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Critical (Intensive) Care Medicine and CPR

A Personal History By Max Harry Weil

MAX HARRY

MAX HARRY (✉)
Well Institute of Critical Care Medicine
North Westrn University
Medical School Chicago, Illnois
Keck School of Medicine of the University
of Southern California, LA, California
35100 Bob Hope Drive
Rancho Mirage , CA – 92270, USA
Phone: 1 760-778-4911
Fax: 1 760-778-3468
E-mail: weilm@aol.co

ABSTRACT

I perceive that the most consitent pursuits of successful innovators and leaders in medicine, as in all endeavors, come from aspirations generated by dreams rather than hope or by fate alone; from the excitement with which the dreamer atracts collaborators who have prepared minds and skillful hands; they join talents and destinities to convert the dream to expert plans.Contigent on the vigor, the persistence and on the attention to detail with which they commit to the execution of their plans, the secure the advances that contribute to the social goods and bring ultimate success to all who have jioned destinies to seriously pursue those dreams.

Key words: cardiopulmonary resuscitation, critical care medicine, intensive care medicine, history, progress, future

More than fifty years ago when the late Dr. Herbert Shubin and I began what became critical care medicine, monitoring and life support interventions which we now accept as routine were at best experimental. The routines of hemodynamic and blood gas monitoring, and even mechanical ventilation outside of the oprating theater were controversial.Transvenous cardiac pacing had just started. This was still in the area of oxygen tents, the iron lung, and the intermittent positive pressure (IPP) devices. The segregation of critically ill patients into discrete units was limited to very special services like Shock Units that began under our uaspices at USC in 1958 and in 1961, Coronary Care Units. In 1960, the remarakable report by Kouwenhoven, Jude and Knickerbocker ushered in the area of closed chest cardiac resuscitation. The following decades have extended critical care monitoring and interventions from medical and surgical Intesive Care Units to neurology and neurosurgery, neonatology, pediatrics, obstetrics and gynecology, trauma surgery, and emergency medicine.

With astounding speed, the monitoring of cardiovascular function and especially the early detection and competent management of major cardiac arrhythmias in coronary care units followed by acute coronary interventions, led to remarkable increases in survival after acute myocardial infarction. Hemodynamic monitoring, initially with central venous catheters was followed in the early 1970s by the introduction of flow directed, balloon-tipped Swan-Ganz catheters. Multi-purpose, multi-lumen catheters became available for percutaneous peripheral and central venous, pulmonary artery, and arterial cannulation. Together with disposable pressure transducers and micro-processor-controlled amplified display and recording systems, the routines of pressure measurement were greatly facilitated. However, both the value and the risks of vascular invasion have been reassessed and increasingly more competent non-invasive options are rapidly gaining dominance. Transcutaneous pulse oximetry, expiratory capnography, ultrasound, including echocardiography, Doppler for pressure monitoring and both pulse wave based and impedance based techniques for estimating cardiac output have evolved. Within the most recent five years, we are witnessing a de-emphasis on the macrocirculation, more concern with the delivery of vital substrates to tissues, and a clear call for better understanding of the microcirculation and cell viability. The availability of orthogonal polarization spectral imaging of the sublingual mucosa opened a new era of microcirculatory measurement on acutely ill patients. There were giant advances in airway management, volume assisted, pressure supported and controlled ventilation, airway pressure controls, elective hypercarbia and recognition of the problem of respiratory muscle fatigue. Extracorporeal oxygenation was initially disappointing but re-emerged for transitional management of life-threatening lung failure especially for newborn and pediatric patients but more recently more selectively also for adult patients. Digital processors, initially used in our unit in 1962, have revolutionized both data acquisition and data management in support of computerized medical recording. Sophisticated interventions with fluid challenge, vasoactive drugs, and vasodilator agents to moderate preload and afterload are widely used. In some instances, vasoconstrictor drugs and adrenergic inotropes are still unproven therapeutic options for management of life-threatening circulatory shock and heart failure. More specific coronary interventions evolved, including acute administration of anti-platelet and thrombolytic drugs, angioplasty and stents. Mechanical support of the failing circulation was initially facilitated by balloon counterpulsation techniques and mechanical hearts are in increasing use, both for transition to cardiac transplantation and very recently, for permanent implantation.

New techniques for diagnosis came to the fore, applicable to pediatric, obstetrical and neonatal patients, including arrhythmia detection and in-utero measurements, computerized axial tomography, radionuclear including PET scanning and both magnetic resonance and sonographic imaging. Impaired immuno-responsiveness due to HIV but also in critically ill and injured patients more generally, is well recognized.

The understanding of mechanisms of cardiac arrest and options for cardiopulmonary resuscitation have changed substantially, witness the major changes in the International Guidelines and the newly recognized de-emphasis on routine ventilation. In our Institute, our laboratory and engineering research has had a special emphasis on CPR after the sudden death, while hiking, of our colleague and co-leader, Dr. Herbert Shubin in 1975.

With respect to CPR including defibrillation, mechanical chest compression, together with early definitive intervention, especially for the majority of coronary artery based caused of cardiac arrest, we see opportunity for increasing resuscitation and meaningful survival. Most, importantly, the most impressive outcomes result from very well organized and exercised programs starting with bystander initiated CPR followed by out-of-hospital diagnosis and management, including automated chest compression, in-hospital triage for coronary interventions, and intensive post-resuscitation management, including hypothermia.

In part based on our research, pharmacological interventions for CPR were reassessed and especially the potentially harmful effects of sodium bicarbonate, lidocaine and calcium salts. Even epinephrine is undergoing reassessment. The overriding benefits of precordial compression to improve forward blood flow have led to new mechanical chest compressors. Hypothermia for post-resuscitation management is now a routine practice. External defibrillators are increasingly more sophisticated for prompting CPR interventions, recognizing both the need and the optimal timing of shock delivery. Such verbally and visually direct "Resuscitation Sequences" such as to serve as comprehensive "Resuscitation Boxes".

Advances in the treatment of infectious diseases were spurred on by the availability of a continuing stream of new antibiotic, antifungal and antiviral formulations. Risks to health care workers after exposure to hepatitis, HIV and the tubercle bacillus during patient management, and the imminent threat of pandemics, witness the emergence of swine and H1N1 influenza viruses. Newer options for prevention of iatrogenic malnutrition and the roles of micronutrients were recognized together with the value of early enteral alimentation with less enthusiasm for parenteral nutrition. For better understanding of multi-organ failure, the roles of infection, free radical scavengers and cytokines have been carefully explored but major breakthroughs in management of septic shock based on these intermediates are still awaited.

Understanding of management of Sepsis, Septic Shock and Multi-organ Failure is largely by consensus with as yet incomplete understanding of mechanisms other than management of the underlying infection. Recombinant human activated protein C (drotrecogin alfa), may be a therapeutically appropriate intervention, but only for the most severely ill. Bioterrorism has become an actual and global threat together with awareness of a greatly expanded need for preparedness for other mass disasters.

The management of brain and spinal cord injuries has been substantially improved. The importance of both abdominal and extremity compartment syndromes has been recognized. Transcutaneous tracheostomy at the bedside has largely replaced conventional surgical tracheostomy and percutaneous gastrostomy has favored early enteral feeding with less risk of aspiration. The laryngeal mask airway has become a standard for emergency management of the airway under crisis conditions, increasingly discarding out-of-hospital endotracheal intubation.

The methods of intracranial pressure monitoring have been improved. There is a new awareness of the adverse effects of multiple drug interventions and the variable drug clearances in critically ill patients, which is in part genetically determined. Transfusion of blood and blood products are ordered with greater care. Unfortunately, the alternative of administering recombinant erythropoietin has not clearly improved outcomes over red cell transfusions in critical care settings. Sublingual PCO_2 measurements, though not widely available as yet, have potentially unique advantages as an indicator of tissue hypoxia, also for triage in Emergency Departments. The human, social, economic, and legal issues, which have had a major imapct on the practice of critical care medicine, are both complex and threatening. Health care delivery systems in the United States impose complex and consuming rules on physicians. Outcome measures and evidence based protocols are unquestionably important so that there may be a more objective basis for the use of costly resources. Technologically formidable and costly diagnostic and therapeutic interventions in the United States are often utilized to avoid legal liabilities even though conscientious clinicians may be secure that there is often greater likelihood of adverse effect than benefit. The professional roles of physicians, nurses, pharmacists, physician assistants, and other allied medical personnel specializing in the care of the critically ill are continually changing. Critical care specialists are now recognized on par with other medical and surgical subspecialists in industrialized countries. The shortage of such specialist has requested that some of the skills are extended to nurse practitioners, physican's assistants and especilla physicians with shortterm training in the specialty. In the United States, the reality is that the modern hospital is becoming one large Intensive Care Unit or groupings of specialized Intensive Care Units. Other patients are directed tou out-patient services. Full time intensivists assume responsibility on a 24-hour basis for a larger number of patients. The model of »shift« presence in the United States was pioneered by emergency physicinas and also by trauma surgeons who themselves are some of the best intesivists. We also recognize the increasingly greater need of specialists in critical care nursing, hospital pharmacy, clinical engineering and bedside technology as well as clinical ethicists who share in the decision-making process for management of the critically ill. We are increasingly altered to to the risks of medical and nursing errors in the complex settings of critical care and their high human and economic costs.