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Commentary and concepts

The formula for survival in resuscitation☆

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ABSTRACT

The International Liaison Committee on Resuscitation (ILCOR) Advisory Statement on Education and Resuscitation in 2003 included a hypothetical formula – 'the formula for survival' (FfS) – whereby three interactive factors, guideline quality (science), efficient education of patient caregivers (education) and a well-functioning chain of survival at a local level (local implementation), form multiplicands in determining survival from resuscitation. In May 2006, a symposium was held to discuss the validity of the formula for survival hypothesis and to investigate the influence of each of the multiplicands on survival. This commentary combines the output from this symposium with an updated illustration of the three multiplicands in the FfS using rapid response systems (RRS) for medical science, therapeutic hypothermia (TH) for local implementation, and bystander cardiopulmonary resuscitation (CPR) for educational efficiency. International differences between hospital systems made it difficult to assign a precise value for the multiplicand medical science using RRS as an example. Using bystander CPR as an example for the multiplicand educational efficiency, it was also difficult to provide a precise value, mainly because of differences between compression-only and standard CPR. The local implementation multiplicand (exemplified by therapeutic hypothermia) is probably the easiest to improve, and is likely to have the most immediate improvement in observed survival outcome in most systems of care. Despite the noted weaknesses, we believe that the FfS will be useful as a mental framework when trying to improve resuscitation outcome in communities worldwide.

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1. Introduction

Many factors determine outcome after cardiac arrest and there is a large variation in reported survival rates.[1] Following a consensus meeting at Utstein Abbey, Norway in 1990, the first of a series of Utstein guidelines was published in 1991.[2] This established a set of common definitions for reporting out-of-hospital cardiac arrest (OHCA), enabling comparisons across communities and nations. A revised Utstein reporting format, published in 2004, attempted to clarify and simplify the required data elements for both OHCA and in-hospital cardiac arrest (IHCA).[3] By defining and using an 'Utstein comparator' (witnessed cardiac arrest of presumed cardiac cause with first monitored rhythm of ventricular fibrillation (VF)), large differences between communities in the reported survival after OHCA became apparent.[1,4] Although many key factors associated with survival have been identified,[5] a full explanation for the variability in survival rates has not been found. Differences in the quality of the local 'chain of survival'[6] may be the major factor contributing to the large worldwide survival differences.

In 2003 the International Liaison Committee on Resuscitation (ILCOR) published an Advisory Statement on Education and Resuscitation.[7] This paper described the discussions that took place during a resuscitation education symposium held at the Utstein Abbey in 2001. It included the statement that "survival rates for unexpected cardiac arrest depend not only on the quality of the education given to potential caregivers but also on the validity of treatment guidelines and a well-functioning chain of survival". The authors described a hypothetical formula – 'the formula for survival' – where three interactive factors, guideline quality (science), efficient education of patient caregivers (education) and a well-functioning chain of survival at a local level (local implementation), form multiplicands in determining survival from resuscitation (Table 1).

2. Utstein 2006 formula for survival meeting

In May 2006, a further symposium was held to discuss the validity of the formula for survival hypothesis and to investigate the influence of each of the multiplicands on survival. The symposium was again held at the Utstein Abbey. Thirty-five invited international experts participated in the symposium and a well-described Utstein rotating group format was used.[7] This enabled small group discussion to develop key pathways that were then refined by moving the groups through a series of panel discussions before the refined product was presented to all participants for consideration as a consensus viewpoint. The participants agreed that the proposed Formula for Survival (FfS) in a simpler format (Fig. 1) could constitute a valid concept worth pursuing and decided to divide the following discussion based on the four parts of the theoretical FfS equation starting with the end product-survival.

The 2005 ERC guidelines published just before the Utstein FfS meeting incorporated a new Chain of Survival (Fig. 2) with a greater focus on pre-arrest identification of patients at risk and post cardiac arrest care.[6,8] It was therefore timely to use elements from three of the rings in the Chain of Survival – rapid response systems (RRS),[9] therapeutic hypothermia (TH)[10] and bystander cardiopulmonary resuscitation (CPR),[11] – to illustrate each multiplicand of the FfS.

3. Survival

Survival after cardiac arrest can be defined in several ways. The demonstration that an intervention improves disease-specific short-term outcomes such as return of spontaneous circulation (ROSC) provides insight into the physiology of cardiac arrest and successful resuscitation and may have implications for the further evaluation of the interventions. However, most resuscitation experts place higher value on evidence of sustained improvements, and neurological outcome at 90 days has most recently been proposed as a reasonable outcome parameter for many clinical trials.[12] Good neurological outcome is generally defined as a Cerebral Performance Category (CPC) ≤ 2 or a modified Rankin scale (mRS) score of ≤ 3; both broadly representing the ability to live independently.[12]

4. Medical science

Although science is one of the three multiplicands in the FfS, it is recognised as an integral part of the other two factors: education and implementation. For many years, ILCOR has coordinated the review of science and the development of evidence-based resuscitation practice.[13] Given the nature of resuscitation, high-quality scientific evidence from randomised controlled trials (RCTs) is often difficult to obtain and in many cases generation of clinical guidelines requires extrapolation from observational studies or from animal experiments. Furthermore, science cannot be regarded as

Table 1
Components of the formula for survival.

	1. Guideline quality	2. Efficient education of patient caregivers	3. A well-functioning local chain of survival	Patient survival relative to theoretical potential (factors multiplied)
Utopia	1	1	1	=1.00
Ideal	0.9	0.9	0.9	=0.72
Attainable	0.8	0.9	0.5	=0.36
Actual	0.8	0.5	0.5	=0.20

Adapted from Chamberlain DA, et al. Resuscitation 2003; 59:11-43 with permission.

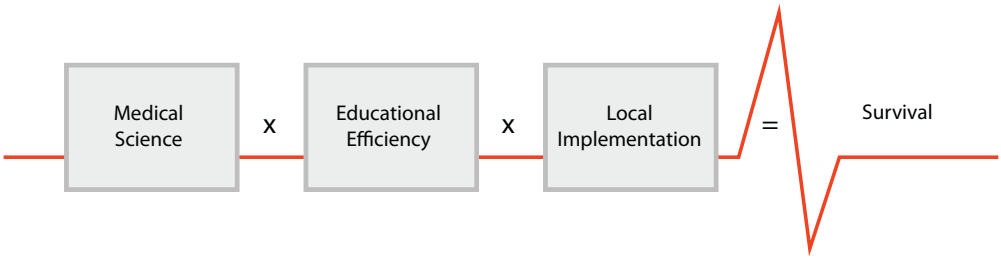

Fig. 1. The Utstein formula for survival.