Development of a Living Lab to find the place of live video tools and improve bystander resuscitation assistance during the emergency call

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Abstract

Introduction: In life-threatening emergencies, early action by bystanders is particularly important for the survival of victims, especially in case of cardiac arrest or airway obstruction. It is currently recommended that bystanders be encouraged to perform first-aid in all situations where it is required. However, few bystanders are willing to perform cardiopulmonary resuscitation (CPR). The main reasons are for this are the fear of not knowing how to perform CPR, coupled with the reluctance of dispatchers to rely on bystanders who are by default considered "untrustworthy". The use of live video during emergency calls appears to have a positive effect on the confidence of bystanders to provide CPR themselves, and on the confidence of dispatchers in them. **Objectives:** The objective is to propose and evaluate the relevance of a Living Lab methodology for simulated life-threatening emergency call situations, when live video tools are introduced in the call sequence. **Method:** The first exploratory phase aimed at analysing the process of dealing with out-of-hospital cardiac arrest (OHCA) situations in an emergency medical communication centre (EMCC) and at collecting the needs of the dispatchers. In the second phase, we pre-test the Living Lab.. This consisted of simulating five OHCA situations, while transmitting a live CPR demonstration video. The aim was to identify and analyse the benefits and constraints of using live video demonstration. The third phase is the Living Lab, in which 16 situations of cardiac arrest and airway obstruction will be simulated. The simulation will include both a live video link between the dispatcher and those present and the live transmission of a video demonstration of emergency procedures. The measures will focus on three areas: the place of live video tools (practitioner axis) and the impact of these on the quality of first aid actions performed by witnesses, the establishment of trust and collaboration within the community, and the interest of developing a Living Lab through an iterative method. **Results**: The first results concerning the practitioner axis show that dispatchers have an interest in visualising the scene with live video, and also in broadcasting a live demonstration video when possible. Initial results also show that trust and collaboration within the community are enhanced by the shared simulation and debriefing experiences, clarifying regulation procedures and improving communication. Finally, an iterative development, based on the learnings, expectations and constraints of each previous phase, seems to bring a lot of precision for the realization of a Living Lab aiming at determining the place of live video tools in the sequence of care performed by the dispatchers. **Discussion-Conclusions**: The Living Lab methodology, as described here, seems to be a powerful tool to determine the place of the use of digital tools within an emergency telephone assistance sequence.

KEYWORDS: Emergencies care, dispatcher, engaging citizens, Living-Lab, apps

Introduction

Background

The care provided in life-threatening emergencies is constantly evolving, partly as a result of technological advances that are leading to changes and further improvements in the way dispatchers respond to and handle emergency calls. Current health recommendations emphasize that all available resources, both human and technological, should be used to achieve better outcomes in terms of patient care [1]. For instance, in France, a new law has been in place since July 2020 establishing the status of citizen rescuer, whereby any citizen can and should attempt to rescue a victim in a critical situation and will not be held responsible for any consequences related to this attempt. This legislation has the broader goal of improving survival after out-of-hospital cardiac arrest (OHCA). Additionally, European and International recommendations for the treatment of OHCA include since 2015 the use of digital applications dedicated to trained citizens to promote rapid response to victims of OHCA [2–4]. This concern stems from the proven fact that a victim of OHCA stands a very low probability of survival (around 10%) despite the numerous measures taken as training citizens in first aid, prevention and massive deployment of automatic electric defibrillators [5–7]. Furthermore, OHCA is not the only situation where rapid intervention, by a bystander for example, can be crucial. In the case of a sudden airway obstruction (choking), particularly affecting children and elderly who are a high risk population [8,9], it is the speed of the intervention that is at stake. In choking situations, it is recommended to perform back blows (Mofensen manoeuvres), abdominal thrusts (Heimlich manoeuvre) or chest thrusts. These manoeuvres have been shown to be effective in relieving foreign body airway obstruction [10].

In both of these situations, the direct intervention of the bystander results in better survival rates. For OHCA, 13.6% of patients discharged alive are the ones who received bystander cardiopulmonary resuscitation (CPR), compared to 7.3% of patients who did not receive early CPR. When defibrillation is performed by a bystander using an automated electrical defibrillator (AED), the rate of increase is the same: 47% of victims survived to hospital discharge, compared with 28% of victims initially defibrillated by a first responder (who arrived later) [11]. For sudden airway obstructions, direct witness action has resulted in a 68% survival rate for patients compared to 44.7% for victims receiving a later intervention 12. Yet bystanders are rare to intervene when they witness an emergency situation. On cardiac arrest, the rate of intervention varies from 1 to 18% for defibrillation and 10 to 40% for CPR [13,14]. Similarly, while bystander performing Heimlich maneuver have been shown to be essential in improving the outcome of unconscious or unresponsive choking victims, only 25% of the victims receive this assistance [15].

Components affecting the willingness of bystanders to act

Several elements can affect a bystander's willingness to intervene. One study has shown that regarding performing CPR, the fear of hurting the patient is the first issue (reported by 63.1% of respondents for the elderly population and 50.9% for children), followed by a perceived lack of appropriate skills (13,4% for elderly, 23,4% for children) and fear of parents blaming for 5,2% in case of child CPR [16]. Numerous others studies have indeed shown that bystanders were afraid of causing injuries to victims [17–19]. This shows that in order to reduce these barriers, it is therefore necessary to better inform citizens about the consequences for the victim of not receiving adequate assistance and to train the population more widely in first aid.

The health professionals themselves also share this limited trust in bystanders, specifically those who are in initial contact with them, the dispatchers. Indeed, several studies show that dispatchers perceive bystanders as a nuisance due to their inexperience, limited first aid training and insufficient knowledge [20–23]. This mistrust is compounded by the fact that interactions between both populations are very rare, which can lead to tension and misunderstanding during their communication [24,25]. Also, neither of them is accustomed to cooperating [26]. In addition, during a call emergency-related interaction, there is no time to build the trust necessary for effective collaboration [27]. In order to improve this relationship between the dispatcher and the bystander who can perform the first aid procedures, two axes can be considered:

1. Establish a common frame of reference between bystanders and health professionals, to allow a more efficient collaboration based on an already established trust.

2. Providing new tools (e.g. live video) in order to overcome the lack of knowledge and training of bystanders and allow them to overcome their fear of acting while providing a sense of confidence to the dispatcher.

Use of live video to enhance communication between the bystander and the dispatcher

The use of live video is an emerging trend in emergency call handling. Live video can be used to assess the condition of the patient or the context, and thus provide feedback to the dispatcher, allowing him/her to have a better visibility of the situation. Indeed, there seems to be a discrepancy between the reality of the situation in the field and what the dispatcher perceives by receiving only audio information [28,29]. Live video feedback has also proven to be an asset in guiding CPR [30]. The dispatcher also has the option of sending a live video demonstration of the rescue actions that can be performed by the bystander. Studies suggest that viewing a live video demonstration of CPR increases the rate of bystander CPR [31] and improves the quality of chest compressions (rate, frequency, depth of compressions, reduction of interruptions, and accuracy of hand placement) [32–36].

The Living-Lab as a space to create a shared referential

The Living Lab is a method developed in the 1990's at Massachusetts Institute of Technology which aims to be a

meeting place for all the stakeholders involved in a situation to test a technological innovation [37,38]. This method allows a test in a situation close to reality and makes it possible to collect and confront the real constraints even before reaching a more advanced development process. Besides, it also provides the opportunity for different populations, varying in their level of familiarity with each other, to interact and collaborate. Living Labs are sometimes used in the health field and show positive results on the development of trust between participants thanks to a better understanding of the reality of others [39]. Moreover, Living Labs offer an opportunity to use a diverse set of complementary methodologies. For life-threatening emergencies, simulation seems to be the most appropriate setting. Indeed, for the safety of the victim and because of the potentially traumatic effects on the participants, it is not possible to carry out this experimentation in a real context [40].

The realisation of simulations with scenarios in a semi-real context seems adequate, and can bring a definite benefit for the participants in emergency or crisis experiences [41,42]. Indeed, experiencing the simulations together contributes to the creation of a discourse and a common frame of reference allowing for a more efficient cooperation later on [41,43].

Research aim

The objective is to propose and evaluate the relevance of a Living Lab methodology in simulated life-threatening emergency call situations when live video tools are introduced into the call sequence, with the aim of developing skills, trust and collaboration among all emergency chain stakeholders (bystanders, first responders, dispatchers and paramedics).

Method

Research questions and settings

The two objects of study are applications allowing video feedback (Urgentime®) and video demonstration of rescue actions (SARA®) on vital emergencies (RCA/FBAO). The emphasis lies on 3 axes driven by three specific research questions:

1. The practitioner axis: which effects, benefits and barriers has the inclusion of video on the early treatment of a victim by bystander? (QR1)
2. The community axis: how shared experiences facilitate the building of a common frame of reference and trust between stakeholders? (QR2)
3. The method axis: to what extent does the living lab methodology adapt to the needs and constraints identified through an iterative and resilient process? (QR3)

Emergency Medical Communication Centre (EMCC) and Emergency Medical Services (EMS)

The emergency medical communication centre (EMCC) of the canton of Geneva (emergency number 144) in Switzerland is part of the University Hospitals of Geneva (HUG). This centre responded to 115,000 emergency calls in 2021 for the whole canton of Geneva (500,000 inhabitants and 120,000 cross-border commuters). Paramedics (50% of the team) or certified nurses (50% of the team), take calls, assess situations and patients, dispatch ambulances and other rescue teams, and assist callers in performing rescue procedures. The same person handles the call from the moment the call is answered to the dispatch of the response resources, and it is also the person who answered the call who assists the bystanders.

Geneva's emergency medical system is a two-tier (or three-tier) system, with the paramedic ambulance as the first tier and an emergency doctor as the second tier. A third level consists of a senior specialist physician. In addition to these professional teams, the centre can dispatch volunteer first responders for OHCA or choking situations. A "Save a life" first responder community was created in 2019, which currently consists of 1,500 people, alarmed by an alarm app (Momentum® from Dos Group®). Alarming these first responders is extremely simple (push a button) in the computerised aid dispatch system used by the dispatchers. These first responders usually arrive between 2 and 4 minutes before the paramedic ambulance.

Materiel

SARA® App

The videos used during the experimentation come from SARA application. The Paris Fire Brigade (BSPP) has developed this application since 2017. It consists of a smartphone / web application and a back office for the dispatch center. Dispatchers can transmit to the witness one of the eight videos demonstrating gestures:

- Cardiopulmonary Resuscitation (Adult, Child, Infant).
- Heimlich maneuver (airway obstruction in adults)
- Mofenson maneuver (Airway obstruction in children under 2 years old)
- Lateral safety position
- Application of a tourniquet
- Application of a pressure patch.

The use of this tool lies in an unexploited segment of intervention. The first aid applications only allow acting on the situation when the volunteer arrives on the site, whereas SARA® videos enable to make the initial relay by involving the calling witness.

Instantview® from the compagny Urgentime®

Instantview® is a web application, which allows the dispatcher to see through the caller's smartphone camera. The dispatcher sends a URL via SMS, and when the caller selects this link, the smartphone camera is activated. If the bystander is already calling the EMCC with the same phone, there is no interruption of the audio communication. The video stream is simply added via data exchange (wifi, 4G, 5G). Once the connection is established, the Instantview® platform also allows documents or demonstration videos to be broadcast on the smartphone, which is connected directly to the EMCC’s dispatcher.

Procotol designs

The study is divided into 3 parts, the first being a comprehension phase followed by two experimentations (a pre-test and a living-Lab). Table 1 shows the protocol for the 3 phases with each associated research sub-question, population, methodological approach; data collection and analysis carried out or planned. The next section will elaborate in more detail methodologies used.

Table 1

		Understanding phase	Experimentation phase	
	Axis	**Exploratory study**	**Preliminary study**	**Living-Lab**
Research questions	1 Practitioner	How the emergencies dispatch center currently manage OHCA?	What are the effects of the video demonstration of CPR on the actual care of the patient?	What are the effects of interacting via video on the handling of emergencies?
	2 Community	What are the barriers to using citizens in OHCA situations?	What are the effects of the simulation and joint debriefing on the CPR lived experience and on the relationship between the stakeholders?	What are the effects of shared experiences of dealing with an emergency on the relationship between stakeholders?
	3 Method	What are the regulators' expectations and needs?	What are the obstacles identified during the Living-lab pre-test?	Which elements of the Living Lab are limiting and enhancing its value?
Population	1/2/3	2 dispatchers 1 dispatch coordinator 1 dispatch assistant 1 doctor	6 partner patients [1] 2 dispatchers 5 first responders (Save a Life) 6 paramedics	24 citizens 4 dispatchers 4 first Responders 4 paramedics
Methodologies employed	1/2/3	Semi-directive interviews Observations	Simulation workshops on OHCA scenario using the CPR SARA video Collective explicitation interviews	Simulation workshops with two scenarios (OHCA/FBOA) using Urgentime and SARA video (CPR/Mofensen maneuver) Collective explicitation interviews Artistic re-staging
Data collection	1/2/3	5 audio recorded interviews (30 minutes)	5 simulations (8 minutes) 5 group interviews (20 to 30 minutes) 1 interview with the regulators (52 minutes) filmed and recorded in audio	16 simulations (8 minutes) 16 group interviews (20 to 30 minutes) filmed and recorded in audio 8 OHCA Re-staging filmed/photographed
Analysis	1 Practitioner	Review of verbatims about current OHCA handling	Comparisons of the simulations between themselves and with other cases documented in the literature	Comparison of control situations (tapes) and simulated situations
	2 Community	Identify interests and barriers of recourse of bystanders	Analysis of interviews on the lived experience of the simulations and of the event to detect evidence of the development of trust and collaboration between the stakeholders	Analysis of the discussion during the artistic process, interviews on the lived experience of the simulations and of the event to detect evidence of the development of trust and collaboration between the stakeholders.
	3 Method	Gathering of dispatchers' expectations for inclusion in the pre-test protocol	Analysis of the difficulties encountered during the simulation workshops to refine the Living-Lab protocol	Review of the constraints and benefits faced during the Living-Lab process to develop a methodological toolkit to implement similar events in other dispatch centers.

Methodological approaches

Simulation scenario

During the pretest, one scenario was tested:

> "You find a 60 year old man unconscious in Chaumettes Park. You call 144 and follow the instructions the dispatcher gives you."

The dispatcher makes the victim's assessment by audio. The patient turns out to be in cardiac arrest, the dispatcher sends the video of SARA CPR demonstration gestures. He then asks the participants to perform CPR on the mannequin until the paramedics arrive (8 minutes in the canton of Geneva). Save-a-Life first responders join the participant around the 6 minutes mark.

The Living Lab will test 2 scenarios:

> "You find a 60 year old man unconscious. You call 144 and follow the instructions the dispatcher gives you."

Video shows the assessment (Urgentime®). Once the dispatcher diagnoses the patient as being in cardiac arrest, he sends the video of the SARA CPR demonstration. Participants starts to perform CPR on the mannequin until the arrival of the ambulance (8 minutes in the canton of Geneva). Save-a-Life first responders join the participant around the 6 minutes mark. 8 situations will be performed with 1 participant and 8 with 2 participants.

> "You find a panicked person with an infant who appears to be choking. You call 144 and follow the instructions the dispatcher gives you".

Video performs the assessment (Urgentime®). Dispatcher finds that the infant is in sudden airway obstruction. The dispatcher sends the video of the demonstration of the Mofenson manoeuvre. The participants are invited to practice the manoeuvre until the child cries (responsive mannequin) or until the situation deteriorates into CBA (2 situations out of 8). 8 situations will be performed with 1 participant and 8 with 2 participants.

Group explication interviews

Collective elicitation interviews follow the simulations with all participants per simulation (about 30 minutes). Elicitation interviews [44] are an interview technique aiming for the interviewee to focus on his or her experiences and 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 [44,45]. This technique can be used with a single person or a group [46].

Artistic approach

Throughout the construction process of the Living-Lab, a researcher artist follows the preparatory meetings between researchers and stakeholders and collects information on how the Living-Lab evolves based on the results of the preliminary experiment. She will contribute to the creation of added value by proposing during the Living-Lab to photograph a particularly significant scene co-constructed with the participants.

Results

In the next section, there is a presentation of the results of the first two phases and then an elaboration of the expected results resulting from the Living-Lab.

Understanding phase

Current cardiac arrest procedure for dispatchers

Around 2 cardiac arrests occur each day in the canton of Geneva, 33% of them are in the public area (street, public transport...) according to the physician. Cardiac arrest being a priority 1, the dispatcher has 90 seconds to send resources from the telephone pick-up. An automated cardiac arrest procedure appears when the dispatcher completes the information related to the patient's condition, which he collects following a specific process. Currently, dispatchers can do the assessment via video (Urgentime®) or via the audio phone call. First, he must obtain the patient's location then assess his state of consciousness and breathing. If the patient is unconscious and breathing anormaly (or not), the dispatcher send an ambulance in priority 1 and send a first responder via the Save a life button, and then tries to set up CPR with the witness.

Barriers to using citizens for CPR in OHCA situations

It appeared throughout the interviews that making the bystander do the CPR is a difficult task for the dispatchers. They described that witnesses are not always willing to come close to the victim during the assessment phase, "*even to put their hand on the stomach [to check for breathing]*." They specify that the bystander often will not perform CPR because they do not want to take responsibility and they are scared. The focus is on rapid recognition of cardiac arrest so the emergency center dispatch can send professionals to the victim's location as fast as possible, since "*continuing to do phone-guided procedures is not the easiest thing to do, quite honestly* ".

Dispatchers' expectation

When asked about the use of SARA® videos, dispatchers expressed that they would need an integration of the videos directly in the Computer-Aided Dispatch (CAD) system to avoid going to a separate computer for the video. They also raised concerns about the target population; cardiac arrest victims are more likely to be at home and senior citizens while people using smartphones are more "*young and geeky*", they said, "*it might be complicated for grandpa or grandma to master this kind of technology*". Nevertheless, they believed that CPR's video offered a real value and could be an asset in motivating some hesitant witnesses. Dispatchers also expressed a need to be able to receive video feedback[2] to "*keep the*

[2] At the time of the interviews (July 2020), Urgentime was not implemented at the dispatch central yet.

connection with the caller ". They could gain more insight on their guidance "*you can see the CPR being performed and guide it further*" and identify potential mistakes in the execution of CPR "*we think people understand and at the end of the day, what is done in reality may not look so good."*

Preliminary study

Effects of the CPR video demonstration on the victim's treatment

During simulations, no participants refused to perform cardiopulmonary resuscitation. Dispatchers recognized the cardiac arrests in 1'09, 1'32, 1'21, 2'51, and 1'56 after call pickup. The video was described as "*useful* ", "*a good input*" and "*stimulating*" by 5 of 6 participants. Overall, they identified two advantages of using a video during CPR: a better posture and more accurate performance of CPR. Some participants shared how viewing the video helped them adjust their hand position so they could do a stronger press. One participant stated, "*It was surprising, I started doing it with my arms not straight, and I was corrected [...] The clue it gave me that maybe I should press a little harder was to put my arms straight because I was like this [soft arms] and I was doing my massage soft*". Participants also valued having a sound that signalled each compression to perform. It was thus easier for them to follow the right chest compression rhythm compared to if they were alone. In fact, when participants started massaging before the video (S3/S5), the pace of the massage was slower. The view of a person performing a massage is also helpful. It aids participants to synchronize with the video and pick up the "*right rhythm* ". Such was the case for the participant 3: "*I heard the beep, that's when I saw that I had to go much faster*", participant 1: "*you have to go very, very fast, press very hard, the rhythm, you follow it with the video, it's something very pleasant*" and participant 2: "*it really gives me the right rhythm for a cardiac massage*"./

Joint simulation and debriefing effects on the CPR lived experience and relationship between participants

An early feedback is that the video had a reassuring effect on participants emotionally affected by the situation: "*we are a little bit, not in a state of panic, but we say to ourselves 'what more can I do' when we see an inert person*", or: "*emotionally it is quite strong, we imagine the person lying down. [...] Thanks to your help, the sound I heard behind, it relaxed me a lot. It put the level [of stress] where it needed to be to be effective anyway*". As dispatchers hinted during the exploratory phase, the video does help to initiate a massage in cases of hesitation by the witness: "*I was a little hesitant but they very quickly offered me a link to see a video that shows exactly how to do CPR so I started doing it*". It also seems to reassure the masseur in their gestures: "*I was glad that I could have a link, to be able to see it, it made me feel secure*", "*this application looks really well done because at one point I thought "I'm connected to this application? " because he said "yeah, it looks good, you have a good rhythm" and I thought "what do you know about it? ', (laughs) but yeah that was enough for me at that point"*. Lastly, the video provides comfort through the words of support implemented "*it adds something comforting with us, like we have someone who is assisting us*", "*I felt more like I was getting good support, even encouragement to keep doing well*". The dispatchers also found that sending the video was reassuring: "*For us at 144, sending the link is also a source of reassurance because we know that the cardiac massage will be properly performed by mimicry. The fact that you're watching, you're going to correct yourself and for us it is reassuring. [...] We know that anyway the witness, by watching the video, is going to do a fairly effective massage and that's probably what's going to save the victim*". They also sensed more "serene", "reassured" witnesses on the phone. However, in the subsequent interview with the dispatchers, they actually described being "*falsely reassured*" because they were ultimately unsure that CPR was occurring and the fact that they were sending the video prevented them from providing voice guidance over the phone.

The simulations also allowed all stakeholders within the survival chain to interact and collaborate together. In opposition to what appears in the literature, professionals (first responders, paramedics, dispatchers) have not considered the witness to be an obstacle but rather an additional resource to accomplish an essential act. A first respondent told us that *" the witness's role is very important and we can see that. It doesn't matter if the massage is good, it's a given massage. I have other skills, I will let the man do the massage*". The bystander can perform a cardiac massage instead of a more qualified person who can carry out advanced techniques. The bystander can also establish and maintain the link with the emergency services " *By the time the ambulance arrives, you start to get tired and being able to have someone who has a contact with the professionals, even psychologically, helps* ".

The bystander is therefore an additional resource that enables a more optimal distribution of the tasks carried out (relaying for massage, placing the defibrillator patches). Yet, both the first responder and the dispatcher must have confidence in the bystander to delegate. The first respondent obtains this trust by the active or inactive position of the witness: " *we arrived at the scene, the lady was at work, so I thought she had understood the instructions well, she had one eye on the mobile and one eye on the victim. She was watching the video and massaging at the same time. It was very important*". For the dispatchers, confidence is based on the witness's ability to understand and respond: "*the quality of the witness we have on the phone can be felt in the first exchanges we have and we can see straight away that the person who was there, understood, was efficient, did the things we asked of him or her very calmly and seriously*".

The simulation also helped some participants to a better understanding of the regulation process. This could help to avoid some frustrations in the future. For example, two participants did not understand why they should not act immediately. The joint debriefing gave the dispatchers the opportunity to explain this process: "*We went back over the steps you might have taken before calling 144. Nevertheless, for us it is important because there are plenty of people calling us for victims who are perfectly conscious*. "

Obstacles identified

One of the first obstacles to consider are Technical difficulties, as they cause a lengthening of response time. When fully functional, as it was in Simulation 1, the app enabled cardiac massage to start in 3.15 minutes. However, dispatchers stated they were unsure whether they saved any time compared to audio guidance. In addition, as the application is still at the

prototype stage, its stability is uncertain and the transmission of video is not always optimal in terms of time or quality.

We also chose to give participants the same "standardised" cell phone to avoid any differences in participants' personal phones. However, this lead to two problems; a difficulty in handling the new phone in an emergency situation and a very low output sound. Dealing with a phone that was not their own was described as an additional difficulty, adding stress as the participants were not always able to identify where the speaker was located and where to go to get the SMS to open the video/webapp on the phone loaned for the test. However, although in a real situation, it can be more complex to perform these simple gestures on one's own phone ("*well, that is to say, you have to master your phone already, to tell yourself where I am going, to look for my text message, so when you normally do it, you know, but when you are a little stressed, you can perhaps lose your bearings a little with regard to that, yes, that can cause a little confusion*"), we can assume that the fact that they were given a new phone accentuated these confusion effects.

Sound-related problems further impacted negatively the handling of the victim. Participants also reported experiencing trouble hearing the instructions given by the dispatcher. As a result, the dispatcher sometimes had to repeat the instruction several times over, and in some cases, participants were unable to understand the action to carry out (especially in the evaluation phase). These elements lead to a degradation of the relationship between the dispatcher and the participant as these elements prevented a proper establishment of communication. This results in a feeling of isolation on both sides.

Furthermore, research indicates that most bystanders are afraid to act and rarely perform cardiac massage. In this case, they carried the simulations during World Heart Day. The workshops were proposed among others and notably CPR training. Therefore, all the participants were willing to perform a cardiac massage and some benefited from training shortly before the simulation. Hence, there was a bias in that no participants expressed unwillingness or fear to perform CPR because they expected to do it.

Living-Lab expected results

Effects of interacting via video on the handling of emergencies

The expected results for the practitioner axis are oriented towards a better handling of the victim by the bystander both in time and in performance of the emergency procedures. For this purpose, a comparison will be made between OHCA and FBAO control situations (audio tapes of real situations) and simulations to apprehend if the video allows to save time on the phase of patients' condition assessment (Urgentime®) and on the execution of first aid actions (SARA®). A comparison of one-witness situations with two-witness situations is also going to be carried out to determine the most appropriate situation to use video. We therefore expect the situation to be easier to manage when there are two witnesses (one holding the phone and the other performing first aid). We will also evaluate whether the use of live video and demonstration video can reassure the witness and possibly convince him/her if he/she is hesitant to perform emergency actions. Finally, we will evaluate whether the use of two functionalities (live video and demonstration video) leads to a cognitive overload for the dispatcher.

Effects of simulation and joint debriefing on the experience of dealing with an emergency and on the relationship between stakeholders

As in the preliminary phase, we expect that the shared experiences (simulations, debriefing and artistic staging) will allow both populations to exchange and learn to collaborate. We expect effects in terms of knowledge transfer with a better understanding of emergency procedures for the participants and that enhanced communication (with video) will lead to better and faster trust building between the stakeholders. Analyzing the debriefings and the construction of the re-staging process will provide insights into the key elements for the participants as well as clues for future Living-Lab focused activities.

Living-Lab constraints, benefits and value

As in the previous phase, the stakeholders will review and analyse the challenges encountered to facilitate the replication of the Living-Lab toolkit in other emergency dispatch centers. In addition, they will assess the direct benefits (expected) and the secondary benefits (reported by the participants but not anticipated).

Discussion

Benefits and barriers on the inclusion of video for early treatment of a victim by a bystander

Before assessing the pertinence of using videos during emergencies treatment process, we investigated the current procedure for cardiac arrests in the involved EMCC. In the exploratory phase, the dispatchers reported that they work with a first responder application (Save-A-Life) that provides them access to trained volunteers for emergency response. Dispatchers use it on every OHCA by clicking on a button implemented in the engagement support system. Dispatchers expressed a strong interest in using a video feedback app to gain visibility of the situation and of CPR guidance which is consistent with the literature reviewed [28,29]. Since this phase, the central office has implemented the Urgentime® application that allows this video feedback. They also showed an interest in testing an application that would allow them to send demonstrations of emergency procedures as they admitted finding difficult to get a bystander to perform CPR by audio-guidance. They reported that few bystanders were willing even to approach the victim, although they felt that the video might help change the minds of reluctant bystanders. Indeed, in the

preliminary phase, one reluctant bystander did perform CPR because he felt "reassured" by the video. Participants in the preliminary phase reported that having the video was helpful and a good support. Research indicates that a demonstration video can improve CPR quality in terms of rhythm, number and depth of compressions, reduction of interruptions and placement accuracy [32–36]. The depth and number of compressions could not be assessed in the preliminary phase, however, a more adequate and sustained rhythm was observed when participants were following the video (thanks to the rhythmic sound implemented in the video), and their posture was more adequate (by mimicry). In terms of the barriers, the dispatchers stated in the exploratory phase that only few cardiac arrests happen on the streets, mainly in an elderly population unaccustomed to dealing with this type of application, especially in a stressful situation. Therefore, during the preliminary phase, we focus on seniors participants. Managing the technology itself proved to be a problem, but mostly because the cell phone was not theirs and the speaker sound was weak. For this reason, in the third phase, participants will be using their own phones to prevent this bias. The Living-Lab phase should provide further information on the benefits and barriers to the CPR video use on the previously unassessed elements. It also aims to evaluate whether the FBOA video can help rising the number of choking manoeuvre executions as the rate of bystander assistance is currently about 25% for this type of event [15]. To conclude this part, we would like to highlight that there is a high level of investment by the EMCC in the deployment of all possible technological (Save a Life, SARA®, Urgentime®) and human resources to improve the handling of cardiac arrests in line with recent European and international recommendations [2–4].

Shared experiences as a way to facilitate the building of a common frame of reference and trust between stakeholders

Researchers point out three main reasons behind the limited reliance on bystanders in emergency situations: citizens' fear of taking any action [17–19], professionals' mistrust towards them [20–23], and the absence of any prior collaboration [24,25]. While the dispatchers confirmed this fear of action on the part of citizens during the exploratory phase, the result of the preliminary phase did not show this element. Some participants expressed that they were intimidated by the situation but felt reassured by the dispatchers assistance. The dispatchers and first responders never reported any reluctance to have recourse to a bystander, in contrast with the literature. Rather, they emphasized how valuable anyone could be because they released the more qualified responders from performing CPR and allowed them to carry out advanced procedures. Furthermore, health professionals have developed skills to assess quickly whether the witness present can be a trustworthy relay or not. For first-responders, it is a matter of seeing an active, calm and focused person on the task. For the dispatcher, this consists of evaluating how the individual understands and responds to his or her questions while assessing the victim's condition. Within this short period of time, limited to 90 seconds to recognize a cardiac arrest and start CPR in Geneva, the dispatcher will already know if he is dealing with a potential relay or not. Lastly, some misunderstandings linked to a lack of knowledge of the regulatory procedures had occurred, which led to frustration on the part of witnesses. For instance, during the evaluation of the victim's condition, the witness had the feeling that time was being wasted, while this is an essential element of the intervention procedure. The post-simulation debriefing provided an opportunity for the dispatcher to explain this procedure, resolving any frustration felt and expressed by the witness.

Continuous adaptation to needs and constraints through an iterative Living-Lab process

Throughout the preparation of the Living-Labs, it became apparent that adapting to the needs of the different stakeholders was crucial in order to be as close to reality as possible and to try to secure a better commitment from the participants. For example, the need for video feedback was expressed during the exploratory phase interviews and then again during the pre-test. In response to the needs of the regulators, we integrated Urgentime® into our protocol, originally focused on the SARA® application. It will help to evaluate in which situations this application is the most relevant since the dispatchers' CAD system has just integrated the application. Similarly, initially the select end users for the living labs were only dispatchers and citizens. However, during the exploratory phase, we became aware that the Geneva's EMCC was working closely with the first responder application Save-a-Life. Consequently, first responders were integrated into the simulations in order to remain as close as possible to a real CAB situation in the canton of Geneva where first responders would be alerted. Both examples highlight how the Living-Lab is built upon a pre-existing territory and is constantly evolving according to the feedback, difficulties encountered as well as the needs and expectations of the stakeholders. Finally, during the third phase, the aim of the project is to collect elements allowing to consolidate the method and to provide keys elements that will enable other actors to reproduce the Living-Lab in other regions in order to increase collaborations within a survival chain on any given territory.

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