Understanding and Improving Collaboration in Emergency Simulations with a Local Chain of Survival

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ABSTRACT

Out-of-hospital cardiac arrest (OHCA) and choking are two emergencies where the rapid action of a bystander can increase the victim's chances of survival. Few bystanders act because they are not aware of their role as the first link in the chain of survival. Working on collaboration among a local chain of survival and using applications to improve communication and provide tutorials of actions to perform can be used to overcome this issue. We investigate these elements in the context of the Geneva Chain of Survival using simulations. The results show that an optimal collaboration means a lead's handover between the intervening parties. Collaboration can be degraded by problems of communication, panic[1], and confusion. Applications constitute a valuable addition to enhance the dispatcher's awareness and to help guide the CPR while not extending the intervention time. Finally, the debriefing that follows enables the acquisition of competencies through experiential learning that relies on emotions.

Keywords

Chain of survival, collaboration, bystander, dispatcher, app

INTRODUCTION

Early action is essential for the survival of a victim in an emergency, notably in the case of cardiac arrest or foreign body airway obstruction. Every year in Europe, at least 343,496 people suffer cardiac arrest outside the hospital (Empana et al., 2022). Among these victims, only about 10% survive (Gräsner et al., 2020). Public health authorities and associations have been trying to improve this rate for several years by promoting measures to be carried out, as training citizens in first aid, prevention and deployment of semi-automatic defibrillators. From 2015 onwards, guidelines have introduced digital applications as a resource to call first responders to perform first aids gestures before the arrival of the rescue team (Wyckoff et al., 2021; Perkins et al., 2015). Recommendations also insist on the importance of integrating bystanders on the rescue team (Mentzelopoulos et al., 2021). The issue is to further implicate bystanders into a local system of rescue and improve the collaboration between the different interveners. Our research is carried out in a multi-partner context (academic, private and public) financed by a French foundation that aims to promote prevention amongst citizens. In this research, the goal was to work with local community actors within a geographical area. Our focus was on the community of Geneva involving the dispatch center, Geneva Save a Life first responders and paramedics as well as citizens living in the city.

[1] The term panic is used to refer to the inability of the bystander to take appropriate action because they perceive 1) an immediate threat to themselves or others, 2) the belief that they cannot get out of the situation, and most importantly, 3) the feeling of helplessness in dealing with the situation, especially in situations where others are not perceived as being able to help (Gantt & Gantt, 2012). This panic translates into a strong sense of anxiety.

STATE OF THE ART

The chain of survival

The Chain of Survival model was created by Nolan (Nolan et al., 2006) in order to explain the required steps to achieve greater rate of survival of cardiac arrest victims. This model has been taken up in the form of recommendations (Figure 1) by the European Resuscitation Council (Perkins et al., 2015).

The model identifies four steps in the treatment of an OHCA victim, early recognition and call for help, early

Figure 1: Chain of survival (European Council Guidelines for Resuscitation, 2015)

cardiac massage, early defibrillation and post-resuscitation care. The first three steps may be performed by the witness (called a bystander) and the fourth by the paramedic team. Many more parties are involved; the dispatcher in the emergency control center, potential other bystanders and eventually first responders. All these interveners have to collaborate (Deakin, 2018). According to Linderoth et al (2015), the links in the chain should be thought as teams and bystander and dispatcher would be "the first resuscitation team". However, even before calling the dispatcher, several elements could already change the bystanders' intention to act or not.

Components affecting the bystander behavior

Less than a third of all bystanders start cardiac resuscitation on their own (Takei et al., 2014). Two elements can explained this phenomenon (Dobbie et al., 2018; Malta Hansen et al., 2017):

- Their level of knowledge, of the gestures to be performed (23% of the bystanders who have not been trained are confident to perform CPR against 72% of those trained) and of their awareness that their intervention is vital and cannot harm the victim.
- The number of bystanders on the scene; a bystander alone will be more likely to act than when surrounded by others, due to the "bystander effect" and the dilution of responsibility (Fischer et al., 2011) or due to the difficulty of managing other panicked bystanders (Malta Hansen et al., 2017).

Challenges in bystander / dispatcher interaction

The second link in the chain concerns early resuscitation. The dispatcher is considered the central actor for initiating this action (Harjanto et al., 2016). According to the research on emergency management, the assessment is often seen as challenging due to the difficulties in obtaining complete and adequate information from the bystander (Van den Homberg et al., 2018; Bharosa et al., 2010). The bystander has to become the eyes of the dispatcher and provide relevant information. However he/she is not always near the victim, nor is he/she fully aware of the urgency of the victim's situation (Linderoth et al., 2015) neither is he/she familiar with the pertinent information to share (Bird et al., 2020; Reuter et al., 2016; McLennan et al., 2016). Additionally, communication and language barriers (up to 30% of difficulties according to Case et al. (2018)) can cause delays.

When cardiac arrest is recognized, the dispatcher may attempt to perform cardiopulmonary resuscitation. While in one survey 82% of bystanders stated they were willing to perform CPR if guided by a dispatcher (Dobbie et al., 2018), in reality the rate of Bystander-CPR deliveries is at least halved (Valeriano et al., 2021). Two factors were identified by Case et al. (2018). The first one is the lack of CPR knowledge resulting in a lack of skills (81% of responders) and a lack of "perceived benefits" (28%) i.e. in their opinion the victim has already died and their action would be useless. The second factor, referred to as "personal factors", concerns the physical capacity to perform the massage (physical inability of the bystander (45%) or positioning of the victim (31%)) and the emotional capacity (20% mentions the possibility of panic).

Collaboration between others interveners

Although studies have shown that citizens are often perceived as a nuisance by health care professionals (Bird et al., 2020; Scanlon et al., 2014), a study in Denmark showed that 67.9% of emergency physicians perceived the assistance of citizen responders as useful and that 84.9% were satisfied with the cardiac massage performed (Jellestad et al., 2021). The study also showed that paramedics often asked citizens to continue massaging when they arrived, showing that they trust them. This trust probably results from the success of the interventions of first responders, citizens trained in first aid, who are alerted in case of vital emergencies including cardiac arrest via applications such as Save a Life (Switzerland), GoodSam Alerter (UK) or Staying Alive (France)(Valeriano et al., 2021). Their early intervention on OHCAs has increased the survival rate of victims to 35% (Derkenne et al., 2020). Therefore, technological solutions can improve the management of an emergency by adding a link to the chain of survival. We will look now at technological solutions available to assist the initial bystander-dispatcher link.

The technological resources to help collaboration between bystanders and dispatchers

Two types of technologies are currently being developed, applications designed to give awareness to the dispatcher by giving him access to a visual feedback via the bystander smartphone and applications dedicated to the bystander allowing him to follow demonstration of first's aids gestures send by the dispatcher. Video feedback is becoming more and more widespread and has shown benefits especially for the evaluation of the patient's condition (Linderoth et al., 2019, 2015). According to a study on GoodSam (Linderoth et al., 2021), it is perceived as useful by 88.6% of dispatchers and has been reliable, with 82.2% of attempts working. This study specifies that video should only be used under certain conditions; at least two bystanders and a condition difficult to assess (e.g. pediatric). One criticism of this video app is that it takes longer than usual[2] to deal with the situation, even with a cooperating bystander. Another option is the transmission of a demonstration video of emergency procedures that need to be accomplished by the bystander. Several studies have shown that it increase the rate of bystander CPR (Lee et al., 2020) and improve its quality (Lin et al., 2018; Stipulante et al., 2016; Bobrow et al., 2011).The two can be combined since visual feedback is also useful in guiding cardiac massage (Linderoth et al., 2021).

Experiential learning to construct improve memory retention

A second way to improve the rate of CPR bystander in a community is to train them in a situation that enhances acquisition and skills retention (Yu et al., 2020). Research has demonstrated that the regular way to learn in BLS leads to an oblivion of the skills after 6 months. Therefore, even when the course is mandatory, as in Switzerland to obtain a driver's license, the benefits are short-lived. Kolb (2014) suggests that it may be worth considering experiential learning as a means to improve retention. Experiential learning is described as learning by being actively engaged in the process, playing a role and experiencing events both cognitively and emotionally. The more intensive the emotion is, the more it can have an effect on the retention. In order to create a realistic testing ground that can elicit these emotions, simulation can be implemented (Gerhold et al., 2020; Mentler et al., 2017). To reinforce the realism of the simulations, it is even more interesting to have access to real professionals (Meischke et al., 2017) and to gradually integrate them into the real-time handling of the "victim" by a bystander (seeking help from other bystander, calling the emergency department, using the defibrillator, and being reached by the paramedics). The aim is to provide the most similar experience of the real activity (Linderoth et al., 2015). Finally, allowing time for discussion and shared reflection as a training team has shown positive effects on skill learning (Cheng et al., 2018; Rumsfeld et al., 2016).

Few literature reports experimentation integrating the complete survival chain in the same experience while several authors underline the importance of collaboration between each link of this chain. Therefore, the purpose of this paper is to understand the obstacles and facilitators of the collaboration within a local survival chain as well as to document how the Living-Lab process could increase this collaboration.

METHODS

The aim of this research is to study the collaboration within a local survival chain, with its specific characteristics and stakeholders, to investigate the impact of digital applications on patient care in this setting as well as to determine the relevance of a collective method allowing experiential learning.

[2] The median time to recognize a cardiac arrest is 1 to 3 minutes and 3 to 5 minutes to perform CPR from the time the dispatcher answer the call (Syväoja, 2019)

Research question

RQ1: Which components influence collaboration in the chain of survival during the handling of a victim of a vital emergency?

Research suggests that collaborative work can be affected at several levels depending on the various links (Bystander/dispatcher; firsts responders/paramédics). Our intention is to examine these different "teams" and the effect on overall collaboration and patient outcome.

RQ2: How does the use of one or more applications affect the treatment of victims?

We seek to analyze 3 points; the reliability of the applications and the duration of the interventions, the effect of a single application (feedback video / demonstration video) and of combined applications to deepens the understanding on when it is beneficial to use these apps and when it is not suitable.

RQ3: Is experiential learning supported by the simulation / debriefing approach?

Initially, we will examine whether the simulations trigger intense emotions among the participants and if sharing them with the stakeholders provides a deeper immersive feeling. Next, we will investigate the effectiveness of debriefing as a means of learning.

Field of experimentation; HUG 144 Health Emergencies center

The 144 Health Emergencies Center is a unit of the Geneva University Hospitals (HUG). The unit responded to 126,000 emergency calls in 2020. In Switzerland, the 144 number is only dedicated to medical emergencies and the dispatchers are either nurses or paramedics who completed a 6-month training as dispatchers. In each center, there is also one or more physicians. The Geneva 144 center currently employs 47 people: 26 dispatchers, 6 supervisors, 3 managers, 4 doctors and 8 support staff. Since three years, the center also collaborates with the Save a Life First Aid application, which reaches a community of 1'500 citizens divided into three groups of volunteers (health professionals, first aiders, citizens with BLS) alerted in case of a life-threatening emergency.

Population

The HUG published an announcement on social networks advertising the "144 days" to recruit a general population. It mentioned that any person wishing to participate in simulations of cardiac arrest and choking of an infant followed by a training in first aid could register on one of the 32 slots proposed on the HUG website over 2 days. There were 34 participants: 18 for the ACR and 16 for the OHCA, 27 women (79%) and 7 men. The majority of the participants were between 20 and 39 years old (21% of 25-29 years old, 20% for 30-35, 18% for 20-24 and 12% for 35-39). Participant are coded as followed in the verbatim: B1A = B: Bystander, 1: simulation 1, A: first bystander to take action. The other participants were 8 dispatchers[3] from 144 center, 4 paramedics[4] and 14 first responder[5].

Material; SARA and Urgentime apps

The applications we propose for these simulations are Urgentime (videos feedback) and SARA application (demonstration video). Urgentime is an app that allows the dispatcher to see through the caller's camera via an sms link connecting the smartphone and the dispatcher computer. SARA includes a smartphone / web app and a back office for the dispatch center. Through a sms link, the dispatcher can send the bystander one of eight demonstration gesture videos implemented in the app. In this experimentation, we tested CPR (adult, infant) and Mofenson maneuver.

Protocol

The experimentation protocol is divided into 3 phases; a first simulation phase (10 minutes), then a common debriefing phase (30 minutes) followed by an artistic restaging phase (1 hour). In this article we focus on the first 2 phases.

Simulation

[3] Coded D1, D2, …
[4] Coded P1A, P1B, …
[5] Coded FR1, FR2, …

We performed 16 simulations on 2 scenarios, an adult cardiac arrest (8) and an infant choking (8). The scenario for cardiac arrest was:

"You are in the waiting room for a job interview with someone who is starting to feel ill and collapses. You can call for help and call 144."

The dispatcher use Urgentime for the assessment and diagnoses the cardiac arrest. The scenario for the chocking infant was:

"You are keeping your neighbor's baby. He starts to choke and turns blue. You can call for help and call 144."

The dispatcher use Urgentime for the assessment and finds out that the infant is chocking. He sends the video of the demonstration of the Mofenson maneuver[6]. The participants are invited to practice the maneuver until the situation deteriorates into cardiac arrest.

In both scenario, participants starts to perform CPR on the dummy until the arrival of the ambulance with SARA video. Save-a-Life first responders join the participant(s) around the 6 minutes mark with a defibrillator (AED)

Debriefing

Debriefing in form of collective elicitation interviews follow the simulations with all participants per simulation (about 30 minutes). Elicitation interviews (Vermersch, 1994) are a technique aiming to focus on feelings during a particular event. The interviewer aims on deepening the lived-experience and sensations while avoiding questions that lead to a rationalization of discourse (Vermersch, 1994; Cahour et al., 2016). This technique can be used with a single person or a group (Balas-Chanel, 2014).

Data collection and analysis

The simulations and interviews were audio/video recorded then fully transcribed and analyzed with Atlas according to our research questions. We also extracted timing for each simulation (time of recognition of ACR and time to start CPR).

We made a thematic analysis of the verbatim. The data was first separated into three main axes: collaboration between stakeholders (positive or negative emotions, feedback on the simulation, discussions, and clarifications during the debriefing), impacts of the applications and effects of the method. First, we compared the 16 simulations with their debriefings in order to identify the postures and elements that could affect the experience of collaboration. We matched the actions observed in the simulation with the effects described during the debriefing. Subsequently, we compared which actions had which effects and categorized them on the basis of the feedback from the debriefing to extract the positive actions for the collaboration and the problematic actions. Then we analyzed the data to gain a deeper understanding of connections between each local stakeholder duo. The second step was to apprehend the impacts of applications by measuring their reliability and reviewed the benefits and difficulties encountered. Lastly, we categorized each verbatim regarding the method to evaluate benefit (experiential learning, confrontation with emotions, involvement) and biases.

RESULTS

Features and behaviors that affect collaboration within the local survival chain

Our first question concerned the understanding of the elements and characteristics of stakeholders that facilitate or hinder collaboration within a local chain of survival. The table 1 provides an overview of the different indicators, features, and effects on collaboration between each pair of partners.

Characteristics of an optimal collaboration

Collaboration is optimal when there is either one particularly competent bystander (S8) or several bystanders with one taking the lead (S1/2/5/11/15). The presence of other bystanders was experienced as reassuring for most participants. When a bystander takes the lead, it helps organize the handling of the situation and even start cardiac massage before the call with the dispatcher (S1/15). Optimal collaboration between the dispatcher and the bystander means that the dispatcher has quick access to important information (address, patient status) thanks to the designation of a dedicated bystander to speak on the phone (D8 to B8 :" *I found you very calm in particular in the information, the address, it was very clear.* ") and that he has the assurance that his instructions are

[6] The Mofensen method is a technique used in the case of an infant (under 2 years old) choking. It requires positioning the infant on his or her stomach on the thigh and delivering 1 to 5 taps on the child's back between the shoulder blades.

understood and carried out (D11: «So *on my side I had information that was clear with people confirming the actions*."). For the bystander, the impression of a good collaboration comes from the feeling of being guided (S4/6/9/13), reassured (S9/12) or encouraged (S1/15). During CPR, the dispatcher being positioned more in the background to give encouragement and the bystander giving information on what he is doing (counting aloud) reflects good collaboration.

Table 1: Features, behaviors and indicators of collaboration between members of the chain of survival

Link		Indicators of collaboration +	Features +	Actions	Indicators of collaboration -	Features -	Compensatory actions
Bystander / bystander		Sense of psychological support (S1/11) Trust in others (S15)	Lead bystander	Coordination (S1/2/5/11/15) Gives instructions to the other and organizes the takeover	Feeling of wasting time explaining to the other person (S2/4/8) Stress of having to organize (S13) Panic of one of the bystanders (S3)	Panicked bystander	/
Bystander / dispatcher	B	Feeling of being guided (S4/6/9/13) Feeling of being encouraged (S1/15) Sense of reassurance (S9/12) Confidence in the service (S8)	Calm dispatcher	Receptive listening/makes actions and feedback	Fear: Not hearing (S15) Not being understood (S3) Jargon (S5) Confusion with defibrillator (S10/15)	Overwhelmed bystander	Attaches to a part (video/defibrillator/dispatcher)
	D	Bystander gives the information (address communicated quickly (S1/8) Bystander confirms actions taken (S2/8/11/10) Ability to understand the dispatcher's needs (S3)	Cooperative calm bystander	Positions himself in support and spreads encouragement	Uncertainty about the implementation of gestures (S9) Uncertainty about the situation (S9/S13/S14) Uncertainty of number of people (S2)	Bystander un/badly responding	Repeat Ask the bystander to count to make sure they are doing things Gives very strict guidance
Bystander / First Responder	B	Soothing (S12) Feeling of being guided (S2/8) for the massage and for the defibrillator	Leading and cooperative First responder	Active and receptive listening	/	/	/
	FR	Listening and Proactive Bystander (S4/14)	Receptive bystander	Use the bystander as a relay for AED or massage	Difficulty to get information (S2) Difficulty in managing defibrillator and bystander (S3)	Bystander un/badly responding	Dispatcher does the transmission (S2)
Bystander / Paramedics	B	Feeling of being guided for the massage (S7) Relief (S2/3/7/11/13)	Attendance of paramedics	Actively participates	/	/	/
	P	Bystander gives information (S1/7/11) Bystander gives a proper massage (S7) Bystander stays and helps to organize the care (S7/11/13)	Bystander available/near/willing	Relay with bystanders S4/5/6/7/9/10/11/12/13/14	Bystanders step aside (S2/9/12/15)	Passive and withdrawn Bystander	Ask the bystanders to stay (S2,9,12,15) To start the massage again (S2/4/5/7/9/10/12/13/15) Relay with first (2/8/15/16) Relay with paramedics (1/3)
First responder / dispatcher	FR	/	/	/	Trouble managing defibrillator and talking to dispatcher (S9)	/	Focus on the defibrillator
	D	First who guides bystander (S2/7/8/10/12/15) Trust in someone trained (S2) First who informs about the situation (S2/8/10/15)	First reporting leading	Hands off and cuts off communication Encourage	Unaware that the first responder is there (S6/11/13) Uncertainty about the treatment (S9/14) Doubt about the ability of the first (S3/5/9)		Takes over control (S2/5/9/14) Keeps talking until he hears something satisfying (S9/14)
First responder / paramedics	FR	Feeling of not being alone (S16)	/	/	First goes away (S6,9)	/	/
	P	First structured and lead (S6) First source of information (S2)	/	Use the first to relay	/	/	/

The first responder then joins the bystander(s). When the first responder takes the lead and integrates the bystander into the process by giving instructions (S2/8/12), the pbystander feels calmed ("B12A: *Honestly it was soothing. It was much easier to wait for rescue at that point*."). The first responder expects the bystander to be active and receptive to his directives (S4/14). Fluid collaboration is achieved when the first responder uses the bystander as a relay either to apply the AED patches or to massage. The link with the dispatcher is still present, either through the bystander or through the first responder, which is valued by the dispatcher (S2/8/10/15). He then delegates and shifts his responsibility to the first responder as D2 expressed "*it is likely that he will take over, we may very well cut off communication* ". The dispatcher express that the trust in the first responder comes from the certainty

that he is trained (S2) and from their awareness that he guides the bystander (S2/7/8/10/12/15).

The final step is the integration of paramedics into the situation. Bystanders expressed feeling great relief (S2/3/7/11/13) just from the arrival of the paramedics. It is also a release for the first responder (S16) who appreciates not being alone anymore. For the paramedics, good collaboration emerge when the bystander is in an active position:

- By doing an "adequate" massage (S7) as described by P7A about B7A: "If *I find the person adequate, I'm not going to stop them. It's the first time I've had trust the person doing this*".
- By giving information (S1/7/11)
- By staying available (S7/11/13)

These elements are essential for a good collaboration. This leads them to use the bystanders as a relay for the massage (S4/5/6/7/9/10/11/12/13/14). They also appreciate a first who leads and gives information (S2/6).

Difficulties in collaboration and compensatory actions

The results show that in some situations (S2/3/4/13) the collaboration between several bystanders might be problematic. Some of the bystanders reported feeling stressed because of the time they had to spend explaining the situation or organizing the assistance. During one simulation (S3), bystander B3A also had to deal with the panic of bystander B3B, which put her under pressure, as expressed later "w*hen you said "the man is dying" for 2-3 minutes, I didn't listen at all. I wasn't listening to anything because otherwise I would have completely panicked."* (B3A).The main issue here seems to be dealing with a very stressful situation with unfamiliar people who may become an extra burden, as the bystander already feels unable to handle the injured person. In many cases, the situation was solved by calling 144, who distributed the roles.

When it comes to the collaboration between the bystander and the dispatcher, two main issues can arise:

- Difficulties in communicating; the bystander does not hear (S10/15/16) or does not understand (S5/9). When bystanders were confused because of an overload of information, they focused on a single element (the dispatcher "*I could always listen to the voice of the dispatcher*" (B15B), AED instructions "*The defibrillator has a much louder sound so it goes over 144"* (B10A) or video instructions "*I couldn't prioritize. So afterwards, I followed the video*" (B3A)) to complete the task.
- A poor awareness of the dispatcher; if the bystander doesn't or hardly answers, there is no certitude for the dispatcher over what is happening; the surroundings, the number of people (S6), the execution or not of the gestures…Dispatchers reported that in these cases they used techniques to ensure that the bystanders are doing something, such as repeating instructions or asking to count (D6 ""*I was making you count, trying to pick up clues over the phone* ").

The arrival of the first responder may also affect collaboration. They sometimes struggles to obtain information from the bystander or have difficulties managing the defibrillator with another person (witness (S3) or dispatcher (S9)). Once again, awareness problems may persist or arise on the dispatcher' side: sometimes he is unaware that the first responder has arrived (S6, 11, 13) or if the cardiac massage is continuing. In some situation, the dispatcher has expressed a doubt about the abilities of the first (S3, 5, 9), in these cases they take over ("D9: "*In my head, she didn't really need me but I felt like she did so I went back to 1 and 2 and 3 and 4*") and continue talking until they hear something "*satisfactory*". Concerning the last link, there is an important break in the collaboration because most bystanders move away when the paramedics arrive (S2/9/12/15) or stop massaging (S4/5/7/9/10/13), so the paramedic often have to call back the bystanders and ask them to remain involved. It is also worth noting that there are two situations where the first responders also moved away (S6, 9). That is two situations where the previous collaboration was difficult with either the bystander or the dispatcher.

Identify the effects of video to define usage criteria

Reliability of applications and temporal impacts

During the 16 simulations, Urgentime (video feedback) was used on each simulation and was not successful 3 times, which gives it 81% of success while SARA (CPR demonstration video) was used 11 times and was successful 4 times, which corresponds to 36% of success. Regarding the time of recognition of the cardiac arrest, it was recognized the fastest in the Urgentime modality doubled with SARA (1'40) and the slowest for the Urgentime modality alone on the OHCA situation (3'20). Times for starting cardiac massage was the fastest with Urgentime / SARA modality for OHCA (2'47) followed by choking baby without application (3'20) then Urgentime and SARA - for OHCA (3'39) and finally Urgentime alone for OHCA (3'53). Interestingly, in terms

of time between recognition of the arrest and CPR, the double use of Urgentime and SARA allows to obtain the best starting times with 12 seconds for OHCA and 58 seconds for child arrest against 1'03 for OHCA and 1'26 for child arrest with Urgentime alone. These findings indicate that the use of two coupled applications allows the shortening of time between the recognition of the cardiac arrest and the CPR. The technical problems does not always affect the starting time of the procedures (in particular for the OHCA). However, waiting for the link or the video can generate frustration or even panic on the part of the bystander ("B3B: *the time before the video starts, I think that we have lost a lot of time*" / "B12A: "*the video, I can't wait for it to download.*").

Urgentime: the beneficial addition of a visual channel for the dispatcher

This system was strongly appreciated by participating dispatchers because they "*regain their sight*" (D5) and stop working with "*the imaginary and the figurative but directly with the concrete*" (D8). The visuals allow the dispatchers to "*get the ambiance*" (D3), "*see if it's panic, if it's organized*" (D11) and to "*confront the anxiety on the spot*" (D2), enabling them to reassure the anxious bystanders. Secondly, the visual is a real help in terms of diagnosis, especially in pediatrics. In the chocking situation, the dispatchers used the camera to assess the baby's breathing "*it's a child described as blue and then I see him and it helps me confirm the diagnosis.*" (D6). Being able to see also gives them the opportunity to guide cardiac massage more effectively:

- By correcting the position ("*we could say you're too high, you're too low*" D7, «I *was able to tell you to come closer*» D13) and the rhythm in real time if necessary ("*I told you to massage more gently. It seemed to me that you were going very fast"* D15).
- By stepping aside and avoiding an overload of information: "*if it goes more or less well, you can give more or less instruction and let things happen*" (D8).

Finally, visualization enables the dispatcher to be more directly involved "*we are even more with the people*" (D1) since he can directly see the different interveners arriving on the scene. He does not need to ask for information from the caller as mentioned by D11 «I *was able to acknowledge certain steps of the procedure* ". By relieving him of the need to confirm verbally, the video increases the reliability of his representation of the situation while confirming (or not) his confidence in the on-the-spot bystanders. Indeed, when video is not available, the dispatcher has to go "*pick up clues by phone*" (D6). Moreover, the fact of filming also allows the second bystander to be more involved, as he/she does not perform the massage.

SARA: a visual aid for bystander

SARA allows reassuring the bystanders in the gestures of a resuscitation, "*from the moment I had the video, I felt able to do it*» (B1B). The videos of cardiac resuscitation for children and adults helped by mimicry to obtain the right position ("*it is especially the video that helps, naturally I had put my arms outstretched*") and the right rhythm "*with the video it was a little easier to count the frequency too*" B3B). The participants appreciated the addition of a visual channel "*It's much easier to tune in to images than to verbal information*" B3A. It also has been an advantage for foreigners.

Limiting elements

For Urgentime, several elements proved to be blocking in the process. The application required clicking on different messages displayed and was a source of stress as evoked by B6B: "*It wasn't easy, it's stressful and I don't know where to press*." It can also lead to an error as for B14A "*So what I did was press photo instead of video*" and B9: "*I actually write a response*". There is also a network flow problems, shared with SARA. A bad connection invariably leads to lags in the video, degradations in its quality, and thus confusion between the dispatcher and the bystander. For SARA, a bad network implies that it is difficult to send the demonstration video or that the dispatcher sends the video, thinks that it is received by the bystander and stops guiding the massage as in simulation 5 "*From the moment I clicked on send the video and it started to play at my place I thought it was playing at your place and in fact not at all*" (D5).

Is simulation and debriefing a way to achieve more long-term learning?

The emotions and the feeling of immersion

The emotion massively evoked by the participants is a certain stress (10 out of 18 for OHCA, 7 out of 16 for chocking) which appears from the beginning of the simulation (B11A: *"the moment we realize that the person is in difficulty"*), continues until the end of the simulation and sometimes even after (B3A during the debriefing "*my emotions are still running high*"). This stress originates from several components:

- A sense of responsibility; they felt it was their role to take action, especially in the child case *«it makes you feel almost more responsible than if it was your own child*." (B14A)
- A feeling of being emotionally overwhelmed "*I felt like I needed help I felt like I couldn't handle it."* (B3A)
- The time spent before the call (B16A "*seeing the seconds tick by and seeing that the child remains unconscious* ") or waiting during the call (B6A "*the longer we wait, the more stressed we are* ")

Moreover, we notice that there is a personification of the dummy, the participants evoke "*the person*" "*a little one*" "*the baby*", they have completely integrated the dummy as real. The child's situation can also lead the participant to project themselves into their own situation (B12A: "*I have a baby about that age. When I saw the mannequin it was difficult*"). We thus note a pronounced involvement in the situation (B2A: "*I really felt a stress as if the person was real*"). This emotional involvement can also have an impact on the future engagement of bystanders as the dispatcher noted "*living it and feeling part of it with us on the phone, with the paramedics, or the first responders, I think that it is a better way to understand and feel it"* (D1) and D2 "It *reinforces the feeling of belonging of the first responders and bystanders to this chain of rescue. We feel that we are all part of the same core. And in terms of federation, I believe it is essential*."

Learning benefits of shared lived situation

Simulation is a way to get experience before being confronted to the real situation. This is a benefit recognized by the bystanders (B2A: *the fact that I have tried it now prepares me in case it happens* ", B8 "*it was really a stressful moment but we never learn as well as in that way* ", B9"it's *a simulation, but if you can already manage this situation it's easier afterwards in real life.*") The first responders (FR10: «to *engage in such exercises is very interesting. To push yourself to act instead of waiting for the day it happens.* ") but also by the dispatchers themselves. Indeed, for young or trainee dispatchers, it gives an opportunity to be confronted for the first time to the handling of a cardiac arrest regulation and as D1 underlines "*It is better that she is stressed and that she loses her means on a simulation rather than on the day she will lose her means and that puts the patient in danger*". For the senior dispatchers, it is a question of "breaking *out of the routine*» (D2) and learning new practices while having the right to make mistakes "because *being wrong about a real vital distress is a real problem, there are real consequences, potentially serious for the patient. Even if we are wrong, we won't make that mistake again*" (D2).

The emotion caused by the situation can remain after the situation is over, so it is essential to have a space to welcome and discuss these emotions in order to give the participants the opportunity to appease themselves. Therefore, a debriefing session is mandatory and can be an opportunity for further development through discussion with the stakeholders of the specific situation. The bystanders learn by having a direct feedback on their actions and deepen their knowledge on emergency procedures and on the local chain of survival. It is also at this time that some participants became aware of their roles in the chain of rescue and the importance of performing the gestures, as in the example below.

B15C: How bad can it be if we stop massaging?
D15: Every time you stop, the person's heart stops. You are the person's heart.
B15C: Oh my God

Finally, the debriefing also enabled the dispatchers to get feedback on their practices from the bystanders "*something they never have access to*" (D5) and notably to realize that some instructions were misunderstood ("every *word we use is very important and can be interpreted differently "D2*) and that some individuals were afraid to even call 144. Therefore, these drills should lead to adjustments in their procedures.

DISCUSSION

The Geneva chain of survival

The chain of survival (Nolan et al., 2006) in Geneva is composed of bystanders, Save-a-life first responders, dispatchers and paramedics. We saw that when the collaboration is effective, the lead is passed from the first bystander to the dispatcher to the first responder and then to the paramedics. If collaboration is not optimal, the dispatcher remains the lead throughout the intervention until the paramedics arrive. The more confident the dispatcher is that the care is going well, the more he/she will take a back seat and move to a position of encouragement or cut off communication. The more he/she feels that the situation is unstable, the more he/she will continue to guide very strictly. In line with literature (Takei et al., 2014), our results showed that few bystanders started resuscitation alone (2 out of 16). However we did not witness a "bystander effect" (Fischer et al., 2011), all participants performed cardiac massage even though their emergency training was old (in

Switzerland, the BLS is mandatory to pass the license) and therefore can be considered as bystanders with little CPR knowledge (Case et al., 2018). The biggest problems between the dispatcher and the bystander were related to communication and to the management of several people and tools at the same time. When the dispatcher is in difficulty related to awareness (Van den Homberg et al., 2018; Bharosa et al., 2010), he/she puts in place compensatory techniques such as making people count, he/she repeats several times or he/she talks until he/she gets a satisfactory feedback. The first respondent is seen as a real relay and support, he has the confidence of the dispatcher and the bystander perceives him as a health professional so the expectation of the paramedics becomes less urgent. Finally, contrary to what we can read in the literature (Bird et al., 2020; Reuter et al., 2016), the paramedics in this situation were rather fond of the presence of the bystanders whom they consider as a resource in terms of information and relay for the massage. The biggest difficulty mentioned was the fact that most bystanders move away when they arrive.

The applications effects on the handling of a victim

The first point we sought to evaluate was the reliability of the applications. 81% of the attempts with Urgentime were successful, similarly to the study with GoodSam (Linderoth et al., 2021), but only 36% with SARA. In terms of treatment, the recognition time for cardiac arrest and for starting CPR are in the average of what is described in the literature (between 1 and 3 minutes to recognize the arrest and between 3 and 5 to start CPR)(Syväoja, 2019). However, the implementation time of the applications generates a certain stress for the bystanders (whether the application works or not). Next, we wanted to evaluate the effects of the applications themselves. We saw that Urgentime added an essential channel for the dispatcher. By restoring his sight, it increases his awareness of the situation, the course of the intervention, the environment and the gestures while allowing to unload the auditory channel which is strongly solicited elsewhere (by the presence of several persons, the SARA video and the defibrillator). It also allows guidance and back off as the dispatcher witnesses that a situation is being handled. When SARA application was successful, there was a reassuring effect on the bystanders who felt guided and supported to perform CPR. The findings show that it does indeed allow for more adequate massage performance as other research has indicated (Lin et al., 2018; Stipulante et al., 2016; Bobrow et al., 2011). It is also an element on which they can fix their attention when they feel lost. In addition, the demonstration video helps to overcome communication difficulties (Case et al., 2018) by demonstrating the gestures to be performed without resorting to oral guidance. Recommendations suggested using visual feedback only when there are two bystanders (Linderoth et al., 2021). While we have seen a situation where a single bystander was able to manage both applications, it would still seem advisable to use SARA when there are two bystanders. According to the dispatchers, it is also more interesting to use Urgentime in pediatric cases to assess the child's condition. Finally, Urgentime can do the guidance of the resuscitation and if it goes on correctly (good angle of view, adequate massage), there is no interest to send SARA, which would lead to an interruption.

The experiential learning effect of these simulations

The literature suggests that experiential learning is triggered by emotions (Kolb, 2014) and by incorporating all the stakeholders into the learning situation (Meischke et al., 2017). The first step was to investigate whether the simulations provoked any emotions in the participants. The main emotion identified was stress leading to a strong projection of the participants who perceived the dummy as a real person. Undergoing these emotionally charged simulations with first responders and paramedics had a federating and unifying effect. It also allowed the bystanders to train in conditions close to real life and the dispatchers to test new applications in a secure environment to be able to assess the potential difficulties. Lastly, the debriefing, considered as an opportunity for acquisition of knowledge (Cheng et al., 2018), is also a safety valve, providing a space to unload the emotions experienced by the participants. It also indeed allows more acquisition of skills since the participants can have feedback on their actions and medical, technical or procedural clarifications on what happened.

CONCLUSION

This Living-Lab has shown its value as a training tool for both the bystanders and the dispatchers. It has allowed the emergence of a certain feeling of unity throughout this survival chain. However, we only worked with volunteers dispatchers and it leads to a bias in the acceptability of the process and of the tested applications. It would therefore be worth pursuing this work with other dispatchers (in other dispatcher center or in this same center) with a more "general population" on the operator side. Further work to analyze the photographic restaging process would also be valuable.

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