



Robert E. Gross Lecture

## Creativity and the surgeon

Michael W.L. Gauderer MD\*

Division of Pediatric Surgery, Children's Hospital, Greenville Hospital System University Medical Center,  
Greenville, SC 29605-4253, USA

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**Abstract** This Robert E. Gross lecture is an analysis of the concept of creativity and how it relates to the practice of surgery. The questions—why surgery and creativity are closely associated; what influences creativity; why we should be concerned about it; and, finally, what rewards it brings—are discussed. In a personal note, the author describes his approach to creativity, with *simplification* as a central theme. He presents 6 examples of his work and the lessons learned from this activity. He stresses the importance of fostering creativity in all institutions in which physicians are trained and the need to focus on medical students, residents, and fellows. The critical importance of identifying, nurturing, and protecting innovators, as well as the role of the mentor, is emphasized. Because creativity has a place in many settings and discovery encompasses a wide spectrum, the author provides multiple suggestions aimed at encouraging the participation of those providing surgical care in the fulfilling experience of creative activity and innovation.

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Thirty years ago when, as a pediatric surgical fellow, I first presented a paper at the American Pediatric Surgical Association, I could not have imagined that, one day, I would have the distinct honor to deliver the prestigious Robert E. Gross Lecture. As one of the founding fathers of modern pediatric surgery, his name has long been associated with many of the closely related and intertwined aspects of patient care, teaching, research, innovation, and, certainly, creativity. In fact, since its inception, our specialty has attracted an uncommonly creative group of physicians who have contributed significantly to contemporary surgical practice.

### 1. What is creativity?

Creativity is traditionally considered an attribute related to the arts, psychology, religion, and, to a much lesser degree, the sciences. However, in recent decades the term *creativity* has become ubiquitous, freely used in a wide range of human activities, from casual conversation to politics, from mundane financial transactions, to strategic planning in the board rooms of major corporations. Although the meaning of creativity appears to be intuitive, its definition is by no means inherently simple. In fact, there are a surprisingly large number of definitions of creativity in the psychology literature alone, clearly demonstrating the multifaceted, expansive nature of this subject [1,2]. From a practical point of view, creativity can be defined as the ability or the power to create or to produce something *useful* that *has not previously existed*. It is characterized by originality, expressiveness, and imagination. The importance of creativity as a subject of scholarly analysis

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\* Tel.: +1 864 455 5070; fax: +1 864 455 4170.

E-mail address: [mgauderer@ghs.org](mailto:mgauderer@ghs.org).

and debate is demonstrated by the sizeable body of literature it has generated. Indeed, there are presently more than 300 books with “creativity” in the title (WorldCat) [3-12], 2 dedicated journals (*Journal of Creative Behavior* and *Creativity Research Journal*) [5], as well as numerous other publications. Further evidence is the existence of organizations dedicated to the study and promotion of creativity (eg, American Creativity Association, The Creative Foundation, The Creative Problem Solving Group, and the International Center for Studies in Creativity) [13]. Creativity has been the theme of articles and editorials in, among others, business, medical, and scientific journals [14-16]. In the field of surgery, creativity, as well as innovation, has been the focus of reviews [17], symposia, lectures [18], and presidential addresses [19-22].

Although creativity and innovation are frequently used in the same context, it is important to distinguish between these. Whereas creativity refers to the act of producing new ideas, approaches, actions, or works, innovation is the process of generating *and* applying these ideas to a given setting. Using a biological analogy, one could equate the nucleus of a cell with creativity and the cell *plus* its nucleus with innovation. Naturally, the nucleus is the engine that drives the cell. The health and the longevity of the organism to which the cell belongs (or, to extend the analogy, an organization) depend on the health of its individual cells. In simple terms: creativity is the starting point for innovation.

The purposes of my talk are to share with you a personal perspective on creativity and hopefully to encourage all of you, particularly the younger colleagues, to take advantage of the inherent creative potential we all possess and to apply it to your daily surgical activities. Furthermore, I would like to convince you that, with the right attitude, creativity can be a most fulfilling endeavor. The pleasure derived from creative activity is, in many ways, similar to that encountered when assembling a puzzle, playing chess, painting, performing music, or, in the case of a surgeon, performing a flawless operative procedure. I will go one step further and submit that this fulfillment should be an integral part of the process, not the sole goal.

Let me introduce and develop my thoughts on creativity in everyday surgical practice in the form of questions:

1. Why should surgery and creativity be so closely associated?
2. What influences creativity?
3. Why should we be concerned about it?
4. What are the rewards of creativity?

### 1.1. Why should surgery and creativity be closely associated?

Creativity should be common to all medical specialties and must be particularly strong in the surgical fields. The very word “surgery” is derived from the Greek *cheirourgia*, from *cheir* (hand), plus *ourgos* (working). It is therefore natural that because, for centuries, “working with the hands”

has been intimately associated with creativity, the concept of its application to surgery should follow naturally. Indeed, the desire to help one’s patient with the process of creating solutions (and innovation) should be one of the basic factors that motivate a surgeon. Although the concept of creativity is still, in many ways, linked to the arts, rather than to science, the physician’s desire to create is quite similar to that of an artisan, a craftsman, or an artist [2-4].

For the surgeon, creativity is usually based on the recognition of a need, formulation of a hypothesis, evaluation of possible solutions, work on one or more of the selected concepts, and, hopefully, ending up with a useful deed that eventually must be verified. And, of course, all along this process the patient’s welfare provides strong motivation. In this setting, truly novel approaches can come from multiple sources: a critical challenge to long-held (and not necessarily proven) “truths,” the ability to look at problems from a different perspective or turning an observation inside-out, or even placing a well thought-out “what if?” Indeed, to quote Albert Szent-Györgyi: “Inventiveness consists in seeing what everybody has seen and thinking what no one else has thought.”

### 1.2. What influences creativity?

Naturally, the process starts with the *creative individual*. But several other, equally important factors play significant roles. Among these are the *environment*; *support from family and peers*; *resources* such as *time*, *equipment*, and *seed funding*; and, of course, *patients*. In addition, a *smile from Fortuna*, the goddess of good luck, can play an important role, particularly if the relevance of a finding is fully recognized by the investigator [7,18].

Let us first look at the *creative individual*. He/she must be curious, interested, and driven, or, better yet, passionate. He/she must be willing to approach a problem with an open and inquisitive mind, preferably without preconceived ideas. At times, he/she should have the courage to let go of “certainty.” He/she may wish to question the “status quo,” but only after thoroughly familiarizing himself/herself with the history of the problem at hand. He/she must keep up with the subject by probing at his/her own institution, finding out about the work of like-minded colleagues at other centers, reading journals in his/her own field and related areas, and attending/presenting at national and international meetings. In this regard, Johann Wolfgang von Goethe, the last of the great “universal men,” wrote: “We see only what we know.”

The creative individual must have the courage to accept risks, have a high threshold to tolerate frustration, be willing to take criticism and failure, and be ready to share information at the appropriate time. Throughout the process, he/she must proceed with diligence and purpose. In fact, according to C. Walton Lillehei: “Determination, persistence and stubbornness are the most important components of research and discovery” [23]. In addition, the creative

individual must be patient. Nearly 3 centuries ago, Georges Louis Leclerc, Comte de Buffon, stated: "Genius is nothing but a great aptitude for patience." And, of course, he/she cannot shy away from work, as illustrated in this statement from Walter B. Cannon: "Neither the bounties from insight or from chance relieve the investigator from the necessity of hard labor" [24].

It is generally agreed that curiosity is the mainspring of seekers, of those who want to know. But here a few distinctions are in order: discovery is different from creation, creation differs from interpretation, efficiency has nothing to do with creativity, and intelligence and creativity, above a certain IQ, are not necessarily associated. In addition, as Niels H.D. Bohr remarked: "Thinking and being logical are different."

Let us now focus on the *environment*. It should be conducive to creativity and starts with the availability of a mentor. The importance of the nurturing process of mentoring has been recognized since antiquity and has been at the core of numerous addresses to surgical associations [19,25,26]. This activity must not only be encouraged, but also rewarded. Investigators, especially when starting in their career, need the freedom to explore new fields, new ideas. Creativity thrives on freedom. Conversely, dogma creates stagnation. Authoritative approaches, such as "that's the way we've always done it," or "that's the way the professor does it" (and therefore everyone else on the service), are certain to inhibit creativity (as well as progress) [14]. It must be remembered that new ideas are fragile, particularly when coming from the young investigator.

If an organization wants to encourage creativity and innovation, there must be a free flow of ideas in all directions throughout the different services. Creativity in medicine is stimulated by peers, residents, nurses, and other health care providers, particularly those who generate questions and ideas. This can lead to a "creative field." As Werner Karl Heisenberg remarked: "Asking the right question is frequently more than halfway to the solution of the problem." Whether in reference to individuals or to their environment, the quote attributed to Lucius Annaeus Seneca is still most pertinent nearly 2000 years later: "A major part of progress is the willingness to progress."

The third factor relates to *support*. Critical here is the moral support that comes from family and colleagues. A supportive spouse can make all the difference. Because creativity and academic productivity are all too often superimposed on a demanding clinical practice, incursions into "family time" present a real risk to the busy practicing surgeon. Undoubtedly, the price of creativity-related pursuits can be high, and excessive strain can lead to serious marital problems. On the other hand, there may also be intangible benefits such as increased professional satisfaction or other rewards, including financial ones that can benefit the entire family.

The fourth element involves *resources*, including time, equipment, and seed funding. "Thinking" or "academic" time is key. On such a period, be it a day, a week, or even longer, one should be as free from clinical activities as possible because in our daily practice as busy surgeons we

have all experienced how easily the "urgent" displaces the relevant. The most important tool for the creative mind is access to information. Never before has it been easier to obtain information, as contemporary capabilities for the acquisition of knowledge offer endless possibilities and are now within the reach of nearly everyone [27]. Although many new ideas germinate without monetary support, the addition of seed funding is an encouraging catalyst. Educators who clearly recognize the importance of the abovementioned needs realize full well that, if you waste creativity, you destroy capital.

The fifth critical factor concerns patients, who must always be at the center of the creative act. It is the patient's welfare that drives this process. Because ideas come from patients' needs, a sufficient patient volume is crucial. Clinicians must learn to listen carefully to those entrusted to their care and to their caregivers. They should go beyond the mere establishment of a diagnosis and probe into what the real problems are so that meaningful, creative solutions can be reached. The patients in turn should be well informed about why certain steps are being proposed. Here it is important to remember that informed consent alone does not necessarily make the research ethical. Fortunately, institutional review boards and a sizeable body of literature are now available to guide the researcher in this complex and at times conflicting area [28-30]. On the other hand, the same boards need to be ever cognizant of the fine balance between patient protection and the stifling of creativity.

### 1.3. Why should we be concerned about creativity?

Our present era has produced unprecedented breakthroughs in practically all branches of medicine. Never before have there been more opportunities for physicians to offer effective treatment to their patients. Yet we find that the interest in the profession has decreased in several Western countries during the last couple of decades. Some specialties, including surgery, have seen a steady drop in the number of strong applicants [31-33]. The reasons are multiple and beyond the scope of this address. However, such a decrease, which inevitably affects academic productivity, worries health care analysts, from educators to researchers, from practitioners to administrators [34]. In a 1988 article in the *New England Journal of Medicine*, Dr Bernardine Healy [35] asks: "Innovators for the 21st century: will we face a crisis in biomedical research power?" In fact, the concern is not limited to medicine or the United States, as illustrated in a recent communication in the journal *Science* [36].

I believe we can all agree that knowledge and creativity are the basic foundations of future growth in medicine and surgery. And we can also agree that the ultimate goal of research in these fields is to discover new and better ways to improve health care. Unfortunately, the general perception of "research" among many medical students and young physicians is that it is somehow beyond their reach. Partly,

they believe research is limited to universities, laboratories, and other “special places.” It is seen as lofty, complex, difficult, and requiring much time, effort, and financial resources. It is not usually associated with pleasure. It is generally considered a necessary step for academic advancement. These and other misconceptions discourage many of our bright young colleagues. In our field of surgery, research offers an exceptionally wide spectrum of possible contributions from simple original bedside clinical observations to complex bench work. Creativity and innovation come in many sizes and formats. Discoveries and solutions to everyday problems can emanate from any medical setting from the ward to the sophisticated laboratory and from any health care worker. Great ideas can be generated anywhere by anyone who is observant enough and lets his or her creativity run free. This freedom to discover and create is not present in many other professions and it should be one of the strong incentives for a career in medicine.

#### 1.4. What are the rewards of creativity?

Naturally, one could say the rewards include the intrinsic joy of creating a “product,” the result of creative thinking. Here it must be stressed that in terms of creativity, “size” and “importance” are not necessarily related. Very few new discoveries are “major breakthroughs.” Another way to put it is that success and significance are 2 different things. Because most of us do not work in research centers and laboratories, our “laboratories,” in addition to our own minds, are usually the clinic, the bedside, and the operating room, as so aptly stressed by William S. Halstead nearly 100 years ago [37]. Often, little incremental innovations can make a world of difference in patient management and care. Unfortunately, when the “product” is a medical device, the road from prototype to packaged unit can be long and at times quite frustrating. However, many innovations are not new devices, not even devices at all. New uses for existing instruments, adaptations and modifications of established procedures, and changes in the flow of information in the clinic or the wards are all examples of creativity. To quote Thomas Alva Edison: “There is a way to do it better—find it!” [38].

What then is our “reward”? In reality, fame and fortune are uncommon rewards of creativity. Indeed, it is often the “popularizer” rather than the creator who reaps the benefits of a major new concept. Peer recognition and academic advancement are certainly incentives (and so are possible financial gains, although these should be regarded as a “bonus”). The desire to create must have its main rewards in the sheer joy of a successful accomplishment (often after many failures), and in an ever-present drive to aid one’s patients. More than 2000 years later, we can still imagine the joy of Archimedes as he exultantly exclaims: “Eureka!” The fulfillment achieved by successfully helping our patients through our own creativity is priceless.

## 2. A personal note

Naturally, there are many ways in which we can apply our curiosity to clinical practice. Allow me to share with you a personal note. My interest in “tinkering, gadgets, and devices” was initially fostered by my father, an engineer, who encouraged his children to use his modest wood workshop at home. In medical school, I received the most stimulation and mentoring during my pediatric surgical rotation with Drs Euro C. Leal and Paulo J.G. Tubino, whose enthusiasm and dedication made my career choice an obvious one. During my pediatric surgical training, I was strongly influenced by 2 giants of surgery, Professors Fritz Rehbein and C. Everett Koop. Rehbein was an exceptionally creative surgeon and the founder of the first pediatric surgical journal (the *Zeitschrift fuer Kinderchirurgie*—1964). Koop, who eventually became our best known Surgeon General while serving under President Ronald Reagan, was an inspiring educator, a masterful technician, and the founder of the second major journal dedicated to surgery of infants and children (the *Journal of Pediatric Surgery*—1966). Inspired by these mentors, I soon realized that an important goal in surgery, one filled with creative opportunities, is the continuous search for the simplest procedure that can safely and effectively correct a specific pathology or achieve a desired goal.

My own work, since the completion of my fellowship at the Children’s Hospital of Philadelphia in 1978, has led me in many different directions: new operative procedures, several devices, and multiple clinical observations. In this work, I have adopted simplification as a “Leitmotiv.” Indeed, I included this intention in the title of some of my publications.

Let me illustrate this with some personal examples of simplification.

- With the percutaneous endoscopic gastrostomy, I sought to achieve a simple and effective, yet safe, access to the stomach without a laparotomy [39]. But first several steps had to be worked out, primarily how to achieve the approximation of the stomach to the abdominal wall without sutures. Would a catheter alone suffice? What kind of catheter? How could it be placed? Would it be safe? What problems might be encountered? After many “what ifs” and exploring many possibilities, I had a plan, a method, a catheter, and a patient. The procedure proved my hypothesis that it could be both simple and effective. It was also acceptably safe. Given its simplicity and reproducibility, it could also be easily performed by non-surgeons. This early minimally invasive procedure led to a paradigm shift. It also established a new principle: the sutureless approximation of a hollow viscus to the abdominal wall. As very young attending surgeons, neither I nor Dr Jeff L. Ponsky, who helped with the endoscopy, could ever have imagined the extraordinary growth of this procedure,

whose acronym, PEG, is now practically synonymous with gastrostomy [40]. Percutaneous endoscopic gastrostomy is an example of how a new concept can be developed with simple, readily available material resources.

- The gastrostomy “Button” is based on the observation that the traditional, long gastrostomy tube was responsible for a number of undesirable problems and complications, and that there was no good reason why access could not be provided by a skin-level device [41]. When I initially approached representatives from the industry, I was told (more than once) that there was no market for such a device. I convinced one of my surgical residents, Dr George J. Picha, who also had a degree in bioengineering, of the advantages and the potential for such an invention. We made several prototypes and doggedly pursued the project. We obtained a patent and Dr Picha eventually built a company that had its start with the Button. Today, the term *Button*, which I chose because it was child friendly, is applied to all skin-level gastric access devices. This development demonstrates why one must persevere in the pursuit of one’s convictions.
- Insertion of a Broviac-type catheter through a peel-away sheath, instead of the previously done cut-down, was based on the observation that in another specialty, radiology, the colleagues started to use the newly developed Seldinger method and the sheath for angiographic access [42]. We applied it to children of all ages and even convinced one of the manufacturers to make ultra-thin Broviac catheters and peel-away sheaths for the insertion in the smallest of premature babies. This method is an example of transfer of available technology from another specialty to one’s own. When my colleague Dr Thomas A. Stellato and I submitted our subclavian puncture approach to *Surgery Gynecology and Obstetrics* (a journal that had a section devoted to technical innovations), it was rejected. We promptly submitted it to *Surgery*, a publication that seldom prints techniques. It was readily accepted because the reviewers recognized the importance of this contribution. More than 1 year later, the journal that rejected our technique published a flurry of variations of our original approach. This is an example of why one cannot be discouraged by an initial rejection. A reviewer who is unfamiliar with the subject may not fully appreciate the importance of an innovation.
- The “Penny-Pincher” technique for the removal of coins from the upper esophagus of children is based on the observation that the flat, round foreign body is nearly always in the same anatomical location [43]. The tip of a simple grasping device, when introduced in the oropharynx, will invariably reach the same site, allowing grasping of the coin under

fluoroscopic control without general anesthesia or traditional endoscopy. Developed with Dr James M. DeCou, this is an example of modifying an existing device and using it for the same purpose in a totally different manner.

- During a Ramstedt pyloromyotomy for hypertrophic pyloric stenosis, the most common complication is mucosal perforation by the tip of the applied spreading instrument, a hemostat or similar device. By using double-pronged skin hooks and applying these to the muscular layer, away from the mucosa, spreading is improved and the danger of accidental perforation nearly eliminated [44]. Here is an example of how one can use a readily available instrument to perform a task that is different from the one for which it was originally designed.
- With the Pediatric Surgical Logoscript (a graphic-pictorial approach to medical terminology), I intended to add a little lightheartedness to otherwise serious descriptions of surgical conditions of childhood [45]. The poster presentation at a previous meeting of this society and subsequent publication in a journal prove that some program committees and editors have a sense of humor.

I will conclude this presentation with 3 questions:

1. What have I learned about creativity?
2. How can we encourage our peers to take advantage of their creative potential?
3. What critical questions should we ask ourselves as health care providers?

## 2.1. What have I learned about creativity?

- Conceiving and developing a new procedure or a new device is exciting. But the process also teaches some hard lessons. Do not be reluctant to champion your ideas, protect your accomplishments, and accept recognition. Someone else will take over if you do not, and take your ideas in directions you never intended.
- Guiding a medical device from conception to packaged product is a long and often frustrating process. Frequently, the interests of the originator and the interests of the industry do not overlap. For this and other reasons, planning ahead, preferably with the guidance of experienced counsel, is highly desirable.
- For individuals to become successful in their creative pursuits, peers, superiors, and the institution’s administration must believe in what the investigator is doing and what they seek to achieve.
- The availability of a “sounding board,” colleagues, or other supportive individuals with whom new ideas can be openly discussed is an invaluable asset.
- Tenacity and perseverance are essential.

- Limited financial resources need not inhibit creativity.
- Often, simplicity leads to great effectiveness.
- Family support is a powerful enabling factor.

## 2.2. A couple of additional thoughts

- Creativity in the medical fields must be encouraged in all institutions where physicians are trained [19]. The emphasis needs to be on medical students and residents. To this effect, George E. Moore stated, in a January 1960 editorial in *Surgery Gynecology and Obstetrics*: “For maximum creativity the habit of imaginative thinking should thus be established as early as possible” [46]. Although there are numerous examples of creative work done in the later years of life [2,47], almost all of these researchers “were creative when they were young and merely continued to be productive” [46]. Fortunately, a less hierarchical and more cooperative milieu is now common in many contemporary surgical services [26,48-50]. It has long been recognized that institutions that foster creativity and innovation are more likely to provide an exciting working environment.
- Innovators need to be identified, nurtured, and protected. In addition, assistance, including time, should be offered to those creative minds willing to embark on a journey of discovery [51,52].
- The importance of a mentor cannot be overemphasized. Mentoring benefits both the mentor (whose activities must be recognized and rewarded) and those guided [25]. In fact, successful academic mentors increasingly now list the name of those mentored with their biographical information.
- Because young investigators are usually without proper direction, institutions that train physicians should provide guidelines on how to take a concept from the inception to development, to publication and beyond [53-56]. Recently published “how to” books, articles, and panels for young investigators can provide a helpful initial “boost” [10,57-60].
- The relevance of the role of innovation in the surgical field has been recently exemplified by the November 2006 issue of *Seminars in Pediatric Surgery* [58] and by the dedication of 43 pages of the February 2008 issue of *Surgery* to this topic [61].

## 2.3. How can we encourage our peers to take advantage of their creativity potential?

- We could approach it with a little humor and say that there are people who make things happen, there are those who watch things happen, and then there are those who wonder what happened. Obviously, the first group will have the most fun. The creative instinct is certainly present, to varying degrees, in every

individual. There is even convincing evidence that creative activity can be learned or, at least, enhanced [1,5-7,10,62]. Therefore, an environment must be created in which individuals have the freedom to explore, are encouraged to do so, and are given the encouragement and the tools necessary so they can rise to their full potential. Such encouragement should start early in the medical career, preferably in medical school [46,60].

- Some of the myths about research need to be dispelled. Creativity has a place in many settings, and discovery encompasses a large spectrum. “Little” discoveries can have a significant local impact and, at times, make their way into the medical literature. They may even change the way we all practice.
- Although modern medico-surgical environments are highly controlled and regulated, and many procedures are standardized to achieve maximal patient care and safety, there will nevertheless always be room for innovative improvements.
- The advent of minimally invasive surgery 2 decades ago is a good example of how dramatic, far-reaching innovation in our field can originate outside the traditional university environment.
- We must urge our colleagues not to let a good idea fall by the wayside. An interesting concept or device kept in a drawer will probably eventually see the light of day—but with someone else’s name under an article’s title or on the label of a medical product package.
- I believe we can safely state that intellectual curiosity and creativity maintain the mind sharp, the profession fresh and interesting, and help keep one’s field of work exciting. The addition of research, be it clinical or bench based, allows us to participate in the “intellectual dialogue.”
- We need to convince our peers that, even though creative activity and research may not be pure fun, they are nevertheless a most fulfilling experience. As Louis Pasteur stated: “[Creativity is] the eternal aspiration of human reason toward knowledge of the unknown—the joy of discovery is certainly the liveliest that the mind of man can feel.”

## 2.4. What critical questions should we ask ourselves as health care providers?

- When contemplating innovation related to established techniques and devices, the main question should be: “Can these be simplified, retaining or increasing their safety and effectiveness?”
- When considering new techniques and devices, the question must be: “Is there a real need?” “Is it really an improvement or are you doing it just so you can publish another paper?” and “Who benefits from it?”

- If, as physicians, we take the patient's perspective (as we all must), the question is clear: "Do these innovations meet the guidelines for ethical research?"

In closing, a final word of encouragement.

Yes, there are obstacles to the full unfolding of the potential for creativity we all possess. Yes, there are hurdles to be overcome, starting with our own inhibition, time availability, and financial constraints, all the way to an ever-increasing barrage of bureaucratic rules and regulations. But no, we must not wait until told: "Look, we have removed all the barriers, you may be creative now!" We as health care providers must find our way around these obstacles. We can, because as pediatric surgeons, we are driven, we are creative, and we have a very clear goal: to improve the treatment of the children entrusted to our care!

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