35] increasing the design team's confidence in the value of SET.

The design team then focused on ensuring all POD staff had the necessary competencies and capabilities. With a better understanding of the relationship between POD staff capabilities and meeting the POD throughput goals, the design team realized the POD training needed to go beyond JASs to include an understanding of the SOP-related capabilities as well as an understanding of systems thinking.[17] For example, the IC needs to be capable at POD clinic operational decisions in consultation with the clinic operations director, overseeing staff, and ensuring the clinic workflow is running efficiently. However, the IC would also need to be trained to understand systems principles. For example, with an understanding of the system concepts of connectedness and cascading failures, the IC would investigate whether the problem resides at the station experiencing the surge or whether the problem is being passed down from an upstream station.

The design team then turned its focus to understanding the impact of the POD culture in maintaining optimal throughput. The design team operationalized a shared culture as a shared understanding of the common POD goals. Thus, POD training needed to be expanded to include helping staff to understand how execution of the SOP at his or her station effects station-specific efficiency and how his or her inefficiencies impact other stations and the overall POD effectiveness. The design team hoped this training-focus would help create a culture of cohesion and empathy for the context and challenges facing all POD members.

Planning and evaluating for POD effectiveness

Systems thinking helped the design team view POD stations holistically, working together to produce something different than what could be accomplished individually. This perspective was especially influential in shaping the evaluation of POD effectiveness. One tenet of exercise evaluation is to operate from a no fault perspective and to focus on system improvement.[36] Therefore, the holistic and interconnectedness systems principles are philosophically consistent with this evaluation principle. To apply this, the design team recommended changing the exercise evaluation guideline (EEG) to focus on system principles. For example, evaluators would focus on identifying where system surges occurred, identifying cascading failures, and monitoring the functionality of feedback loops.

DISCUSSION

The application of the systems perspective led the design team to think more meaningfully about POD planning, training, execution, and evaluation. Systems thinking and theory shifted the focus from individual capability to creating a culture of collective responsibility in meeting POD efficiency and effectiveness goals. Based on this finding, it is recommended that future POD design teams integrate system thinking at all levels. This is not to suggest the capability approach be deemphasized or abandoned, rather that it be expanded to include systems thinking.

System thinking must be incorporated into POD planning and should be consistently part of distribution strategies for medical countermeasures.[37] In addition to the standard capability goals, the POD plan should be bolstered to include system efficiency and effectiveness goals. Setting system efficiency and effectiveness goals forces planners to develop detailed SOPs (not just plan on dispersing JASs) so as to understand the POD staffing needed to maintain an optimal POD flow.

The impact of system thinking on JITT is immediately obvious. The training must go beyond a JAS and emphasize (1) the ability to execute the required station SOP; (2) an understanding of the impact of an individual's station efficiency on the collective whole; and (3) the need to maintain regular information flow among POD leadership. Thus, JITT must build in extra time to review the detailed steps of the SOP and the basic system goals.

System thinking and system theory also dictate a change in the exercise evaluation and training. EEGs must include both an evaluation of individual capabilities as well as an evaluation of system efficiency and effectiveness goals. Additional evaluators trained to evaluate system-specific goals related to efficiency and effectiveness may be required to complete the system evaluation. If evaluators are not system trained, then they may fail in providing key information to assist corrective action and more importantly decision-making. This is a matter of ethical responsibility, because the client trusts the evaluation information they are receiving is the most useful for improving efficiencies and effectiveness.

Although the described application of SET was to PODs per se, it seems reasonable to posit system thinking has value to many, if not all, other strategies employed to prevent, protect, respond, and recover from all hazards. For example, almost all responses require establishing an ICS and/or EOC. These are systems with multiple subsystems (eg, planning, logistics, operations, finance). Applying systems thinking to these structures would help lead to targeted strategies for better closing information loops and providing quality feedback to avoid the inevitable and vague AARs corrective action to "improve ICS/EOC communication."

In conclusion, the application of SET significantly altered and improved the approach to planning, conducting, and evaluating POD exercises. However, as SET is robust and many other response strategies operate as systems, the application of SET to these other areas shows great promise and investing in testing its efficacy seems warranted.

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