Evolution of out-of-hospital emergency cardiac care: Heart attack therapy for a retired president helped modernize American emergency medical services

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ABSTRACT

In the late 1960s, American emergency medical services (EMS) began to upgrade from mere Red Cross first aid to systems that now provide sophisticated advanced life support. This revolution in EMS stemmed from two pioneering Belfast reports in *The Lancet* that described how early out-of-hospital coronary care saved lives. Inspired, a handful of American physicians implemented avant-garde programs in the USA. One such physician, Richard Crampton of the University of Virginia, supported by the university and by Charlottesville–Albemarle Rescue Squad staffs, led an early effort to provide out-of-hospital drug treatment and defibrillation via a mobile coronary care unit (MCCU) ambulance. Half a dozen high-profile local cases, including successful treatment of retired President Lyndon B. Johnson, demonstrated MCCU efficacy to the Virginia and American public via local and national press coverage. The economic feasibility of the MCCU system was established. With two Virginia colleagues, Crampton successfully lobbied for a bill to permit trained nonphysicians to render out-of-hospital cardiac care with no on-site physician. This MCCU-augmented EMS system reduced coronary deaths in Charlottesville and Albemarle County, Virginia. It also stimulated nationwide progress in care by EMS systems that yielded countless lives saved in the succeeding half-century.

KEYWORDS Charlottesville; emergency medicine; Lyndon Baines Johnson; mobile coronary care unit; University of Virginia

A half-century ago, American prehospital emergency care bore no resemblance to ambulances today staffed by paramedics and emergency medical technicians (EMTs). In this era before 911 systems, ambulances were hearses, limousines, and station wagons usually operated by funeral homes. No medical attendant monitored the patient in the rear coffin compartment. The sole healthy individual aboard was the driver. Although several Virginia towns had rescue squads, first responder skills never exceeded Red Cross first aid, which in that era never included skilled cardiopulmonary resuscitation (CPR).

Meaningful change began after the two Pantridge and Geddes reports in 1966 and 1967.^{1,2} The mobile coronary care unit (MCCU) based at the Royal Victoria Hospital in Belfast, Northern Ireland, saved lives by early drug treatment and defibrillation. After he read these reports, Richard Crampton,

founder-director of the hospital coronary care unit (HCCU) at Lenox Hill Hospital, New York City, visited the Royal Victoria Hospital to meet Pantridge and Geddes and to ride in the Belfast MCCU. Inspired, he surmised that an MCCU added to emergency medical services (EMS) systems could significantly reduce community cardiac mortality rates in the USA.

Months earlier, several American physicians had acted after the Belfast reports. In 1968, William Grace led the way with St. Vincent's Hospital's MCCU care in New York City. Physicians Leonard Cobb in Seattle; Leonard Rose in Portland, Oregon; Eugene Nagel in Miami; and Michael Criley in Los Angeles updated EMS care adapted from the Royal Victoria Hospital MCCU. Cobb taught CPR and defibrillation to Seattle firemen. Criley did likewise for Los Angeles. Nagel trained Miami firefighters in CPR before the Pantridge reports and added defibrillation to the fire service's

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capabilities after reading the Belfast reports.³ In Portland, Rose became the first American physician to introduce CPR and defibrillation to the private, fee-based Buck Ambulance Company. Rose's program burst into national publicity when the Buck ambulance staff successfully defibrillated Portland's mayor in his office and later Mr. Buck, owner of the ambulance company (R. Crampton, diaries, 1968–1975). In parallel, Costas Lambrew taught CPR beyond fire rescue services to the Nassau County Police, Long Island, New York.

After his return from Belfast, Crampton sought a trial mid-Manhattan-based MCCU at Lenox Hill Hospital. However, the trial was rejected based on imagined costs and beliefs that an MCCU would not reduce cardiac mortality. This refusal prompted Crampton to accept associate professorship at the University of Virginia (UVA) School of Medicine and directorship of the UVA HCCU in June 1969. Less than a year after arrival, Crampton urged creation of a community MCCU system following his analysis of local cardiac mortality rates, which yielded a theoretical model that predicted that early MCCU care would reduce community coronary mortality by 17% (R. Crampton to G. Spence, written communication, September 15, 1970).

SETTING UP A TRIAL MCCU

Crampton and UVA resident physicians partnered with the Charlottesville–Albemarle Rescue Squad (C-ARS) to bring an MCCU to Charlottesville and Albemarle County. Staffed solely by volunteers, C-ARS provided community-wide emergency ambulance care at no cost. Because personnel were solely trained in Red Cross first aid, Crampton taught all C-ARS members American Heart Association standard CPR using the Laerdal mannequin Resusci Anne in 1970.⁴ Next, Drs. Ken Wallenborn, Lesley Rudolf, and Crampton certified every C-ARS volunteer in the 80-hour emergency medical technician (EMT) course, a rarity at the time. In May 1970, the first major step to an MCCU came when the C-ARS board of directors approved a trial. C-ARS Squad Surgeon Ken Wallenborn informed Crampton: “It is our understanding that this [MCCU] will be set up on a 6-month trial basis, and that if it works out satisfactorily, we would hope to continue this” (K. Wallenborn to R. Crampton, written communication, May 11, 1970).

Assisted by friend and colleague William Grace, Crampton secured funds for the MCCU trial with a Charles A. Frueauff Foundation grant of \$15,000 (K. R. Pawson to R. Crampton, written communication, October 9, 1970). With grant support, Crampton appealed to the UVA HCCU resident physicians, whom he asked to staff the MCCU. Luckily, the resident physicians were amenable and the C-ARS–UVA MCCU team was formed.

With Frueauff funds, Crampton equipped the MCCU with a LifePak33 defibrillator (in use by Seattle Fire Department) from PhysioControl for \$3890 and a Biophone to view electrocardiograms (ECGs) for \$5000 (Purchase

Orders, December 29, 1970). Next, the C-ARS–UVA team rehearsed emergency cardiac care with new MCCU equipment (*Figure 1*).

TELEPHONE TRIAGE FOR MCCU ACTIVATION

After equipping the MCCU, the C-ARS–UVA HCCU team devised an activation protocol. Because no 911 emergency phone system yet existed, the public summoned emergency care via C-ARS's highly publicized phone number. C-ARS dispatchers then alerted HCCU personnel via a conference phone line. Once connected with HCCU staff for triage, “the CCU nurses ‘screened’ with brief interviews of callers to determine if the symptoms described were sufficiently like those of a cardiac emergency to warrant a MCCU response” (UVA Department of Internal Medicine, internal memo, January 13, 1971). If HCCU personnel suspected that the patient had a possible coronary event or cardiac arrest, they mobilized the MCCU. First, if HCCU staff identified the patient as potentially suffering a coronary event, two rescue workers drove from the C-ARS depot to the UVA emergency department (ED), where they collected MCCU equipment and the HCCU resident physician. While EMTs spent 5 minutes en route, ED nurses assembled MCCU equipment: the LifePak 33 battery-powered

Figure 1. A staged event raised public awareness of mobile coronary care units. Charlottesville–Albemarle Rescue Squad and University of Virginia staff demonstrated use of a portable defibrillator carried by a resident physician to a collapsed construction worker. Photo courtesy of *The Daily Progress*.

monitor-defibrillator, a foot locker containing a battery-powered ECG recorder and suction apparatus, intubation and intravenous access equipment, and a drug box with pre-loaded syringes of lidocaine, atropine, epinephrine, morphine, pentazocine, and naloxone (UVA Department of Internal Medicine, internal memo, January 13, 1971). A second MCCU telephone triage protocol applied when the patient was identified as in cardiopulmonary arrest. In this case, two units were dispatched from C-ARS. The first ambulance drove to the ED for the physician, equipment, and drugs and the second went directly to the scene to start CPR before the MCCU's arrival.

DEALING WITH ADVERSITY

Issues arose that forced updates to the EMS system to improve quality of care and speed up workflow. Personnel shortages were major issues from a quality of care standpoint. When the MCCU trial began, "the service was limited to 118 (70.2%) hours per week. No pre-hospital coronary care service was available from 8 AM to 6 PM Monday through Friday."⁵ Crampton's year-long effort to attain round-the-clock MCCU service was only achieved in April 1972.⁵ This upgrade was provoked by local, national, and international publicity of the MCCU care provided to retired President Lyndon Baines Johnson (LBJ).

Dire staffing needs also changed MCCU care. Crampton wrote to John Harlan, UVA hospital director: "We really need support from the nursing service. ... On several occasions, nurses responded to a MCCU physician's request, and there is no question that their presence in two instances made the difference between life and death" (R. Crampton to J. Harlan, written communication, October 25, 1971). Unfortunately, nurses who honored requests from physicians to assist in the field were denied salary for the EMS hour spent out of hospital because the UVA nursing service had not granted them permission to leave the hospital. Crampton wrote to Dr. E. W. Hook, chair of the UVA Department of Medicine, to advocate both use of expert nurses in the field and their fair compensation for critical care work. To bolster his argument, Crampton described the actions of one of the finest coronary care unit nurses:

Mrs. Harriet Ross under the supervision of Dr. Carl Friedman accompanied the [MCCU] team to the Farmington Hunt Club where they encountered a 58-year-old man in ventricular fibrillation (VF) from acute myocardial infarction. As 300 members of the public looked on, our patient's repetitive VF needed 8 DC shocks to maintain life. Mrs. Ross, Dr. Friedman, several on-looking physicians in the crowd and C-ARS EMTs effectively resuscitated, gave stabilizing drugs and attained the patient's long-term survival and return to work. Dr. Friedman and C-ARS EMTs especially noted that Mrs. Ross's skills assured the patient's survival. The UVA Nursing Service docked Mrs. Ross's pay for her hour of absence from UVA Hospital. She was forced to list one hour less than she actually worked that day. (R. Crampton to E. W. Hook, written communication, November 8, 1971)

Pressure from Harlan and Hook forced the UVA nursing service to pay nurses' salaries for their time working in MCCU service.

MCCU CARE OF RETIRED PRESIDENT LYNDON B. JOHNSON

The following narrative is derived from the C-ARS dispatch log and call report, Crampton's daily handwritten diary, and daily staff notes in the UVA hospital chart.

The phone rang me awake at 3:45 AM on Friday, April 7, 1972. After I said, "Hello," a Mr. Charles Robb asked: "Are you Dr. Crampton?" I replied, "Yes." Robb requested my help for his father-in-law, who he knew had a history of heart attack and who was having severe chest pain. I sleepily growled, "What's your father-in-law's name?" He replied, "Lyndon Johnson." I sat bolt upright as I recalled news stories that the former President Johnson had a heart attack in 1955 in rural Northern Virginia while majority leader of the US Senate.

Robb gave directions to his Farmington house, 5 miles from C-ARS, UVA Hospital, and my house. I phoned the C-ARS dispatcher. We used our dedicated conference connection to UVA HCCU to activate the MCCU. I raced off in my old 122-S Volvo wagon. As I sped to Farmington, the full moon shone and I wondered whether this was possibly a hoax call. I felt somewhat reassured as the flashing lights of the C-ARS MCCU appeared in my rearview mirror. They tailed me up the driveway to the Robb house. On arrival, I grabbed my doctor's bag, leapt from the car, and ran quickly toward the front door. As I trotted through the trees on the lawn toward the front door, I saw half a dozen men in dark suits scattered about, and I wondered whether they were Secret Service. I hoped that they would not slow my arrival by stopping me to ascertain who I was.

Our wee hours, predawn team included C-ARS EMTs Lynwood McCauley and John R. Miles, also a medical student; as well as Dr. Robert Harris; Deaton Smith, a third-year medical student; and myself. We found President Johnson sweating profusely with chest pain radiating to the left shoulder and neck. When chest pain had awakened him at 2:30 AM, he took an antacid and six sublingual nitroglycerin tablets without relief. Examination disclosed a blood pressure of 165/90 mm Hg, no jugular vein distention, a regular heart rhythm with premature beats, a forceful apex beat, a loud fourth heart sound, a single second sound, no murmur, no friction rub, and rales at both lung bases. He quickly responded to our intravenous morphine 4 mg injection and oxygen by mask. Next, intravenous lidocaine 100 mg abolished his R on T early coupled ventricular premature beats. His 12-lead ECG showed anterior Q waves with ST segment elevation indicative of acute anterior myocardial infarction (*Figure 2*). On the spot, LBJ's wife Lady Bird wisely phoned Dr. J. Willis Hurst of Atlanta so that we could discuss LBJ's cardiac history. Hurst had cared for LBJ during his 1955 heart attack and recalled it as inferior

Figure 2. Bedside home electrocardiogram showing acute anterior myocardial infarction, with new anterior Q waves in leads V2–V4; elevated ST segments of acute anterior myocardial injury in leads I, aVL, and V2–V6; and reciprocal depression in leads III and aVF.

infarction. Thus, we both realized that LBJ had a new site of acute infarction.

Half an hour after intravenous morphine treatment, LBJ felt so improved that he declared that he did not wish to go to the HCCU for further care when advised that it was the next therapeutic step. His family tried to intervene, but he remained sturdily reluctant. LBJ then asked me directly: “Doc, what care could I get in a HCCU that I have not already received right here in my bedroom?” A deep silence fell upon the crowd of family, emergency personnel, and Secret Service. Not a whisper was heard. I sensed that I had just unwittingly elicited one of LBJ’s legendary one-on-one confrontations that had marked his storied political career. I knew well that he had often thwarted opposition by meticulous reasoning and overcome contrapositions by his formidable powers of personal persuasion.

My answer: “Mr. President, there is absolutely nothing we can do for you in the HCCU that we have not already done for you right here in your daughter’s house.” But I added: “As long as our EMS remains here to care for you at home, 80,000 people in our 745 square mile ambulance district will not have their heart attack service available should they need the type of urgent care that you are now receiving.”

LBJ replied immediately. “All right, Doc, I’ll go.” Signs and sighs of relief flowed from every face in the bedroom, not to mention my own personal ease. After we placed LBJ into the MCCU, we transported him to the UVA HCCU where he was monitored and cared for by UVA nursing and medical staff until he departed to Brooke Army Hospital in San Antonio, Texas.

AERIAL TRANSPORT TO TEXAS

On April 11, 1972 (hospital day 5), LBJ insisted upon returning to San Antonio. His wish for hospital privacy from “newsies” had been carried out. As we prepared him for the

flight, he said, “Doc, send me your bill.” I responded: “Mr. President, I cannot bill you as you created Medicare for the American people.” Current President Richard Nixon arranged Air Force One to transport LBJ with Hurst and me aboard as airborne MCCU staff. We hid his departure from UVA Hospital by exiting from the psychiatry wing, and we moved him via the C-ARS MCCU to Air Force One at the Charlottesville–Albemarle Airport. PhysioControl kindly lent us a LifePak 33 defibrillator so that the C-ARS MCCU stayed equipped with its defibrillator while Hurst and I monitored LBJ’s heart rhythm with the loaner LifePak during flight. Air Force One flew LBJ, Hurst, and me to Lackland Air Force Base with the MCCU equipment. We asked that the aircraft fly no higher than 10,000 feet to minimize oxygen loss. After landing, we moved LBJ to the presidential suite of Brooke Army Hospital. After farewell to LBJ and before flying home, I called the C-ARS–UVA MCCU staff to note that the recorded distance between UVA and Brooke Army Hospitals measured 21 ventricular premature beats thanks to oral procainamide treatment.

As expected when a former president experiences a health crisis, the press churned out a substantial number of reports. The *New York Times* printed several pieces on LBJ’s care. One was headlined “Improvement in Johnson’s Condition Credited to Emergency Care by Mobile Coronary Unit.”⁶ This, coupled with later successes and community cash donations, bolstered our local MCCU. The flurry of media coverage depicting how MCCU care dealt smoothly with LBJ’s coronary event spread the MCCU concept to Virginia and the USA. Thus, Frank Pantridge’s legacy that upgraded American EMS care was further aggrandized.^{7,8}

Many hoped that LBJ might address the future UVA commencement when his son-in-law Charles Robb would receive his law school degree. Tragically, this did not happen. LBJ died suddenly at home in early 1973. In his stead, Lady Bird Johnson spoke at the 1973 UVA commencement and gifted her UVA travel expense check to the MCCU.

FURTHER EVOLUTION OF OUT-OF-HOSPITAL EMS CARDIAC CARE

When added to the international publicity garnered by the MCCU care of LBJ, several prior local, dramatic, and highly publicized MCCU DC shock life-saves had also fortified the importance of the MCCU teamwork to the public and engendered more national support for MCCU care. Crampton voiced several public service radio announcements. The local newspaper, *The Daily Progress*, printed MCCU publicity pieces (*Figure 1*).

In February 1975, the *American Journal of Medicine* printed Crampton’s analysis of the first 3 years of MCCU operation.⁹ These statistics showed that the MCCU service lowered community cardiac mortality in the Charlottesville–Albemarle region and reduced community coronary death rates, a feat that the two local HCCUs had not accomplished (*Figure 3*).^{10,11}

Figure 3. Yearly coronary deaths from 1971 to 1973. Mobile coronary care units lowered age-specific deaths outside the hospital. Community age-specific and total deaths fell also. By contrast, coronary mortality rose 6% in areas of Virginia not served by a mobile coronary care unit.⁷

Crampton noted, “Unquantifiable influences included pre-hospital relief of ischemic chest pain, correction of acute dysautonomia and abolition of otherwise pre-fatal dysrhythmias.”⁹ Clearly, the influence of the MCCU could not be measured solely by CPR-defibrillation life-saves. Crampton concluded, “Since pre-hospital CPR, ventricular defibrillation and emergency cardiac drug care cheaply and effectively expedited and abbreviated hospitalization for acute myocardial infarction and lowered community death rates from coronary artery disease, MCCU care adoption in the USA and western world seems justified.”⁹ Thus, Pantridge’s legacy passed more EMS milestones because nearly all American ambulance services now provide focused emergency cardiac care. Charles Wilson’s elegant community study of MCCU efficacy in reducing coronary deaths in Ballymena, Northern Ireland, confirmed the Central Virginia assessment.^{9–13}

COST-EFFECTIVENESS AND PERSONNEL CHANGES

To prove MCCU efficacy in community service, Crampton ascertained its economic viability.¹³ He noted that yearly cardiac life-saves netted over \$175,000.¹³ The C-ARS–UVA partnership was unusual in that C-ARS provided free ambulance service and its EMTs received no compensation. Public donation was the only C-ARS financial support. The only unique MCCU-based costs came from drug and equipment prices and salaries of hospital staff. Although this system was clearly unrealistic for most EMS systems in the USA, the dramatic economy of useful life-saves drew attention to MCCU care and the Pantridge EMS legacy continued to grow.^{7,8}

Because hospital personnel were the major source of MCCU costs, Crampton worked with Drs. Andrew Dickinson of Virginia Beach and Lewis Baird of Richmond for methods to reduce these EMS expenses. They lobbied the Committee of the Courts of Justice of the General Assembly of Virginia to permit trained cardiac EMTs to perform cardiac intensive care in the field with radio supervision by a physician. The legislature amended the section of the Code of Virginia and permitted qualified persons to perform

“emergency CPR, cardiac defibrillation or other emergency life-sustaining or resuscitative treatments or procedures which have been approved by the State Board of Health to any sick or injured person” free from liability.¹⁴ Virginia’s cardiac EMT program, still extant today as EMT–Intermediate Certification, developed thanks to this legislation. The amendment to the Code of Virginia removed the expensive requirement to have physicians or nurses in the field and furthered the economic appeal of the MCCU concept.

The Virginia State Board of Health EMS Committee, of which Dickinson and Crampton were members, developed a basic curriculum that set minimum requirements to train persons in prehospital coronary intensive care. Once state requirements were set, Crampton worked with C-ARS to train the first Virginia cardiac EMTs to serve the region. He required the communication systems used by C-ARS to add real-time contact with HCCU physicians. For this he turned to Frank P. Hunter, the leading biomedical engineer at UVA Medical Center. Hunter successfully modified the Biophone (originally designed for ultra-high-frequency use only) to work with the very high-frequency system in the C-ARS ambulances. With this addition, EMS field personnel could speak to HCCU staff via radio with concurrent ECG transmission. Crampton also insisted that cardiac EMTs communicate directly with HCCU physicians and never with ED staff. In that era, the highest trained UVA ED staff were junior surgical residents with little knowledge of ECG interpretation or therapy for cardiac emergencies. Captain Robert Jaskiewicz, a past president of C-ARS, recalled his Biophone use: “The doctors received the information and told us what drug intervention was needed. We became essentially an extension of the HCCU.”¹⁵

By 1975, Biophone use had profoundly changed MCCU responses that reflected independent action by cardiac EMTs. If two cardiac EMTs and one standard EMT were on call to go directly to the emergency scene, they now responded without a physician (UVA Department of Internal Medicine, unpublished departmental guideline, February 2, 1977). With the new EMS protocol with cardiac EMTs in service, the MCCU equipment moved to the C-ARS depot where a dedicated new MCCU ambulance was stationed. C-ARS personnel no longer collected doctors, nurses, drugs, and equipment from the UVA ED. This change gradually phased out physicians and nurses in the field as more cardiac EMTs were trained.

CONCLUSION

Analysis of local data indicated that a significant number of community sudden coronary deaths came from out-of-hospital cardiac arrests. The opportunity to treat these cardiac arrests successfully impelled the addition of the MCCU to the extant EMS system. As in Seattle, Crampton added citizen CPR classes taught by C-ARS members and by UVA premedical students to increase life-saves. Essential building blocks for the MCCU system included training EMTs in

cardiac care technology and drug treatment in the field. During the MCCU trial, C-ARS volunteers and UVA HCCU staff worked together in out-of-hospital settings, including the treatment of President Johnson for an acute myocardial infarction, which garnered this fledgling system international press attention and helped usher in the era of emergency cardiac care in the USA. This relationship gradually saw the removal of physicians and nurses in the field as C-ARS members became certified as cardiac EMTs and paramedics. The MCCU addition to the Charlottesville–Albemarle EMS system lowered out-of-hospital ambulance and coronary death rates and reduced age-specific community coronary deaths. Lowered coronary deaths in this community MCCU trial showed how the model MCCU system created by C-ARS–UVA teamwork expedited development of the nationwide out-of-hospital cardiac EMS that we have today.

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