Effective Practices and Recommendations for Drive-Through Clinic Points of Dispensing: A Systematic Review

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ABSTRACT

Objective: Drive-through clinics (DTCs) are a novel type of point of dispensing where participants drive to a designated location and receive prophylaxis while remaining inside their vehicle. The objective of this review was to identify effective practices and recommendations for implementing DTCs for mass prophylaxis dispensing during emergency events.

Methods: A systematic review was conducted for articles covering DTCs published between 1990 and 2019. Inclusion criteria were peer-reviewed, written in English, and addressed DTCs sufficiently. Effective practices and recommendations identified in the literature were presented by theme.

Results: A total of 13 articles met inclusion criteria. The themes identified were (1) optimal DTC design and planning via decision support systems and decision support tools; (2) clinic layouts, locations, and design aspects; (3) staffing, training, and DTC communication; (4) throughput time; (5) community outreach methods; (6) DTC equipment; (7) infection prevention and personal protective equipment; and (8) adverse events prevention and traffic management.

Conclusions: DTCs are an essential component of emergency preparedness and must be optimally designed and implemented to successfully dispense mass prophylaxis to a community within 48 hours. The effective practices and recommendations presented can be used for the development, implementation, and improvement of DTCs for their target populations.

Key Words: capacity building, community health planning, emergency preparedness, public health, public health practice

Emergency events, such as disease outbreaks, natural disasters, and biological terrorist attacks, require public health agencies and community stakeholders to be adequately prepared to conduct rapid mass dispensing operations to decrease large-scale morbidity and mortality.[1-4] In 1999, the Centers for Disease Control and Prevention (CDC) created the Strategic National Stockpile (SNS), a supply of antibiotics, chemical antidotes, and medical supplies to protect against an array of public health threats.[5,6] SNS medical countermeasures are intended to supplement state, local, territorial, and tribal jurisdictions when their emergency-specific medical countermeasures are absent, diminished, or are not locally available in sufficient quantities.[7] In accordance with the Cities Readiness Initiative and the CDC, during these public health emergencies communities must dispense post-exposure prophylaxis to the population in its entirety within 48 hours.[4,8] The potential human cost of these emergency events (ie, mass morbidity and mortality) and high transmissibility of infectious agents involved provide a strong case for communities to be optimally prepared and capable to carry out emergency mass prophylaxis operations.[4,5,9]

The standard method to increase dispensing efficiency during public health emergencies is the utilization of strategically located emergency dispensing clinics. Often termed as *points of dispensing (POD)*, these clinics serve as the foundation to dispense mass prophylaxis to the general population.[1,5,6,10] Drive-through clinics (DTCs) are a novel type of POD in which participants drive to a designated location and receive prophylaxis while remaining inside their vehicle.[11,12] DTCs are particularly well-suited for mass dispensing operations and have demonstrated beneficial aspects superior to traditional walk-in clinics. These benefits include increased access for minority and underserved populations, support for infectious disease outbreak mitigation, the provision of a more streamlined mass dispensing model with decreased patient bottlenecks, and decreased disease propagation within emergency clinics due to participants' vehicles acting as an isolation chamber.[4,6,12,13]

Existing research on DTCs have studied DTC processes (eg, DTC layouts, staffing allocation, throughput rates) either through conducting live DTCs (eg, seasonal influenza vaccination clinics and mock emergency events) or using computer software as a decision support system (DSS) to model, simulate, and optimize DTCs. To date, there is no comprehensive review on practices and recommendations derived from these studies. Thus, there is a need for a formal, evidence-based summary of known effective practices and recommendations for implementing DTCs.

Establishing evidence-based practices and recommendations ascertained from peer-reviewed literature is a critical step for understanding how to best implement DTCs so patient throughput times, adverse events, and disease propagation are minimized. These evidence-based practices and recommendations encourage DTCs to effectively and efficiently dispense prophylaxis to their targeted community within the specified time frame. Doing so has the potential to minimize morbidity and mortality associated with the emergency event, which serves as the primary goal of DTCs. This review aims to identify and present evidence-based practices and recommendations for implementing successful DTCs during public health emergency events.

METHODS

Article Inclusion and Exclusion Criteria

Initial article inclusion criteria were broad. An article included in this review must (1) be written in English, (2) include "drive-thru" or "drive-through" or "mass prophylaxis" or "point-of-dispensing" or "public health infrastructure" in its title, and (3) address DTCs in the body of the article. Articles excluded from this review were (1) articles not published in peer-reviewed journals, (2) letters to the editor, (3) journal news periodicals, (4) articles published before 1990, and (5) articles that did not sufficiently address DTCs in the bodies of the articles.

Search Strategy

To ensure complete article ascertainment, 2 authors (the primary author and a research librarian) conducted multiple search strategies. The first search strategy used 5 databases, including ScienceDirect, Academic Search Complete, MEDLINE with Full Text, CINAHL Complete, and Complementary Index. Key words used to search the databases included "drive-thru AND clinic AND vaccination," "drive-through vaccination clinic," "drive-thru vaccination clinic," "mass prophylaxis drive through," "drive-through AND medicine," "drive-thru influenza," and "drive-through influenza." The search used expanders, in that key words could be in the title of the article, within the full text of the article, or contain related words in the article. The search was limited to academic journal articles published between 1990 and 2019.

The second search strategy used PubMed and CINAHL complete databases. For the PubMed search, MeSH terms "influenza vaccines" and "mass vaccines" were used as major headings and were combined with "drive-through." For the CINAHL complete database, a key word search of "open points of dispensing" was conducted.

Every title from each search strategy was evaluated for relevance. If the article was considered relevant, the abstract was read, and, if available, the full article was electronically searched for mentions of "drive-through" or "drive-thru." If the article covered DTCs, then it was screened to ascertain whether the article covered DTCs sufficiently. Moreover, references from the articles that met initial inclusion criteria were assessed for relevance. A detailed overview of the study screening and selection process is presented in Figure 1.

Data Extraction

Data extraction was completed using a customized data extraction spreadsheet developed for this review. The extracted data were entered into the spreadsheet by study characteristics, including (1) study author names, (2) study title, (3) publication dates, (4) article database, (5) article journal, (6) study type (ie, cross-sectional/descriptive observational studies, feasibility/pilot studies, mathematical modeling/simulation studies, literature reviews), (7) study location, (8) study sample size, (9) sampling methods, (10) research question, (11) potential themes, (12) exposure, (13) outcome, (14) ascertainment of outcome, (15) measure of association and results, (16) main findings, (17) effective practices and recommendations, (18) future directions, (19) study limitations, and (20) whether the article met eligibility requirements. The extracted data were checked by 2 co-authors, and disparities between authors were resolved through consensus.

When all data were extracted, the primary author created a document, using the partial portfolio grounded theory methodology for narrative development[14] that categorized effective practices and recommendations identified in each article by themes. Specifically, final themes were developed by extracting all effective practices and recommendations and grouping them by high-level abstraction concepts.[15] Concepts were then refined and categorized into themes that addressed the study aims.[15] Two co-authors reviewed the document, and it was finalized through consensus. A review outline was developed to guide the synthesis of the manuscript based on the effective practices and recommendations identified. Identified effective practices and recommendations were presented by theme.

RESULTS

Study Selection and Study Characteristics

After screening, 25 articles were assessed for eligibility. During the second stage screening process, 12 articles were excluded

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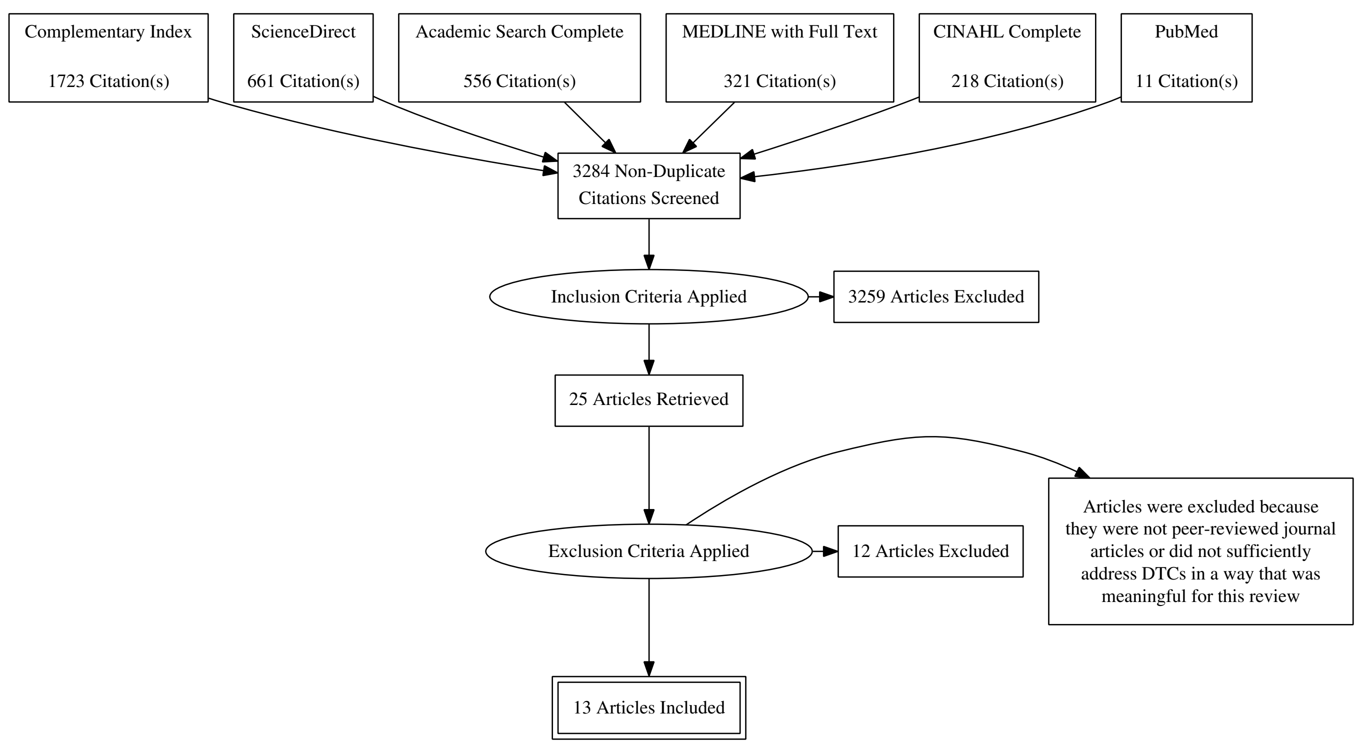
FIGURE 1

Systematic Review Search Strategy.



because they were not peer-reviewed journal articles (ie, news periodicals, letters to the editor, commentary) or did not sufficiently address DTCs. In total, 13 articles satisfied the inclusion and exclusion criteria and were included in this review.[2-6,11-13,16-20]

The majority of the articles were descriptive studies (53.85%, n = 7), followed by modeling and simulation studies (30.77%, n = 4), and summary articles (15.38%, n = 2). Five of the descriptive studies were real-world scenarios – where participants were members of the community being served – and 2 of the descriptive studies were hypothetical exercises, where case scenarios were created to mimic/replicate an outbreak. The main aims of the descriptive studies were to assess participant throughput times,[6,11,16,17] exposure to toxic carbon monoxide (CO) levels,[12] clinic usage questions and demographic characteristics of the DTC participants,[18] and to evaluate the effectiveness of university organized DTCs in the event of an outbreak.[19] The modeling and simulation studies focused on creating DSSs and decision support tools to be used by decision-makers and public health agencies for preparing and responding to future outbreaks and potential biological attacks.[2,3,5,13] The summary articles focused primarily on adverse events associated with DTCs and traditional PODs. Specifically, Carrico et al.[20] estimated the probability of an adverse event (ie, syncopial and vehicle accidents) occurring during a DTC, while Rebmann and Coll[4] outlined infection prevention recommendations for traditional and DTC POD modalities.

Although most articles did not focus primarily on the identification of effective practices and recommendations, each article did address effective practices and recommendations specific to its study. Therefore, extrapolation of effective practices and recommendations was conducted. The effective practices presented in this review refer to practices demonstrated as being effective, but not as a best practice through a formal validation process.[21] The identified themes and associated number of articles were (1) optimal DTC design and planning via DSSs and decision support tools (5 articles [39%]); (2) clinic layouts, locations, and design aspects (5 articles [39%]); (3) staffing, training, and DTC communication (9 articles [69%]); (4) throughput time (7 articles [54%]); (5) community outreach methods (6 articles [46%]); (6) DTC equipment (6 articles [46%]); (7) infection prevention and personal protective equipment (PPE) (5 articles [39%]); and (8) adverse events prevention and traffic management (7 articles [54%]). Table 1 presents the overall results (ie, themes, effective practices, recommendations, and study findings) from each article.

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TABLE 1

Effective Practices, Recommendations, and Study Findings by Article

Author, Year; Study Design	Themes	Effective Practices, Recommendations, and Study Findings
Lee et al., 2009; Modeling and Simulation	Optimal Clinic Design and Planning via DSS Staffing, Training, and DTC Communication Throughput Time Infection Prevention and PPE	**General** *Utilization of RealOpt as a DSS:* RealOpt allows decision makers to (1) investigate optimal locations for dispensing-facility setup, (2) design efficient DTC and POD layout, (3) determine staffing needs and staff allocation at each station, (4) assess disease-propagation within the DTC and ways to mitigate, (5) evaluate resource needs and determine minimum resources to begin treating target population, (6) execute large-scale drills and to analyze performance and alternative strategies, and (7) execute dispensing scenarios to aid in staff training for emergency dispensing situations. **Findings from a Multimodal Mass-Dispensing Network Designed for a Metropolitan Area** The optimal dispensing plan (ie, cost-effective and efficient) consists of a multimodal dispensing network of drive-through, walk-through, and closed PODs that operates at optimum capacity based on their target population, facility layout, and staffing. Effective multimodal mass dispensing requires sharing labor resources across counties and districts within the same jurisdiction. Increasing the number of PODs operating does not necessarily increase the staff needed. Optimal staffing and throughput times are not linear, so cannot use an average estimate. DTCs operate at optimal capacity based on the population intended to treat, and the most effective staffing allocation is different at each DTC. If operating at above capacity, a reduction in capacity (patients per hour) decreases operational issues, law enforcement burdens, and crow controls tasks. The optimal combination of POD modalities is dependent on facility capacity restrictions and public health staff availability. **Validation and Successful Utilization of RealOpt** Eight county anthrax emergency drills conducted in Georgia, where each county was responsible for planning and executing their POD. Only 1 county (DeKalb) used RealOpt to determine staffing needs and to design the POD layout. DeKalb achieved (1) the highest throughput, (2) the most efficient layout, (3) the lowest labor-to-throughput ratio, (4) the shortest average wait time, (5) the shortest average queue length, (6) was the only county that met and exceeded the targeted throughput goal, and (7) processed 50 percent more individuals than the second place county.
Richter et al., 2009; Modeling and Simulation	Optimal Clinic Design and Planning via DSS Staffing, Training, and DTC Communication	**General** *Developing a quantitative value additive model with an objective hierarchy as a DSS:* The model allows decision-makers to address the needs and gaps of specific communities to determine their objectives and quantify the tradeoffs between using different dispensing modalities (ie, traditional walk-ins, DTCs, pharmacies, USPS), which can help determine the best POD modalities for specific populations. Effectiveness of alternative dispensing modalities based on dispensing speed, staff requirements (clinical and nonclinical), and security needs (on-site and medication transportation security). **Finding from an Oral Prophylaxis Dispensing Scenario in a Metropolitan Area** Dispensing modalities such as USPS and pharmacies are more efficient than DTCs for dispensing oral prophylaxis by decreasing personnel and security needs.
Ramirez-Nafarrate et al., 2015; Modeling and Simulation	Optimal Clinic Design and Planning via DSS Staffing, Training, and DTC Communication Throughput Time	**General** *Utilization of the genetic algorithm (GA) developed as a DSS:* The flexible GA model optimizes DTC locations and capacity by (1) providing a DSS designed for assessing and designing POD dispensing plans, (2) simultaneously optimizing the location and capacity of PODs, (3) enabling decision-makers to deal with infeasibility of the POD locations and problems with optimal capacity, (4) analyzing the accuracy of QAs to estimate the average throughput times for different arrival patterns, and (5) suggesting staffing allocation so throughput times are minimized. *Unique Features:* (1) The GA model can relax soft constraints when the dispensing goals cannot be met. (2) The GA model can distribute a fixed number of staff across multiple PODs. (3) The GA model can estimate average waiting times and average travel time adjusting for non-stationary arrival patterns. (4) The GA optimizes location and capacity simultaneously, which allows the model to determine locations based on the knowledge that some PODs will be larger than others. **Findings from Anthrax Emergency Case Study in a Metropolitan Area** GA model found that allocating staff dynamically reduces throughput times compared to sequentially determining location and then capacity. PODs of different sizes can decrease throughput time. Reducing the number of PODs can improve throughput time because resources are used more efficiently.

TABLE 1

Continued

Author, Year; Study Design	Themes	Effective Practices, Recommendations, and Study Findings
Gupta et al., 2013; Modeling and Simulation	Optimal Clinic Design and Planning via DSS Staffing, Training, and DTC Communication Throughput Time	**General** *Utilization of the generalized discrete-event simulation model developed as a DSS:* The discrete-event simulation model allows decision-makers to determine (1) the number and length of vaccination and consent form lanes required, (2) number of staff needed at the consent and vaccination stations, (3) and the average patient throughput times. *Unique Features:* (1) customizable for communities of any size, (2) easy to use for decision-makers that may not be accustomed to simulators, and (3) can be used along with RealOpt to best design DTCs. **Findings from Simulations with Varying Population Sizes** In large communities, the area recommended by the model may have to be split up between multiple locations due to not having enough space in one location. For fixed vaccination and consent lanes, increasing the number of consent form staff per lane reduces patient throughput times much more than increasing the number of medical staff per lane.
Weiss et al., 2010; Descriptive	Clinic Layouts, Locations, and Beneficial Design Aspects Staffing, Training, and DTC Communication Community Outreach Methods DTC Equipment Infection Prevention and PPE Adverse Events Prevention and Traffic Management	**General (For DTC in Open Parking Structure)** *General Clinic Layout:* (1) entrance/flu screening station, (2) registration station, (3) triage station, (4) medical screening station, (5) dispensing/observation station, and (6) discharge/medical records station. *Location*: Used a covered, open-sided parking structure near the hospital, which is beneficial because of its availability in most communities, it is designed to accommodate vehicles, it provides protection from the environment, and it provides electrical outlets. *Beneficial Design Aspects*: (1) Screening station at beginning of DTC staffed by nurses to divert unstable patients to the emergency department (ED) as necessary, stable patients directed to the DTC queue. (2) Provided a bypass lane for premature exit and emergency vehicle access to transport patients to ED. *DTC Communication*: (1) Radios used to notify emergency department of incoming patient. *Recommended Community Outreach Methods:* (1) Use a local radio station for public safety-managed broadcasts so the community can receive live reports, instructions, and projected wait times about the DTC. (2) Provide influenza information sheet. *DTC Equipment:* See Table 3 for a detailed breakdown of equipment used and recommended by each article. *Infection Prevention and PPE:* (1) Staff wore a single fit-tested disposable N95 respirator with eye protection and gown. (2) Disposable nonsterile gloves changed after each patient encounter. (3) See Table 3 for the full list of PPE. *Adverse Events Prevention and Traffic Management*: (1) Drivers were instructed to turn off their vehicles before staff approach. (2) Security personnel staffed both outside and in the structure to direct and manage traffic. (3) No backing up was permitted. (4) Signs used to designate specific lanes and stopping points. (5) Golf cart equipped with stretcher and resuscitation equipment was readily available for patient transport to ED. **Findings from the DTC Exercise to Assess Throughput Times, CO Exposure, and Rapid Evaluation of Patients in a Parking Structure Adjacent to a Hospital to Reduce ED Crowding** DTCs located near hospitals can help decrease ED overcrowding during a pandemic or emergency situation by treating stable patients efficiently (increasing throughput times), effectively, and accurately diagnosing and directing unstable patients to the ED CO levels did not reach toxic levels.
Le et al., 2017; Descriptive	Clinic Layouts, Locations, and Beneficial Design Aspects Throughput Time Community Outreach Methods	**General** *General Clinic Layout*: (1) entrance, (2) registration station, (3) child seat station, (4) flu vaccination station, and (5) exit. *Location and Beneficial Design Aspects:* Used a large open parking lot to allow for safe vehicle flow. *Recommended Clinic Locations and Time:* (1) DTCs should be located near major intersections and streets so they are highly visible and accessible and (2) hold DTCs for a full weekend to increase the amount of the community served. *Throughput Time:* Verbally administered surveys to decrease length-of-stay (LOS). *Community Outreach Methods:* Provided incentives to increase community participation. *Recommended Community Outreach Methods*: Diverse advertising including using the Internet, local newspapers, radio, and primary care clinics. **Findings Specific to the Child Passenger Safety Seat Fitting Combined-Service DTC** Child safety fitting station should come before the vaccination stations. Preliminary findings suggest combining services can be accomplished without sacrificing effectiveness and efficiency of care.

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TABLE 1

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Author, Year; Study Design	Themes	Effective Practices, Recommendations, and Study Findings
Zerwekh et al., 2007; Descriptive	Optimal Clinic Design and Planning via DSS Clinic Layouts, Locations, and Beneficial Design Aspects Staffing, Training, and DTC Communication Throughput Time Community Outreach Methods DTC Equipment Infection Prevention and PPE Adverse Events Prevention and Traffic Management	**General** *Optimal Clinic Design and Planning via DSS:* Used simulation model based on the BERM as a DSS to help plan the DTC by assessing resource requirements and potential bottlenecks. *General Clinic Layout:* Main Stations: (1) entrance, (2) triage station, (3) registration station, (4) evaluation station, (5) dispensing station, (6) exit. *Supporting Stations:* (1) supportive services, (2) first-aid station, (3) food/water station. *Location:* DTC was held at a stadium that was large enough to accommodate the large influx of cars and was well-known and easy to locate. *Beneficial Design Aspects:* (1) Spatial arrangement - large distance between stations (30 feet) allowed cars to stack up. (2) Triage station was located at the beginning of the DTC to screen out potential sick patients and to identify patients with disabilities who need special assistance. (3) Evaluation station located between registration and dispensing stations to identify proper medication for each patient. (4) Tents of different colors were used to identify each station (ie, triage, registration, evaluation, dispensing). (5) Provide emergency bypass lane. *Staffing, Training, and DTC Communication:* (1) Multiple trainings to train staff on SNS preparedness plans, leadership, safety, security, clinic design and function, worker roles, mental health support issues, and communication. (2) RNs appointed to each station that would be familiar with clinical terms. (3) 2-way radios used for communication. (4) Offered pre-registration for the staff, staff's family, and first responders (ie, police, fire department) to help in training and staff recruitment. *Throughout Time:* (1) Registration form single-sided and in large print (increases throughput and accuracy). (2) Staff asked questions and filled in registration forms (increases throughput). (3) Vehicles stacking at each station allowed staff to evaluate bottlenecked vehicles more rapidly. *Recommended to Decrease Throughput Time:* (1) Increase staff when needed. (2) Thoroughly train staff on registration form format. (3) Give explicit instructions on how to deal with inquisitive patients (decrease questions, increase throughput). (4) Specify the number of persons per car that best matches DTC dispensing capacity. (5) Provide multiple DTCs to reach whole community. *Community Outreach Methods:* (1) Advertised using multiple outlets including newspapers, radio stations, and flyers. (2) Provided US $5 incentive to increase participation. (3) Provided brochures at DTC entrance to educate patients about the exercise process and background. *DTC Equipment:* See Table 3. *Infection Prevention and PPE:* See Table 3. *Adverse Events Prevention and Traffic Management:* (1) Police officers directed traffic. (2) Provided designated space for individuals needing special assistance where they would receive the entire medication dispensing procedure. (3) Used medication algorithm at evaluation station to choose safest medication for each patient. (4) Spatial arrangement - large enough space to allow staff to safely move about and ensured adequate ventilation for CO exhaust. (5) Prophylaxis inventories protected and closely safeguarded by security. *Recommended for Adverse Events Prevention:* (1) Anchor down tents. (2) Highway dividers and barricades to help direct traffic. (3) Larger signs to direct patients who need special assistance to the correct stations. **Findings Specific to the DTC Exercise** The community was able to receive prophylaxis efficiently and effectively using the streamlined DTC model, therefore limiting mortality and morbidity from a public health emergency. Medication decision algorithm was 98.9% accurate.
Banks et al., 2013; Descriptive	Clinic Layouts, Locations, and Beneficial Design Aspects Staffing, Training, and DTC Communication Throughput Time Adverse Events Prevention and Traffic Management	**General** *General Clinic Layout:* (1) entrance, (2) vaccination station, (3) special needs station, (3) exit. *Location:* Large open parking lot. *Throughput Time:* (1) Vaccinated multiple people per vehicle by having multiple staff approach the vehicle with small trays to carry supplies. (2) Processed multiple vehicles per lane simultaneously as staff become available. (3) Optimum number of vaccinations per vehicle is 3 to 4. *Recommended to Decrease Throughput Time:* Encourage carpooling (3 to 4 patients per vehicle). *DTC Equipment:* See Table 3. *Traffic Management:* Directed participants who required special assistance or had additional questions out of processing lanes and into a preselected area. **Findings from the DTC for Throughput Times for Adults and Children** Including children at least 10 years old in DTCs does not decrease throughput times significantly.

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TABLE 1

Continued

Author, Year; Study Design	Themes	Effective Practices, Recommendations, and Study Findings
Nicholas et al., 2009; Descriptive	DTC Equipment Infection Prevention and PPE Adverse Events Prevention and Traffic Management	**General (For Indoor DTC)** *Location:* Enclosed school bus garages. *Recommended DTC Equipment:* See Table 3. *PPE:* CO monitors (see Table 3 for a full list). *Recommended for Adverse Events Prevention*: (1) To decrease CO exposure, problematic vehicles should be identified before they enter the building. (2) Identified problematic vehicles should be processed outdoors or indoors in an expedited fashion. (3) Collaborate with local fire departments, health departments, and utility companies to provide CO monitors or purchase CO monitors to be worn by staff to identify vehicles that may raise CO levels. **Findings from the Two Indoor DTC CO Assessments** *DTC A:* CO levels remained below 1 ppm for the majority of the DTC, with 2 spikes in CO which was associated with 2 gasoline powered problematic vehicles per spike. The highest 2 CO levels during this session was 8 ppm and 10 ppm. *DTC B:* CO levels remained below 1 ppm for the majority of the DTC, with 2 spikes in CO which was associated with 2 gasoline-powered problematic vehicles for each spike. The CO levels measured during this session was 73 ppm and 150 ppm for the first and second vehicles, respectively. *Both Clinics*: CO levels fell rapidly when problematic vehicles were turned off. CO monitors can help identify problematic vehicles, and identified vehicles can be processed outside of the DTC to decrease CO exposure.
Banks et al., 2014; Descriptive	Community Outreach Methods DTC Equipment	**General** *Community Outreach Methods:* (1) Advertised DTC through e-mails (students and staff) and standard news releases (newspaper, television, university website, and radio). (2) Provided incentive to increase participation (free vaccination). *Recommended Community Outreach Methods:* (1) Using surveys that obtain demographic characteristics of the individuals who participate in DTCs can help modify outreach methods to target vulnerable communities. (2) Surveys should assess patient insurance coverage, high-risk conditions, and other variables associated with participation. (3) Surveys in different languages are needed to obtain accurate data from patients who do not speak English. *DTC Equipment:* See Table 3. **Findings from the Influenza DTC Characterizing Participants** The age group that participated the most (English and Spanish speaking) was 41-64 years old (53%), with English-speaking participants being significantly older than their Spanish-speaking counterparts. Participants were mostly female (57%). Most participants had previously used a DTC (65.28%). The 2 other vaccination options reported most often was PCP (44.18%) and pharmacy (17.60%). Best outreach modalities were newspaper ads (33.85%) and television ads (33.21%).
Rega et al., 2010; Descriptive	Clinic Layouts, Locations, and Beneficial Design Aspects Staffing, Training, and DTC Communication Throughput Time Community Outreach Methods DTC Equipment Adverse Events Prevention and Traffic Management	**General: Lessons Learned and Positive Aspects from the University Held DTC** *General Clinic Layout:* (1) entrance, (2) dispensing station, (3) EMS/observation station, (4) exit. *Location:* Open parking lot. *Staffing, Training, and DTC Communication:* (1) Use an AM radio transmitter for time, traffic, and vaccination updates for the community and participants waiting in line. (2) Provide staff and volunteers with ample communication and radio etiquette training. (3) Establish a Command Communications Center. (4) Establish a Joint Information Center. (5) Invite HAM radio operators to assist in communications. (6) Provide standardized instructions and training about DTC event, staff and volunteer tasks, staff and volunteer responsibilities, event times, pre-event planning, etc. (7) Collaborate with multiple agencies for support (ie, health department, sheriff's department, EMS, campus police, American Red Cross, varying colleges and universities). *Throughput Time:* Participants completed forms while in queue to increase throughput. *Community Outreach Methods:* Confirmed DTC times posted in media are consistent and accurate. *DTC Equipment:* See Table 3. *Adverse Events Prevention and Traffic Management:* (1) Vaccinate patient outside of the vehicle if accompanied by aggressive pets. (2) Provide portable commodes along processing lanes. (3) Provide mental health resources. (4) Safety monitoring teams should travel around the DTC to monitor vaccinated patients and to provide water when needed. (5) Establish towing availability prior to event. (6) Provide escape lane for vehicles. (7) Campus police directed traffic. (8) Use various colored balloons to identify different stations and locations for participants.

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TABLE 1

Continued

Author, Year; Study Design	Themes	Effective Practices, Recommendations, and Study Findings
Carrico et al., 2003; Review	Adverse Events Prevention and Traffic Management	**General** *Recommended Adverse Events Prevention*: (1) Prospective assessment of outcomes following DTC vaccinations can help monitor adverse event occurrence. (2) DTCs encouraged to provide an observation station where immunized patients can be monitored for 15 minutes for syncopial events following immunization. **Findings from the Estimated Average Rate of Adverse Events per Hour Using 15 Years of DTC Data** The highest probability of an adverse event (syncopial or vehicular accident) occurring during a 2-day DTC event (16 hours) was estimated to be 0.8 percent. Estimated that 1 adverse event will occur for every 2.5 million immunized. Syncopial events are very rare and the risk of such events can be effectively managed, therefore, these events should not deter the utilization of DTCs.
Rebmann et al., 2009; Review	Staffing, Training, and DTC Communication Community Outreach Methods DTC Equipment Infection Prevention and PPE Adverse Events Prevention and Traffic Management	**General: Recommendations for Infection Prevention in DTCs** *Recommended Staffing, Training, and DTC Communication:* (1) Infection prevention strategies should be contained in DTC planning documents and staff should receive training on infection prevention strategies pre-event or during just-in-time training. (2) Train staff on safe handling of sharps to prevent exposure. (3) Train staff on correct cold chain techniques. (4) Train staff on correct hand hygiene protocols. (5) Reporting and communication should be conducted through an ICS. *Recommended Community Outreach Methods:* Provide informative brochures on (1) signs and symptoms of disease, (2) transmission methods, (3) exposure prevention, (4) infection prevention strategies, (5) who is at risk, (6) who should seek prophylaxis, (7) where to seek prophylaxis. *Recommended DTC Equipment:* See Table 3. *Recommended Infection Prevention*: (1) Screen patients for illness (transport severely ill to medical facility) and determining contraindications for vaccination should be completed first. (2) Screen staff for signs of disease and remove staff if infected. (4) Provide correct PPE and DTC equipment. *Recommended PPE:* See Table 3. *Recommended Adverse Events Prevention:* (1) Provide refrigeration for vaccine and medication storage.

CO = carbon monoxide; DSS = decision support system; DTC = drive-through clinic; ED = emergency department; EMS = emergency medical services; GA = genetic algorithm; ICS = incident command system; LOS = length of stay; PCP = primary care physician; POD = point of dispensing; PPE = personal protective equipment; PPM = parts per million; RN = registered nurse; USPS = United States Postal Service.

Optimal DTC Design and Planning via DSSs and Decision Support Tools

Five DSSs identified in the literature focused on the DTC design and planning phases, and 1 decision support tool focused on identifying the safest medication for each patient. The DSSs varied by their intended applications, model type (eg, simulation, optimization, combination of simulation and optimization), features (eg, graphical tools, user interface), model complexity, and ease of use. Patient throughput time/speed of dispensing, performance evaluation through large-scale emergency event simulation, and the number of staff needed were the most popular topics for modeling, with every DSS identified evaluating said variables in a way specific to the models' intended application.[2,3,5,6,13]

Specifically, Lee et al.[2] developed a DSS to design and simulate various DTC layouts to optimally allocate staff and resources based on a specified throughput time. Gupta et al.[13] combined generalized discrete-event simulation and optimization to estimate the average patient throughput time based on the expected number of vehicles, the number and length of consent form and vaccination lanes, and the number of staff per lane. Ramirez-Nafarrate et al.[3] proposed a flexible algorithm to select optimal PODs from a candidate list and allocate the optimal number of staff to each dispensing station so the average travel and waiting times are minimized. Zerwekh et al.[6] used the Bioterrorism and Epidemic Outbreak Response Model (BERM), which predicts the number and type of staff needed while providing feedback on patient throughput and queuing times. Last, Richter and Khan[5] applied a qualitative value additive model with an objective hierarchy to assess the trade-offs between using various dispensing modalities (eg, DTCs, traditional walk-in clinics, pharmacies, and USPS delivery) for a specific population by determining their overall effectiveness based on POD dispensing speed, staff requirements, and security needs. In addition to the applications mentioned previously, unique applications and features that distinguish each DSS and decision support tool can be found in Table 2.

Clinic Layouts, Locations, and Design Aspects

Various clinic layouts and locations were ascertained from the descriptive studies. They varied by the number of stations, types of stations, number of processing lanes, and clinic locations based on specific target populations and goals. The types of stations identified included (1) triage, (2) registration,

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TABLE 2

Decision Support Systems and Decision Support Tools

Decision Support System	Decision Support Tool	Features
RealOpt	RealOpt-Regional	Assists in determining DTC locations, assessing regional population densities and demographics, and identifying well-known regional landmarks that the public can easily identify Provides solutions so that trade-offs between the number of PODs required and the maximum allowed travel distance can be assessed under varying hourly capacity limits Helps determine the optimal number and location of PODs (DTCs and walk-ins), and allows for the analysis of resource sharing between counties
	RealOpt-POD	Assists in designing DTC layouts and allocating resources Contains a Simulation Manager, Optimization Manager, User Interface and Linker Manager, and a graph-drawing tool for designing and simulating various DTC layouts and optimally allocating staff and resources (within and between jurisdictions) for specified throughput times Allows for the estimation of resources needed to protect the general population, assessment of available resources per region, and analysis of labor trade-offs Contains a disease-propagation module that uses the SEIR model and the SEPAIR model Allows public health agencies and decision-makers to assess disease-propagation and mitigation strategies across various clinic designs and dispensing modalities (ie, multimodal vs centralized vs decentralized). Gives them the ability to evaluate the difference between standard incidence versus mass-action incidence events and to model batch processing areas where a large number of patients are in contact with each other
	RealOpt-RSS	Helps in managing the logistics of prophylaxis, including receipt, stage, and storage
	RealOpt-CRC	Specialized version of RealOpt-POD that contains additional components that deal with radiation screening and decontamination
Gupta et al.'s Generalized Discrete-Event Simulation and Optimization Model		Determines the number of vaccination lanes, consent lanes, length of vaccination and consent lanes, number of staff needed at the consent and vaccination stations, and the average throughput time for patients The model is generalized so that it can be applied to communities of any size Requires little to no prior knowledge on running simulations
Ramirez-Nafarrate et al's Flexible Genetic Algorithm (GA) Optimization Model		Contains 4 Modules (1) A GIS that maps the locations of candidate PODs and the restricting areas for PODs (2) An optimization system comprising the optimization model and the GA that selects optimal PODs from a candidate list and allocates the optimal number of staff to each dispensing station so that the average travel and waiting times are minimized (3) Interactive tools for assessing various scenarios (4) A discrete-event simulation model of individual PODs to validate the GA's results Returns results that are comparable to similar systems (ie, RealOpt) but contains the unique advantage of dealing with scenarios that are found to be infeasible – due to scarce resources – by relaxing soft constraints The constraints that can be relaxed (one at a time) when a scenario is determined infeasible are (1) assigning census tracts to nearest POD, (2) capacity constraints, and (3) target dispensing times. Another unique feature that is not considered by RealOpt is the model's ability to estimate average waiting times across all PODs within a specific region.
Richter and Khan's Quantitative Value Additive Model with an Objective Hierarchy		Quantifies the trade-offs between using different dispensing modalities (ie, traditional walk-ins, DTCs, pharmacies, USPS) Helps determine the best POD modalities for specific populations (ie, rural vs urban) Assesses the effectiveness of alternative dispensing modalities based on dispensing speed, staff requirements (clinical and nonclinical), and security needs (on-site and medication transportation security)
Bioterrorism and Epidemic Outbreak Model (BERM)		Predicts the number and type of staff needed for a disease outbreak or biological attack Simulates the exercise (from registration to dispensing) and calculates throughput and waiting times
	Zerwekh et al.'s Medication Algorithm	Assists staff in determining the safest medication (ie, doxycycline or ciprofloxacin) and dose for each patient Based on patients' age, weight, allergies, kidney status, current medications they are taking, and whether the patient is pregnant or breastfeeding

DTC = drive-through clinic; GA = genetic algorithm; GIS = graphical information system; POD = point of dispensing; SEIR = susceptible, exposed, infectious, and recovered; SEPAIR = susceptible, exposed, infectious, asymptomatic, symptomatic, and recovered; USPS = United States Postal Service.

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(3) screening, (4) evaluation/examination, (5) special needs/services, (6) dispensing/vaccination, (7) emergency medical services/post-vaccination observation, (8) discharge, and (9) medical records. Locations included a large covered parking-structure,[16] open parking lots,[11,17,19] a large stadium,[6] and an enclosed school bus garage.[12]

Beneficial clinic design aspects were identified. A large spatial arrangement was found to be beneficial due to the large distance between stations, which allowed vehicles to stack up.[6] The stacking of vehicles allowed the staff to process bottlenecked vehicles more rapidly, therefore, increasing throughput.[6] It was recommended to locate DTCs near major intersections and streets to increase visibility and accessibility.[11] Providing a screening/triage station at the beginning of the DTC was found to be beneficial because it allowed staff to identify patients in need of special assistance or who needed to be diverted and transported to a hospital.[4,6,16] Critically ill patients could be transported quickly to a hospital by exiting the normal processing lanes via an emergency bypass lane.[6,16] An evaluation station located between registration and dispensing stations was found to be beneficial in determining the correct medication for each patient.[6] Using various colors for each tent station helped patients identify specific stations.[6]

Staffing, Training, and DTC Communication

Determination of staff needed for DTCs, proper staff training, and establishment of communication within DTCs were crucial planning and implementation steps identified in the literature. Utilization of the aforementioned DSSs and decision support tools (ie, RealOpt, BERM, Gupta et al.'s DSS, Ramirez-Nafarrate et al.'s DSS, and Richter and Khan's DSS) was found to be an effective practice in determining the optimal number of staff needed for each DTC and station within each DTC.[2,3,5,6,13] Allocating registered nurses to clinical stations where they were more familiar with clinical terms (ie, compared to nonclinical staff) was also found to be effective.[6]

Effective training strategies and recommendations were mentioned in the literature. They included multiple trainings on SNS preparedness plans, leadership, safety, security, clinic design and function, staff roles, staff responsibilities, mental health support issues, event times, DTC communication and radio etiquette, and infection prevention strategies.[4,6,19] Training on implementing infection prevention and occupation health strategies, such as exposure prevention, handling and disposing sharps, using cold-chain techniques (ie, refrigerate vaccines), proper screening, hand hygiene techniques, environmental decontamination, selecting and using the correct PPE, respiratory etiquette, and spatial distancing techniques, were recommended to decrease disease transmission.[4] Preregistration of the staff, staff's families, and first responders was found to be beneficial in training staff on efficiently administering registration forms.[6]

DTC communication practices identified were using 2-way radios,[6,16,19] inviting HAM radio operators to assist in communications,[19] communicating and reporting through an Incident Command Communication Center,[4,19] and establishing a Joint Information Center for communication between multiple stakeholders and PODs.[19]

Throughput Time

Increasing overall participant throughput while decreasing participant length of stay was identified as a critical effective practice. Staffing strategies included optimal allocation of staff via utilization of the aforementioned DSSs and decision support tools,[2,3,5,6,13] staff increases when and where necessary,[6] and thorough staff training on the registration form format (ie, registration station was often found to be the most time-consuming station).[6] Moreover, registration forms provided in large, single-sided print,[6] verbally administered surveys/registration forms,[6,11] and forms that were completed while patients were in queue helped decrease patient throughput times.[19]

Other effective strategies and recommendations identified were vehicle stacking at each station, which allowed the evaluation of multiple vehicles simultaneously,[6,17] specification of the optimal number of patients per vehicle (ie, 3 to 4 patients per vehicle based on resources and DTC capacity) and encouragement of carpooling,[6,17] small trays with supplies carried by multiple staff members allowed vaccination of multiple patients per vehicle,[17] and having plans that address inquisitive patients in a way that decreases questions and maximizes throughput.[6] Last, multiple PODs (ie, combination of traditional walk-ins and DTCs) across a region could also decrease throughput time.[6]

Community Outreach Methods

To inform and attract the community, a diverse advertising campaign that used multiple outlets was found to be effective. The outlets used and recommended were newspapers,[6,11,18] radio stations,[6,11,16,18] television ads,[18] websites,[11,18] student/staff e-mail,[18] flyers,[6] and ads posted at primary care clinics.[11] Banks et al.[18] surveyed DTC participants on how they were informed of the DTC to ascertain the most effective advertising modalities. Newspaper and television ads were discovered to be most effective, with 33.85% and 33.21% of participants reporting they heard about the DTC through these 2 modalities, respectively.[18] These advertising modalities were followed by word of mouth (19.6%), university website (8.17%), radio (2.81%), and other websites (2.36%). Rega et al.[19] noted the importance of confirming accurate and consistent DTC opening and closing times posted by various media outlets. Furthermore, incentives such as free vaccinations[18] and child car seat fittings[11] were used to increase community participation.

In addition to informing the public about DTCs, local radio stations dedicated to public safety broadcasts can routinely

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update the community on projected wait times, DTC instructions, and live reports.[16] Informative/educational brochures should be available to inform the public about the DTC event, the specific disease outbreak, infection prevention strategies, strategies to identify infected individuals, methods to limit exposures and high-risk populations, and when and where someone should seek prophylaxis.[4,6,16]

Banks et al.[18] recommended using surveys in future, non-emergency DTCs to ascertain participating community member demographic characteristics so members of the community who do not participate could be identified and better targeted. Furthermore, it is recommended that the surveys be culturally sensitive (ie, offered in various languages using culturally appropriate terminology) to increase the accuracy of responses and should incorporate other critical variables associated with participation and vulnerable populations, such as insurance coverage and high-risk medical conditions.[18]

DTC Equipment

DTC equipment and supplies used and recommended in the articles included general equipment,[4,6,12,16,17,19] emergency equipment,[16] traffic control supplies,[6,16,19] prophylaxis and medication,[4,6,16,17] documentation/forms,[4,6,12,16-18] environmental decontamination supplies and PPE,[4,6,12,16] and patient care supplies.[16] Public health agencies and decision-makers should assess the equipment needed for their specific DTC based on the event (ie, disease outbreak, biological attack, seasonal flu vaccination, natural disaster), target population, location and size of the DTC, capacity restrictions, and resources available. Table 3 presents the specific DTC and PPE identified or recommended in each article.

Infection Prevention and PPE

A unique advantage of DTCs over traditional walk-in clinics is the social distancing of patients (ie, vehicle acts as an isolation chamber), which mitigates providers' exposure to infected patients.[4,6,12,13] Isolating patients helps reduce infection propagation, especially at PODs where large numbers of infected patients may be in close proximity. Other strategies and recommendations identified in the literature to prevent infection propagation were screening and triage (ie, patients and staff),[2-4,6,16] infection prevention training,[4,16,19] proper hand hygiene,[4] occupational health techniques,[4] sufficient PPE provision,[4,6,16] and potential disease-propagation evaluation (eg, RealOpt) within the DTC pre-event so mitigating strategies could be employed.[2]

One study recommended screening and triage be conducted at the beginning of the DTC to divert critically ill patients to a hospital to receive specialized care.[16] Additionally, screening of the clinic staff should be conducted periodically. If a staff member presents symptoms of infection, prompt removal from the DTC is recommended.[4] Multiple screening strategies were recommended, including visual screening, measuring temperature, direct questioning, or a combination of these techniques.[4]

Proper hand hygiene, environmental decontamination, and providing PPE were critical aspects of infection prevention in DTCs. To decontaminate hands, physically washing with soap and utilization of alcohol-based sanitizers are effective.[4] Environmental decontamination should involve Environmental Protection Agency registered disinfectants or a 0.5% bleach solution.[4] Last, PPE should be appropriate to the task performed and the transmission route of the disease/pathogen.

Adverse Events Prevention and Traffic Management

In addition to infection prevention, adverse event prevention was identified as crucial to DTC implementation. Possible adverse events included CO exposure,[12,16] vehicle accidents,[20] syncopal episodes,[20] adverse reactions to medications,[4,6] aggressive pet interactions,[19] and other issues such as lane blockage and delays in the transport of critically ill patients.[4,16,19] The likelihood of these adverse events occurring depended on the specific DTC location (ie, indoor versus outdoor) and the target population served.

Exposure to toxic levels of CO was a concern primarily for indoor/sheltered DTCs that lacked sufficient ventilation. Weiss el at.[16] instructed participants to shut off their vehicle before staff approached. Nicholas et al.[12] recommended the identification of vehicles in disrepair with the potential to emit high levels of CO before entrance into the indoor DTC and to process these vehicles outside or in an expedited fashion. Moreover, it was suggested to purchase CO monitors or to collaborate with local agencies (ie, fire departments, health departments) that can provide CO monitors to be worn by staff.[12]

Contraindications were avoided through utilization of a medication algorithm tailored to the specific medications intended to treat the disease/agent that were addressed by the DTC. For example, Zerwekh et al.[6] used a medication algorithm to select the safest medication (ie, doxycycline or ciprofloxacin) for each patient based on the patient's medical history. Using this algorithm, 98.9% of dispensed medications were the safest option.[6]

Syncopal episodes following vaccinations have been documented.[20] Although rare, consideration of these events is necessary for implementing DTCs.[20] To avoid these events and/or to mitigate their impacts, it was recommended to provide an observation station following prophylaxis to monitor patients.[16,19,20] Further, safety monitoring teams could be dispatched to roam around the DTC to monitor vaccinated patients.[19]

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TABLE 3

DTC Equipment and Personal Protective Equipment Identified or Recommended

General	PPE and Environmental Decontamination
Tables[12,16,17,19] Chairs[16] Waste containers[4,16,17] Waste container liners[4,16] Two-way radios[6,16,19] Wheelchairs[16] Gurneys[16] Cots[16] Extension cords[16] Lighting[16] Megaphone[16] Tents (varying colors for each station)[6,16,19] Blankets[16] Fans[12,16] Heating elements[16] Portable commodes/restrooms[4,16,19] Privacy screens[16] Refrigerator/cooling unit (store vaccines/medications)[4]	N95 respirators (or equivalent)[4,6,16] Alcohol swabs[4,16] Gloves[4,16] Safety glasses[16] Biohazard bags and bins[4,16] Isolation gowns[4,16] Surgical masks/facemasks[4,16] Booties[16] Hand sanitizer[4,16] Disinfecting wipes[4,16] Paper towels[4,16] Sharps container[4,16] Carbon monoxide monitors[12,16] Bandages[4] Absorbent pads[4] Gauze[4] Tape[4,16] Facial tissue[4,16]
Documentation	**Emergency**
Medical records folder[16] Registrations forms[6,16,17] Vaccination consent forms[17,18] Triage forms[16] Screening forms[16] Discharge forms[16] Order sheets[16] DTC/infectious disease information sheets/brochures[4,6,16] Maps and directions to ED[16] Clipboards[6,16] Paperweights[12] Surveys[18]	Golf cart for transportation[16] Crash carts (adult and pediatric)[16] Defibrillator[16] Suction unit[16] Oxygen cylinder w/regulator[16] HEPA viral filter[16] Oxygen masks[16]
Traffic Control	**Prophylaxis and Medication**
Orange traffic cones[6,16] Barricades/highway dividers[6,16] Caution tape[16] Traffic wands[16] Signs (entrance, stations, exit, etc.)[6,16] Colored vests[19] Colored balloons (to identify stations)[19]	Acetaminophen[16] Ibuprofen[16] Ondansetron[16] Juice[16] Preloaded syringes[4,16,17] Vaccination supplies[4,17] Needles[4] Antacid[16] Albuterol[16] MDI spacer[16] Oral rehydration fluid[16] Antibiotics[6]

TABLE 3

Continued

Patient Care
Thermometers (patient screening and refrigerator monitoring)[4,16] Stethoscopes[16] Blood pressure cuffs[16] Pulse oximeters[16] Otoscope[16] Ophthalmoscope[16] Scales (adult and infant)[16] Glucometer[16] Lancets[16] Tissues[16] Bedpans[16] Emesis bags[16] Infant diapers[16]

DTC = drive-through clinic; ED = emergency department; HEPA = high efficiency particulate air; MDI = metered-dose inhaler.

Transport of critically ill patients to a clinic or hospital to receive specialized care was an effective practice. If the DTC was located adjacent to a hospital, providing on-site transportation, such as golf carts equipped with stretchers, was found to be effective.[16] If the DTC was not located adjacent to a hospital, an emergency exit/bypass lane should be provided for vehicle exit and emergency vehicle access.[6,19]

Additional adverse event prevention strategies identified were vaccination of patients outside vehicles if patients were accompanied by aggressive pets,[19] tents anchored to the ground,[6] large signs used to direct special needs patients,[6] provision of mental health resources,[19] and the presence of security to protect medications and vaccinations.[6]

Last, traffic management was a critical component of effective DTC implementation. To best address this issue, the aforementioned DSSs were used to optimally design and select DTC layouts and locations. Additional traffic management strategies included the presence of police/security to direct traffic,[6,16,19] designated lanes and stopping points with clear and visible signs,[6,16] identification of stations and locations through the use of various colored balloons,[19] traffic flow management to prevent the backup of vehicles,[16] pre-establishment of towing procedures,[19] designation of a space for special needs vehicle processing,[6,17] the use of barricades/cones to direct traffic,[6,16] and the provision of sufficient space to allow staff to move freely.[6]

DISCUSSION

This review identified evidence-based effective practices and recommendations for implementing successful DTCs that can be applied to various emergencies and populations. We found dispensing prophylaxis to a large population in a short amount of time required DTCs to be well-planned and optimally designed to meet their target dispensing goals. Optimizing DTC layouts and staffing allocations pre-event ensured the minimization of patient throughput times, adverse

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events, and disease propagation, which allowed efficient and effective dispensing of prophylaxis to the target population. Evidence showed that optimally dispensing mass prophylaxis can be achieved through utilization of DSSs and decision support tools to plan and optimize DTC layouts, locations, staffing, resources, capacity, medication decision-making, disease propagation attenuation strategies, and multiple POD modalties[2,3,5,6,13] – and through proper staff training,[2,4,6,19] effective traffic management,[6,11,16,17,19] the establishment of communication channels within the DTC and among participating stakeholders,[6,16,19] the provision of sufficient PPE and DTC equipment,[4,6,12,16-19] and the development and deployment of effective community outreach methods to ensure that the DTC attracts as much as the community as possible.[4,6,11,16,18,19]

In addition to the evidence-based practices and recommendations identified in this review, the CDC,[22,23] the Federal Emergency Management Agency (FEMA),[24] the National Association of County and City Health Officials (NACCHO),[25] and the Division of Emergency Medicine and Department of Health Research and Policy at Stanford University[26] developed resources to help health departments with their DTC strategic planning and emergency preparedness and response capabilities. Each of these resources vary in the breadth of DTC-specific practices recommended and their specific applications. For instance, 3 resources focused exclusively on DTC recommendations,[24-26] while the other 2 only briefly mentioned DTCs.[22,23] The findings of this review corroborate many of the components outlined by the aforementioned resources, such as identifying dispensing locations, assessing resource availability, cross-jurisdictional resource sharing, medical countermeasure logistics, security measures, informing the public on dispensing sites, dispensing medical countermeasures, and reporting adverse events. Findings also distinctively contribute to the literature on DTCs by highlighting evidence-based practices found to be effective either through real-world drive-through vaccination clinics, feasibility/pilot studies, or simulation/optimization studies.

The use of sophisticated DSSs and decision support tools to optimize DTC efficiency will be crucial during emergency events that require complex interactions between various organizations and where a large influx of community members may severely strain the mass dispensing site. There is a great need for public health systems thinking to continue to develop and use various analytical DSSs to improve strategic decision-making for emergency preparedness and response.[27] Ideally, simulation and optimization DSSs would be widely used at all levels of emergency preparedness (ie, federal, state, local, regional, tribal), but the complexity and cost associated with developing and\or employing DSSs may limit their use, especially in smaller health departments that often lack dedicated funding and staff expertise.[28,29] DSSs were similarly developed and widely employed in other focus areas with success, such as supply-chain systems,[30] project-monitoring and control,[29] sustainable supply-chain management,[31] health care systems operations and various hospital units (eg, intensive care units, operating rooms, critical care units, pharmacies, screening units),[32,33] and population health models (eg, infection prevention, vaccination strategies, population screening).[34]

While health departments often conduct DTCs as an emergency preparedness exercise,[22] they can also present opportunities to further local health department goals through community outreach and awareness, increasing community-wide vaccination rates, conducting community health assessments, and providing services to underserved, rural areas. Le et al.[11] and Banks et al.[18] demonstrated the added utility of DTCs by providing child passenger safety seat fittings and surveying DTC participants to gather relevant data on participant demographics, prior DTC use, alternative vaccination options, and how they learned of the DTC, respectively. Furthermore, the DTC model was also used to provide companion animals with rabies vaccinations. Thus, when feasible and appropriate, DTCs should be conducted in a way that addresses the community's needs, as well as builds public health emergency preparedness and response capabilities.

The effective practices and recommendations identified in this review can directly inform future areas of research for DTCs. Specifically, research on if and how health departments at various levels (ie, local and state health departments) and jurisdiction sizes (ie, < 50 000, 50 000–499 000, and 500 000+) use these effective practices and recommendations could provide useful information for targeting the least prepared departments. These agencies may benefit from capacity building efforts, such as state or federal assistance, cross-jurisdictional sharing, and/or intersectoral collaboration, especially for smaller health departments that lack personnel and financial resources and access to appropriate tools (ie, DSSs).[28] Identifying how often DSSs are employed, the influencing factors to conduct DTCs, what training techniques are used, security measures most often taken, and barriers to the use of evidence-based practices can inform decision-makers and policy-makers on the current state of DTC emergency preparedness and response capacities. Future research should also include comparison studies on the effectiveness of various DSSs to ascertain which ones are best suited for different types of emergency events. Last, an increase in research on DTCs may lead to the establishment of best practices through a formal validation process, which can lead to more effective DTCs across the nation.

Limitations and Strengths

Major limitations of this review included a small sample size (ie, 13 articles included), the limited inferences inherent to descriptive studies, heterogeneity between the DTCs studied,

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and the extrapolation process used. The small sample size can be attributed to the novel nature of DTCs, resulting in a limited number of published research articles addressing DTCs. The small number and heterogeneity of the studies included in the review did not allow for an adequate comparison and contrast of practices between studies, making it impossible to ascertain best practices. Therefore, effective practices mentioned in the literature were identified and presented. Although these practices have not been designated as a best practice through a formal validation process, they have been demonstrated as being effective. This demonstration was the first step in developing best practices and should be used for practice recommendations when there is no other evidence available.[35] Ascertaining effective practices and recommendations from descriptive studies that have inherent limitations was acceptable in this case due to the lack of other more robust empirical evidence.[35] Another necessary compromise was extrapolation when a study did not directly address this study's research question or when a study used simulations for their research. Most studies had a relatively small sample size or simulated an emergency outbreak, which may have produced an artificially controlled, manageable environment. These studies may have overstated or misclassified effective practices. In a real-world emergency, the practices deemed effective may be strained by a large influx of stressed, anxiety-stricken community members, inducing a more chaotic environment where these practices may not suffice.

Major strengths of the current study included a robust search strategy using multiple databases, researchers, and bibliography searches; an adjudicated data extraction process; and, most notably, this review was the first of its kind to use published empirical research on DTCs to identify effective practices and recommendations. The effective practices and recommendations identified in this review can help public health agencies and decision-makers optimize their DTCs by ideally designing and planning their DTC, which will optimize the effectiveness of the DTC based on location, resources, target dispensing goals, and staffing. Further, this review can serve as a guide for health departments with little to no experience conducting DTCs and can be used in conjunction with resources developed by the CDC, NACCHO, Stanford University, and other organizations/agencies to ensure optimal DTC implementation.

CONCLUSION

Emergency events such as biological attacks, infectious disease outbreaks, and natural disasters may require health agencies to dispense prophylaxis to the entire community within 48 hours. Failure to dispense prophylaxis to the entire community within 48 hours could result in dire public health consequences. To best accomplish this goal, the effective practices and recommendations identified in this study for implementing DTCs can be employed.

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Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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