# Misadventures in Health Care

## INSIDE STORIES

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# 9 The Intensive Care Unit May Be Harmful to Your Health

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## INTENSIVE CARE UNIT ATTENDING PHYSICIAN, WILLIAM JONES, M.D.

*Dr. William Jones, the attending physician in the intensive care unit (ICU), works 5 days a week, is well paid, does not have to pay loans, and is in good health. His medical training was in anesthesia; he has had experience working in the ICU. He enters the ICU at 7 a.m. relaxed and confident to start another day. The minute he enters the ICU, he is exposed to its unique and noisy environment, the 10 patients he left just 12 hours ago, and the need to update himself on the condition of each of those patients plus the two who arrived in the ICU in the last hour. He begins to read the large amount of information on the patients' charts. The nurses are doing their rounds.*

*Within 5 minutes of Dr. Jones' arrival in the ICU, the radiology department requests the transfer of a patient for a computerized tomography (CAT scan) that must be organized immediately. He must complete his review of the charts and his evaluation of the medical condition of the each of the patients, be it stable, changed, or perhaps hopeless, in which case ethical measures must be taken. Based on the information from the charts, he issues new orders for the care of each patient. He has not finished issuing those orders when a call comes from the emergency room notifying him that a patient in critical condition is being sent for admission to the ICU. This presents a problem for Dr. Jones because criteria for admission of patients to the ICU are not well defined.*

*The broad screening criteria for admission states that patients should be accepted who are likely to die within 24 hours yet have a good chance of recovery if admitted to the ICU; however, no bed is available in the ICU for this new patient. Although beds frequently are made available for new patients by transferring ICU patients to standard hospital wards, from the information Dr. Jones has read during the brief time he has been on the ICU, there appears to be no clear candidate for transfer to a standard ward. Nonetheless, he gives the new patient a general examination to determine need for ICU care. After the examination and diagnosis, Dr. Jones negotiates an ICU bed for the new patient, records his orders on a special form specifying the manner of respiration, the rate of administration of fluids and medications, the posture in which to place the patient, special treatments, and requests for consultation and tests. The execution of the orders is the responsibility of the nursing team. Dr. Jones takes a deep breath and returns to issuing orders for treatment for the other ICU patients as he experiences the first pain of a migraine headache.*

Thus even if a care provider arrives for work in a calm mood and good health, within a very short period the conditions in the ICU can cause overwhelming demands sometimes incompatible with human performance. Such demands can and do affect performance of care providers—performance that impacts patients, as in the case of Dr. Jacob Butcher.

*Dr. Jacob Butcher was a successful surgeon in a local hospital not far from the capital city. He was the typical doctor as seen in the old movies. Like Dr. Ben Casey, he was hardworking and devoted to his patients. As he was reading one evening, with no warning, he suffered excruciating pain in his abdomen. He diagnosed himself as having pancreatitis; within 48 hours, he was admitted to the ICU of the hospital in which he practiced. Twenty-four hours later, he was transferred to the ICU of a major medical center. This is where our story begins. Unlike a classic detective story, I will disclose at the beginning how this story ends. Dr. Butcher was discharged from the hospital after a 3-month stay and currently is functioning normally.*

*When Jacob Butcher arrived as a patient at the ICU, he had a blue endotracheal tube in his mouth that was attached to a portable ventilator that pumped air into his lungs, thus breathing for him. Suspended above his head were seven different bags of fluids and drugs that he was receiving; all the plastic tubes leading the fluids of life into his veins were tangled on the bed. Locating the origin of each plastic tube required the expertise of a weaver; Nurse Roth managed to unravel the tangle. Because the automatic syringes that controlled the flow of medications were not in use during the ambulance transport, it was necessary to verify which tube was connected to what bag.*



*The bags contained some drugs in concentrations that were not used in this particular ICU, so it was necessary to prepare the proper dose. Nurse Bates added 2 ampoules of Dopamine, a drug administered to maintain blood pressure and strengthen the heart muscle, to the 500 ml of saline, as was the usual practice. From this bag, she filled 200 ml into a special reservoir that protects the patient from getting too much fluids or drug. She removed the bag from the referral hospital, substituted the one she had prepared, and attached it to the intravenous (IV) infusion pump, a computer-chip-based device that is programmed to regulate the flow of fluids by controlling the drops. Ten minutes later, Dr. Butcher's blood pressure rose to 190 and his heart rate accelerated to 166—both abnormally high. The alarms on the monitors sounded, indicating something was wrong. To the nurse's surprise, the 200-ml container of Dopamine that was to be administered slowly during 20 hours ran out within minutes. This was a new model of the infusion device that looked the same as the older models but was programmed differently. After the drug was discontinued, Dr. Butcher's heart rate went down to normal and his blood pressure returned to its previous value. During this time, he was fully sedated with an intravenous drug and did not feel a thing.*

*Later in the afternoon, Dr. Butcher's lab results came in; they were very strange. His BUN, the level of urea in the blood that reflects the functioning of the kidneys, was three times higher than the previous reading from the referral hospital. His potassium reading was at a level almost incompatible with life. Mr. David Blecher in Bed 2, a patient with chronic renal failure, received the best lab results ever—namely, normal BUN and normal potassium. This was not due to the care he received; rather it indicated a mix-up of names when labeling the test tubes containing specimens from the two patients.*

*There were no more alarming events on the first night; however, during the morning rounds, Dr. Butcher's chart indicated he was not producing enough urine. A fluid load (increase) was immediately ordered. Later, when the nurse from the morning shift recalculated the total urine output using a calculator, unlike the night shift nurse who had done all the calculations in her tired head, she realized that 2.450 + 1230 does not equal 1213. The physician on duty promptly cancelled his order for the extra fluids.*

*A few days later, the oxygen saturation level, as measured from the tip of the finger via a pulse oximeter (an optic, noninvasive detector) fell from 99% to 84%, which was an alarming sign. Dr. Butcher's chest x-ray was normal; the endotracheal tube was placed in the proper position through his mouth to his lungs enabling ventilation. A careful physical examination revealed no abnormal findings. The team on the afternoon shift discussed a few theories about the causes of the low oxygen saturation reading for Dr. Butcher.*

*On a routine check, the respiratory therapist discovered that the oxygen concentration knob, a small, almost unrecognizable, knob on the wall oxygen outlet,* *a knob lacking any safety features to avoid unintentional position change, was not at the proper setting. Without saying a word, he set it to the correct position and Dr. Butcher's saturation level returned to normal. The problem with the knob confirmed what the medical staff had been trying to communicate to the hospital administration—that the oxygen outlets on the walls are old and can cause problems; they are accidents waiting to happen. The administration continued to state that it is too expensive to install new ones, so from time to time, an incident like this happens.*

*A very unusual event occurred on the 52nd day of Dr. Butcher's stay in the ICU. That event involved Osmolite, a special, tasteless nutrition solution that supplies necessary nutritional elements to the patient who cannot eat. Osmolite is fed via a nasogastric (NG) tube going from the mouth or nose into the patient's stomach. On this occasion, the bag containing the Osmolite that was to go into Dr. Butcher's stomach was inadvertently substituted for the IV nutrition solution that was connected to a tube inserted into the patient's central vein instead of the NG tube. At the last minute, the head nurse, who just happened to be passing by, noticed this and avoided a very serious incident.*

*Throughout Dr. Butcher's stay in the ICU until he left the unit, there were more potential incidents. For example, some drugs continued to be administered for a few days after orders to discontinue them had been given. This was discovered on one occasion at the beginning of an afternoon shift when Dr. Ben, the resident during the morning shift, said he thought he had ordered discontinuing a particular drug; the nurse on duty swore that she had never received that order. There was no time to determine why the confusion happened because rounds were resumed in response to pressure to release the morning team so they would not miss their ride on the transportation provided by the hospital.*

*On another occasion, antibiotics were given twice. Fortunately, there were no adverse side effects. Other errors included administering too high and too low dosages of vasoactive drugs (medication that affects blood circulation), leaving a urinary catheter in place for 3 hours rather than a few minutes, and failing to diagnose pneumothorax (a common complication of ventilated patients where air enters the tissues surrounding the lungs and disturbs ventilation unless it is evacuated via a chest drain), which can be easily diagnosed through chest x-rays. Fortunately, most of the errors were discovered before they caused any real damage and what did happen had no lasting affect, so Dr. Butcher survived his stay in the ICU.*

Is this a true story? The patient is real. All of the events actually did occur. Indeed, one to two potentially serious incidents per patient per day in the ICU are attributed to error (Donchin, Gopher, & Olin, 1995). If not discovered in time, they could be fatal. Why is this rate so high? How can anyone survive? To



answer these questions, let us consider the origin of the ICU and its evolution to the contemporary, technologically sophisticated ICU.

## ORIGIN AND EVOLUTION OF THE ICU

The first person to propose that patients who had undergone surgery require specialized facilities and particularly dedicated care was Florence Nightingale, the legendary pioneering nurse (Smith, 1951). She recognized that the prevention of common complications resulting from surgery, namely vomiting and respiratory distress, necessitated the uninterrupted monitoring of postoperative patients. In her day, such monitoring could be accomplished only by intensive and constant personal surveillance. It required the meticulous and frequent checking of the patients' vital signs, such as the pulse rate, the character of the respiration, and color of the urine. The vigilance she proposed demanded a nursing staff specially trained to recognize, by sight and touch, the signs of postoperative distress. That component of competent, intensive care for the seriously ill patient stands in stark contrast to the type of intensive care that is provided today.

Acknowledgment of the need to gather all critical-care patients into one unit within the hospital followed the success of the individual pioneers who started resuscitating patients and treating severe diseases of the lung (Hall, Schmidt, & Wood, 1992). Initially, the ICU was a single room containing a respirator to ventilate patients who are unable to breathe, a monitor to record their heart rate, and most importantly, trained nurses to operate these complicated devices. In the first years following formal establishment of the ICU, the basic physiological and medical principles for treatment of critical patients were elaborated. Development of increasingly complicated surgical procedures that may last hours, such as open-heart and brain surgery, created the need for expanded supervision of patients, including intensive observation both during and post surgery.

Anesthesiologists were the first to apply their expertise to the ICU environment. This is reasonable because the patient in the operating room is basically in a one-bed ICU where the anesthesiologist provides intensive care for that patient during crucial moments of surgery. The anesthesiologist's responsibility for the patient's physiological integrity includes maintaining respiration by controlling the ventilator, blood pressure by regulating the flow of drugs, and temperature by using a heating mattress. By following their patients from the operating room to the ICU, it became possible for the anesthesiologists to continue to supervise their care in the postoperative period. In some hospitals, anesthesiologists who had become interested in the field assumed responsibility for the ICUs. In other hospitals, proactive surgeons left their operating rooms to establish ICU services. Physicians specializing in pulmonary physiology, as well as surgeons or anesthesiologists, depending on the initiative of the particular hospital, were appointed to supervise ICUs.

### Specialized ICUs

As pressure to transfer patients from overburdened hospital wards to ICUs rapidly increased, specialized ICUs came into being to address the needs and requirements of various categories of patients and medical specialties. Neonatal ICUs care for premature newborns, usually in incubators; pediatric ICUs provide care for children from a few weeks of age to puberty. There are ICUs for the treatment of burn victims, ICUs for neurosurgical patients, and ICUs for patients suffering spinal injury. There also are ICUs that monitor patients admitted with acute myocardial infarction (heart attack) and those with arrhythmia (irregularities of the heart beat). All of the ICUs are equipped with sophisticated medical devices.

### Sophisticated Medical Devices

To ensure that the sophisticated devices function optimally, technicians trained to service and maintain them are included in the staff of ICUs. In addition, the physical setting of the ICU is adapted to respond to the devices' needs for continuous supplies of medical gases, sterile water for dialysis, adequate electrical outlets and an uninterrupted supply of electricity, appropriate lighting, and a reduced level of noise. New areas of ICU specialization evolved within the various physician and nurse specialties. Those ICU specialist caregivers adapt to the conditions of the ICU by ingesting large amounts of information, much of which comes from sophisticated devices.

***Information from Sophisticated Devices.*** It is crucial that the physician knows what drugs the patient is taking and understands the effect of such medication on the results of laboratory tests, as well as their influence on the heart, lungs, and blood vessels of the patient. The physician also must have access to all the data regarding the patient's on-going condition such as blood pressure, heart rate, urine output, body temperature, and much more. Can a human being with limited memory remember so many details, analyze all the possibilities, and arrive at a proper conclusion for the 6 to 12 ICU patients who must be treated simultaneously (Abramson, Wald, & Grenvik, 1980)? Before we answer this question, let us visit the ICU of a large, teaching hospital, the ICU in which Dr. Butcher was a patient. Please cover your clothes with the special ICU gown and shoe covering. Just press the code number on the door to open it and you are in.



## VISIT TO AN ICU

As soon as we enter the ICU, we see 12 patients in special beds in a large room. The majority of patients in this ICU are postsurgery. There also are young patients who sustained major trauma and those who suffer from disease that damaged their ability to breathe—all in critical condition. The physical layout of ICUs is not uniform. In some hospitals, ICU patients occupy private rooms (cubicles); in others, patients occupy a large hall-like ward. The place where the medical staff actually provides intensive care to a patient, the standard working station of the ICU, consists of the patient's bed surrounded by an area approximately twice the size of the bed. This area contains the equipment required to monitor and treat the patient. This machine-dominated setting contrasts with that of the standard hospital ward, where the furniture surrounding the patient's bed accommodates the patient's personal needs.

### Bed No. 6

Let us visit Bed No. 6. Although not a very human approach, patients are referred to by their bed number to simplify and expedite matters when conducting ICU rounds. As you can see in Fig. 9.1, equipment is placed both above and beside Bed No. 6; most of it is attached to electrical outlets in the adjacent wall. Patients in the ICU are dependent on life-sustaining machines that continuously pump potent drugs into their veins and artificially breathe for them. The various medical devices are mobile to facilitate the transfer of the patient to other locations within the hospital or within the ICU.

***Equipment.*** Above the bed is a machine that monitors the patient's vital signs. Data from various sensors located on the patient's skin or intrusively introduced into his blood vessels or heart are brought to a central screen that, as in an airplane cockpit, graphically displays the vital information. This information includes the tracking of the patient's cardiac status from an electrocardiogram (ECG) and graphic representations of the electronic measures of pressure in the arteries, the level of oxygen saturation in the blood measured by a pulse oximeter, the level of carbon dioxide in exhaled breath via capnography, and the body temperature. Additional devices such as the Swan-Ganz catheter that measures the filling pressure of the heart and a mixed venous saturation probe also may be present, thus increasing the information displayed on the screen. Although the monitor stores the data it gathers, nurses customarily use pencil and paper to record that information on a chart that is kept on or beside the patient's bed.

FIG. 9.1. Bed 6 in the ICU at the Hadassah Hebrew University Hospital, Jerusalem, Israel.

Equipment located at the bedside falls into two categories: input equipment that supplies fluid and medications to the patient and output equipment that removes the patient's secretions from the stomach, chest, abdomen, and urinary tract. Also at the bedside in some cases, special equipment substitutes for or supports body functions such as a dialysis machine to substitute for a nonfunctional kidney and haemofiltration equipment to purify the blood from an overdose of drugs or dangerous levels of electrolytes in the blood, or a balloon pump to support a failing heart. These devices are attached to the patient with tubes and to wall outlets by electrical cables. There may be as many as 30 tubes exiting and entering a patient's body.

A wall outlet near the patient's bed in the ICU supplies both oxygen and compressed air to allow the preparation of different concentrations of oxygen to be administered to the patient via the respirator. Plastic tubes carry the mixture of oxygen and air from the outlet into the patient's lungs via pressure generated by the respirator. Many electrical outlets that provide power for the various medical devices also are on the wall. As all the tubes and wires are gathered at the same location—the patient—they intermingle like macaroni, hence the unofficial term *macaroni syndrome* as shown in Fig. 9.2.



Augmenting the harshness of the setting is the presence of an alarm that beeps and a light that flashes on each piece of equipment. The alarms sound at a rate of 1 to 5 per minute. In a six-bed ICU with many alarms sounding simultaneously, the noise can be irritating and identifying the source of an alarm can be difficult. In addition to the numerous, sometimes noisy machines and the plethora of tubes, cables, flashing lights, and beeping alarms, strong lighting in the ICU is mandatory 24 hours a day. A conscious patient, surrounded by the cacophony of ICU sounds that resemble white noise and the relentless light, can experience a form of sensory deprivation that is manifest as ICU psychosis. The congested and overwhelmingly artificial work setting, as well as the small area

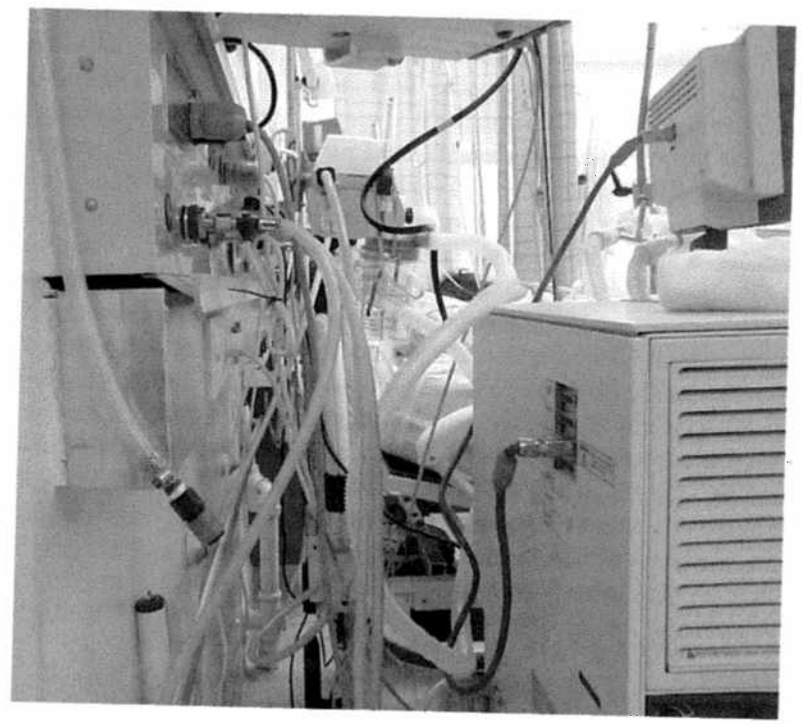

FIG. 9.2. The *macaroni syndrome* of tubes and wires from a patient's medical equipment.

surrounding the bed of the critical patient, is further taxed by the presence of nurses, physicians, and other allied personnel who need to access the patient, as well as members of the patient's family.

## ICU MEDICAL STAFF

During hospitalization in the ICU, patients are treated by a large number of health care personnel: one or two nurses per bed and one to three attending physicians as well as the intensivist, the ICU specialist who is the ICU director and guides colleagues and residents as well as consultants. More nurses are needed for patients in separate cubicles. Physiotherapists, respiratory therapists, radiology technicians, and other technicians also may be part of the team.

### ICU Nurse

Nursing care is a crucial part of the ICU. The nurses not only carry the main burden of the daily work, but they also are responsible for the continuity of memory about the patients and the uninterrupted transfer of information about the day-to-day changes within the unit as well as the follow-up of the critically ill. Without the nurses, there is no intensive care. Technology without experienced nurses has absolutely no value. Nurses in the ICU are assigned to specific patients, usually to one or sometimes two patients, unlike the physician who is responsible for 10 to 20 patients at a time. Although there are official ICU nursing procedures, the dynamics of intensive care inevitably prompts many deviations.

In addition to executing the physician's orders, the ICU nurse is responsible for collecting and recording information about the patient such as respiratory rate, which is measured by using an instrument as well as by direct observation. The nurse must keep abreast of many parameters on the monitors: the heart rate and the shape of the ECG, the blood pressure waveform, the central venous pressure, body temperature, and oxygenation, to name only a few. When required, the nurse must respond immediately and must record and date in the patient's chart all the data generated by the monitors; the nurse also is responsible for ensuring that the potent medications used in the ICU are administered in precise dosages. Any deviation can be dangerous to the patient.

## ICU AS THE TEMPLE OF TECHNOLOGY

The hospital ICU is dedicated to the care of the seriously ill patient. ICUs typically are equipped with the most advanced medical technology and are intended to provide patients with the best medical care available. Nevertheless, care in the ICU has been found to expose patients to substantial risk resulting from the limited ability of the persons working in this environment to cope with both the technology and the enormous amount of data presented to them. To respond to a change in the medical condition of each patient, as in the case of Dr. Butcher, the attending physician must have access to the patient's medical history, which often is very long and complicated.



### Impact of Technology

Contemporary caregivers are required to know the patient primarily as a set of numbers and laboratory results. Part of the daily care of the patient involves routine nursing procedures that make the difference between an ICU and a regular ward. Although it is the continuity of care that is of the utmost importance, the medical staff needs to simultaneously observe both the trends of the data and the patient's appearance and mental condition. It is absolutely necessary to pay strict attention to details that escape the monitoring system and can only be detected by good, old-fashioned, clinical observation. No monitor or device will supply information regarding a red irritation or reaction at the site of an infusion. There is no substitute for the meticulous observation of the patient's skin; only a clinician can discover that the patient is waking up from a deep coma. Nonetheless, the emphasis is on information provided by technologically sophisticated medical devices and tests.

Not only do the demands of technologically supplied information restrict the time available for clinical observations, but the continuous flow of data which must be integrated with other data such as laboratory test results, background information, previous diagnosis, care plan, and medication can cause information overload. That overload results in an inability to efficiently use all of the information available about the patient's state (Sukuvaara & Koski, 1995).

Whereas the early caregivers had to observe, talk to, and touch patients to stay abreast of their health status, today's ICU caregivers mainly refer to data provided by the technologically sophisticated devices that monitor patients. ICU personnel familiarize themselves with the physiological status of patients such as heart regularity from the ECG, blood pressure from invasive intra-arterial cannulae (tubes placed in an artery), and the qualities of the blood from the sophisticated flow-directed balloon as well as the Swan-Ganz catheter. Despite its importance, interaction between the medical staff and the patient is purely a matter of personal preference constrained by available time.

### Physical Environment

The physical environment of the ICU can be detrimental to optimal care (Donchin et al., 1995). The area around the patient's bed is congested by instruments, monitors, wires, and IV lines. This often complicates access to the patient's head, which creates problems of identification and status assessment as well as airway access in case of a rapid change in condition. Means of providing care such as tubes, fluid bags, and drugs typically are insufficiently marked or have labels that are difficult to read (Donchin et al., 1995). The forms for recording information often are not designed specifically for the needs of the ICU, which forces many staff members to improvise and develop their own style. Other forms can be inappropriate in terms of layout and clarity of display.

## Stress

The medical staff in the ICU works under considerable stress due to the harsh time constraints imposed by the immediacy of the patient's condition. They must wage a constant battle to preempt the development of ever more urgent conditions such as hemorrhaging and cardiac failure, and to prevent the rapid deterioration of the patient's condition due to severe sepsis. Sepsis, a life-threatening infection, is the most dangerous threat to the life of the patient today. Microbes are very efficient and formidable foes.

It is not possible to converse with most patients in the ICU as they are either heavily sedated, under the influence of medication, or they need to be mechanically ventilated by a respirator which breathes for them, as in the case of Dr. Butcher. Being ventilated prevents a patient from talking because air from the respirator travels via the endotracheal tube bypassing the vocal chords. For those patients who cannot verbally describe what is wrong or regulate their fluid intake and urine output, the ICU physician, the intensivist, must use readings from various monitoring devices to serve as those patients' regulatory functions.

The ICU patient's physiological vital signs displayed on the monitor can change at a very rapid pace; it is crucial to discover such changes as soon as they take place. For example, in the ICU it is essential to follow the patient's blood pressure from second to second. As a pilot in the cockpit must continuously observe the instruments that provide vital flight data, the ICU medical staff must continuously observe the monitors of their patients' vital signs. This is in contrast to internal medicine ward patients for whom physiological changes typically are so gradual that it is acceptable to measure blood pressure every 6 hours.

The rapid pace of gathering data for diagnostic purposes is characteristic of the activities in the ICU, such as the daily recording of more than 30 important parameters. These include all the measurements taken by the nurse, from the blood pressure and heart rate to the hourly output of urine. The ability of the personnel to respond on short notice to the rapidly changing condition of the patient requires the prompt analysis of the data and the swift execution of tests and other related activities. Orders written on admission of the patient to the ICU may be



invalid within a brief period. The ICU physician needs and expects test results immediately, whereas the physician in the internal medicine ward is satisfied to receive the results of tests taken in the morning in time for the evening rounds. In the ICU, consultation with specialists occurs as soon as the need is identified. Prompt and appropriate responses to changes in the patient's condition are necessary to avoid further deterioration (Sexton, Thomas, & Helmreich, 2000).

Technological developments have occurred to meet the need for immediate test results. A machine the size of a small television set has been created that, when stationed within the ICU and operated by members of the ICU team, can provide results of electrolytes and blood gases in a matter of minutes from the analysis of a few drops or a teaspoon of blood. That machine, the blood gas analyzer (BGA), has revolutionized postoperative patient care. Rather than sending blood samples to various laboratories in the hospital and waiting hours to get the results, the patient's haemodynamic status (the condition of the heart and circulation), oxygen concentration in the blood, the level of acidity in the tissues, as well as lung and kidney functions, can be accurately ascertained within a few minutes using the BGA.

***Technology and Stress.*** Staff in the ICU function under considerable stress, pressured by time constraints imposed by the immediacy of patients' needs and the battle to preempt the natural progression of urgent conditions such as rapid deterioration due to severe sepsis, hemorrhage, and cardiac failure. In addition, the work environment is noisy and crowded—conditions that cause stress. It is increasingly acknowledged that traditional ICU working conditions impose an untenable degree of mental and physical stress on the medical personnel who staff them; such stress undermines the quality of care that they are able to provide. Much of the stress has been traced to the actual physical environment in which intensive care is administered.

The rapid, spontaneous development of intensive care technology over the past 40 years has generated an extraordinarily harsh environment that is incompatible with the human needs of health care personnel. The dedicated caregivers who initiated intensive care could not have anticipated the direction that management of critical patients would take. Their successors, captivated by the evolving potential of technological devices to save or prolong lives, are oblivious to the increasingly alienating work environment that rampant technology has been creating for providers of intensive care.

## Communication

Nurses in the ICU are assigned to specific patients. Work in the ICU is carried out in three shifts, and each change of shift requires transfer of a great deal of detailed information about the patients. The content of that information is vital to the course and outcome of patient care, so effective communication and transfer of information between doctors and nurses is critical (Donchin et al., 1995). Nurses have closer and more continuous monitoring of each patient than do physicians. By serving as an active liaison, they can help doctors bridge information gaps and avoid confusion.

In the training environment, proper communication and exchange patterns can enable residents and students in the unit to learn conventions and routines from the accumulated experience of nurses. Often, however, a lack of effective information exchange in verbal communications occurs between ICU physicians and nurses. This has been a factor in one third of reported errors (Donchin et al., 1995). This is surprisingly high considering that verbal communications between physicians and nurses were observed only in 2% of the activities.

### The Human Factor

About 40 years after the introduction of technological monitoring in ICUs, attention has turned to the human beings who provide care in the intensive care environment and how that environment may affect them. It was only after the best pilots of the Royal Air Force in England demonstrated an alarming degree of fatigue and incompetence that a thorough examination of the cockpit was conducted. Factors that contributed to those conditions were identified and many necessary changes were made. A similar examination of the conditions in the ICU finds error-provoking factors.

The reality is that ICU caregivers are social beings. Although they appreciate the value of the information readily produced by the various inanimate, technologically sophisticated devices on which their attention must be focused, their minimal human needs are not met in the pervasively artificial setting of the modern ICU. To meet those needs as well as reduce the likelihood of error through miscommunication, it is necessary to create an atmosphere of continuous communication between the different teams. Until that occurs, the ICU that gave life to so many people may be dangerous to the patients.

## ICU AS A LABORATORY

The ICU may be considered as a large laboratory because the continuous monitoring and meticulous recording of critically ill patients' functioning allows the examination of those patients' responses to drugs and the immediate physiological effects of treatment. For example, physiological measurements done in the ICU and in the laboratory demonstrate that during the state of shock, there is no



blood supply to the tissues, and adding drugs that cosmetically increase blood pressure contributes to deepening the deleterious effect of shock. As a result of that better understanding of the mechanism of shock, physicians are more tolerant of short periods of hypovelomic shock or low blood pressure due to bleeding, and administer blood and fluid to restore blood pressure rather than a drug to force a higher value. Indeed, because of this better understanding of shock, use of medications such as Isoproterenol to increase blood pressure has been withdrawn.

Based on the ability to accurately measure on-going physiological parameters, the physician is able to discover and respond to signs of deterioration in the patient's condition by providing logical and supportive treatment before it is too late. Hence, intensive care has become increasingly proactive. By measuring and recording, every hour, the patient's urine output as well as the volume of clear fluids and other intake such as food and drugs, it is possible to accurately balance and repair any deficit by increasing or withholding the fluid administration every few hours. Working in the ICU has been compared to the work of a pilot and to that of an air traffic controller. Although there is no basis for comparison of tasks, the level of responsibility—that of caring for the lives of others—is similar, as is the potential for error and the dire consequences of mistakes occurring in these highly charged circumstances.

## ERROR

It was clear from our visit to the ICU that the physical setting of the ICU and its accouterments are not friendly to the medical team and are likely to contribute to error. For example, illegible print on IV bags presents, in a similar uniform manner, important information as well as unimportant details required by law. Even on close scrutiny, deciphering whether a solution contains 5% or 15% glucose is difficult. This is dangerous because administering 15% glucose to a patient with high blood sugar may have very deleterious consequences. Similarly, the identification of containers of potassium that could cause considerable damage to patients is not clear. Strict regulations regarding the storage of potassium were developed to avoid the fatal consequences of the erroneous administration of this dangerous drug. Despite best efforts by ICU personnel, errors can occur.

More errors per hour occur during the day than at night because more active care and procedures are performed during the day, hence more opportunities for error. When taking into account the typical instability of the medical status of ICU patients and the complex and demanding task of physicians and nurses, an overall error rate lower than 0.5% percent, of which only 29% were rated severe (Donchin et al., 1995), may be considered a very high and reliable level of performance. Given the critical condition of the patients and the large number of daily activities per patient, the percentages compute to two errors with the potential for a severe adverse outcome per patient per day. This is a matter of concern.

It is not surprising that in the 1980s, reports about mistakes in the ICU began to appear in literature describing the stress experienced by ICU staff (Merrill & Boisaubin, 1981). The most common errors reported were related to the administering of medications. (Tissot et al., 1999). Although this indicated an urgent need for a major research initiative to identify factors that contribute to error, fear of legal prosecution for admitting to errors inhibited its development.

## HIGH VISIBILITY—HIGH COST

Hospital administrators have mixed feelings regarding the ICU. On one hand, it is the flagship of the hospital, the place to bring the mayor or other distinguished guests. It is also the temple of technology, the pride of the organization. On the other hand, the costs of maintaining an ICU are extremely high. When the hospital management wants to lower expenses, a good place appears to be the ICU. For example, the number of nurses at the evening shift might be reduced; however, such intervention is likely to decrease the effectiveness of the ICU.

If instead of one nurse per patient, the ratio is increased to one nurse per 1.5 patients, not only will the quality of care be different, but the workload will be heavier and the team more prone to errors. It is no wonder that in order to perform the 1,001 tasks for which nurses are responsible, they will try shortcuts that may work only part of the time. Attempts to cut costs in the design of a new ICU are also not realistic because it is very difficult to design a new ICU in an old building. The ICU requires space, personnel, and money.

### ICU Ethical Dilemma

Controversy continues to rage regarding issues such as the criteria for admission of patients to the ICU, for ceasing treatment of critical patients, and for initiating or withholding treatment in the first place. The average length of stay in the ICU is from 4 to 7 days; Dr. Butcher's stay was exceptionally long. The ICU mortality rate of 20% would be considered extremely high for a regular hospital ward. That 20% mortality rate for an ICU, however, means that instead of a 100% mortality rate for 100 critically ill patients who would die without ICU care, 80 are saved; only 20 die. This underscores the importance of the ICU.

The rapid pace of unchecked technological development that enables prolonging life by maintaining some patients on a ventilator for years raises ethical issues that the medical establishment did not anticipate and for which they are not prepared. The ethical dimension of critical care has been elaborated, analyzed, and well documented (Oppenheim & Sprung, 1998; Sprung, Eidelman, & Pizov, 1997). Indeed, medical ethics has become field of study in its own right. Nonetheless, profound ethical questions confront ICU personnel.



Should a cancer patient without hope for improvement be maintained on a ventilator? Would that prolong the patient's life or misery? A diagnosis of brain death authorizes disconnecting a patient from the ventilator; however, a family that refuses to have the patient disconnected could keep a young person who might be saved with ICU care from being admitted because that ICU bed is unavailable. Should a patient with no hope of surviving be sent to the department of internal medicine where supervision is not as meticulous as in the ICU? Should a few more monitors be purchased or the budget stretched to hire more nurses who are more beneficial to the patient but more expensive (Nyman & Sprung, 1997)?

## CONCLUSION

Health care providers have become accustomed to the encroachment of technology; however, people entering an ICU for the first time as visitors may feel they have entered the control room of a nuclear power plant where technology dominates. After a few moments, they observe that human beings are connected to all those wires and understand they are in a hospital—a place where technology and medicine are working together.

The ICUs of hospitals are locations dedicated to the care of the seriously ill patient. Typically, ICUs are equipped with the most advanced medical technology and are intended to provide patients with the best medical care available. Nevertheless, care in the ICU has been found to expose patients to a substantial risk resulting from human error. For example, unintentional disconnection of the endotracheal tube from the ventilator will stop the patient's breathing and cause irreparable damage; therefore, every machine is equipped with alarms to alert others to this unfortunate event. Because of the number of machines that alarm and because most alarms sound the same, it is often difficult to identify the device emitting the alarm, which can delay correcting the problem.

The development of advanced technology has been the primary focus of efforts to provide the best care possible to critically ill patients in the ICU, but the human factor has been greatly neglected. It is increasingly acknowledged that traditional ICU working conditions impose an untenable degree of mental and physical stress on the medical personnel who staff the facilities. The source of much of the stress has been traced to the actual physical environment in which intensive care is administered (Donchin et al., 1995). This stress undermines the quality of care that they are able to provide.

The physical environment also can stress the patients if they are conscious. To provide quality care, the medical staff must be acutely conscious, which heightens the impact of the conditions of the ICU, their work setting, on them. The rapid development of intensive care technology has produced an extraordinarily demanding environment that is incompatible with the human needs of health care personnel as they provide treatment for the sickest of patients. Thus, the ICU that has given life to so many people may be harmful to the care providers as well as the patients.

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# 10 Challenges and Adverse Events in the Home

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## HOME HEALTH NURSE, MRS. JEAN LOWE, R.N.

*Mrs. Jean Lowe, R.N., completed her baccalaureate degree in nursing a year ago. She had been working as a home health aide for 3 years when she decided to become a registered nurse. She needed a stable income; she received minimal child support from her ex-husband for her children ages 12, 14, and 16. Registered nurses were making over $50,000, so Jean, at 35 years of age, pursued her degree and professional licensure for the financial security needed to assist her children with college. It took several years to complete the degree because it was necessary for her to work while she attended classes. Because she had worked as a home health aide for so long, Jean felt confident in her home care clinical practice skills and knowledge after her licensure so she joined a private for-profit home care nursing company (WECARE) in San Diego.*

*Because WECARE Home Health Nursing Services was known among nurses to pay substantially higher hourly rates than other companies, Jean found she could double her income through extra overtime by working 12-hour shifts 6 days a week. Although her paychecks were substantial, Jean found that after she paid for her children's needs, the mortgage, living expenses, and college investment plans she had little left. There was a major nursing shortage so she had the opportunity to supplement her income by working seven 12- or 16-hour shifts at least twice a month, which she did.*