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Commentary

Challenges in the use of intraosseous access

Imagine a scenario when a patient arrives in the emergency department in cardiac arrest. Cardiopulmonary resuscitation (CPR) is tried but attempts at establishing intravenous (iv) access have been unsuccessful. In such cases intraosseous access (IO) is a fast, effective and potentially lifesaving procedure.

In this issue, Singh *et al*[1] present a feasibility study of a novel device for intraosseous access. It seems to be meticulously carried out and a high quality simulation set-up has been used with cadavers. There are several caveats when interpreting the study. First of all, there is only a single user is the study - how will the device perform when people who are less familiar with it, try it out? Secondly, the success rate in the study, measured by rate of penetration of cortex at first attempt, was 66 per cent. This is somewhat lower than the success rate of 80-90 per cent for the best of the other available devices[2]. Third and finally, the device will need to prove its worth against some of the best other IO devices available, *e.g*. the EZ-IO, in a simulation study. Only then it will be ready for the real world. There are, however, good reasons to welcome the efforts at developing new IO devices. One of the issues with many current devices is the cost, especially for resource challenged health care systems[3]. There are also indications that user friendliness could be improved even though the equipment is relatively straight forward to use[3]. These challenges could be addressed by a combination of education about IO use and improvements in the design of IO devices. An effective device that proves to be cheaper and easier to handle than the existing devices will be a great leap forward.

In the current guidelines[4], IO is recommended as a rescue device if iv access cannot be obtained in cases of cardiac arrest. If IO really is fast, effective and life saving it should be considered as a first choice, at least in selected cases. The concept of starting off with IO access straight away and use it for temporary circulatory access has several advantages. With IO established from the very beginning of the resuscitation effort, the patient can receive drugs and fluids in less than a minute[5]. With fluid and drug administration readily established, a more permanent iv access can be established in due time.

Early use of IO could possibly have advantages for hard endpoints. Though the efficacy of epinephrine in out-of-hospital cardiac arrest is debated, there seem to be an emerging concept that the timing of epinephrine administration determines if it improves survival or not[6]. According to this concept there are three phases of cardiac arrest and epinephrine should be given in the second, "circulatory" phase of a cardiac arrest[6,7]. Zuercher *et al*[8] in an animal model of ventricular fibrillation (VF) compared an optimal IO scenario (IO epinephrine given after 1 min of CPR) with a realistic iv scenario (iv epinephrine given after 8 min of CPR). The early administration via IO of epinephrine improved 24-h survival in the swine model of prolonged ventricular fibrillation[8]. Interestingly, the concept of cardio-cerebral resuscitation (CCR) has incorporated this in a treatment algorithm that includes early epinephrine via IO (or iv if available)[7]. The reported improvements in survival rates with CCR are remarkable, with an increase from 17.7 per cent with conventional CPR to 37.7 per cent with CCP within the study area (for patients in VF).

IO is one of a handful of procedures in emergency treatment that are at the same time quite rare and lifesaving; emergency tracheostomy and emergency needle decompression are other examples[9]. The question is how novel techniques and devices for such rare emergency procedures should be evaluated? There is growing concern that we tend to require much less evidence for medical devices before adapting these to everyday life in the clinic compared to drugs[10]. Given the costs involved and the consequences that suboptimal functioning equipment can have, this concern should be taken seriously. In a study from Denmark it was found that IO procedure was used only five times per year (median) in each Danish emergency department[11]. Performing a randomized study comparing IO devices would take years even in this setting and require resources beyond justification. So for very rare procedures, like intraosseous access, it seems reasonable to use other study set-ups.

Simulation studies have become the mainstay for research set-ups when evaluating resuscitation procedures, including IO devices[12]. There are obvious advantages when using a simulation set-up. But in order to accept the premise, that simulation set-ups can (to some extent) be used as a surrogate research environment, the set-ups need to be continually improved. One issue with many simulation research set-ups is that the simulation often focuses on one resuscitation procedure per simulation session, frequently with a workshop about the procedure minutes before the session. This is in contrast to most real-life resuscitation attempts where there are many decisions and procedures that need to be performed simultaneously - with no time to brush up on how to perform the procedures. Therefore, the idealized situation in simulation set-ups might overestimate how easy and effective a procedure is. Thus, we need to estimate if the simulation set-ups reflect the stress and complexity of real life situations. A novel solution to this question is using salivary cortisol levels as a measure of level of stress[13]. In studies of IO access there is an additional validation issue that the bone model used in simulation set-ups varies hugely among studies.

Some of the obstacles encountered when studying rare procedures could perhaps be overcome by supplementing simulation studies with alternative methods for data collection. Emergency medical services based databases could be used, but their focus is often primarily on already established quality parameters, *e.g.* on response times. This makes many of these of little value when searching for clues regarding new, radical advancements in CPR. But if we take a look at the challenge from a global perspective, even very rare procedures are performed every day by someone, somewhere. If we could gather these data in a structured manner, it would increase our knowledge immensely and hopefully speed up innovation. The novel idea of crowdsourcing research data fits into this concept[14]. In crowdsourcing, information from many users are given voluntarily to an online database. Although crowdsourcing cannot replace traditional methodologies, it is quite possible that it can provide valuable, supplemental information in the investigation of rare, emergency procedures. In a previous study, we did a questionnaire survey to gather users' experiences on IO use[4]. In just a few months, healthcare personnel from around Scandinavia reported their experience with 1,802 cases. Thus, when studying a rare, emergency procedure like IO access, the enlistment of several different methodologies could show the road forward.

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