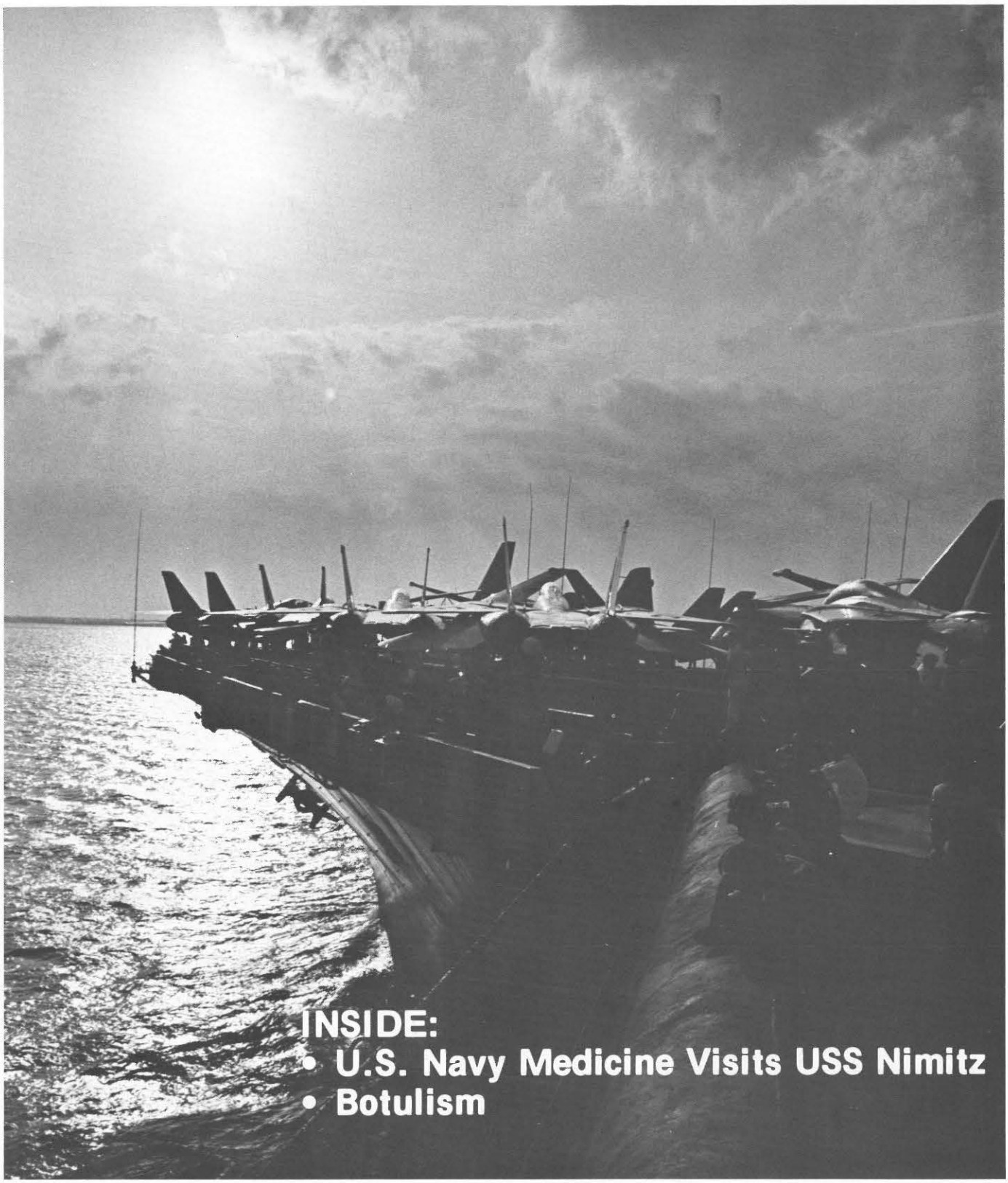
U.S. NAVY MEDICINE

July 1981



INSIDE:

- U.S. Navy Medicine Visits USS Nimitz
- Botulism

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U.S. NAVY MEDICINE

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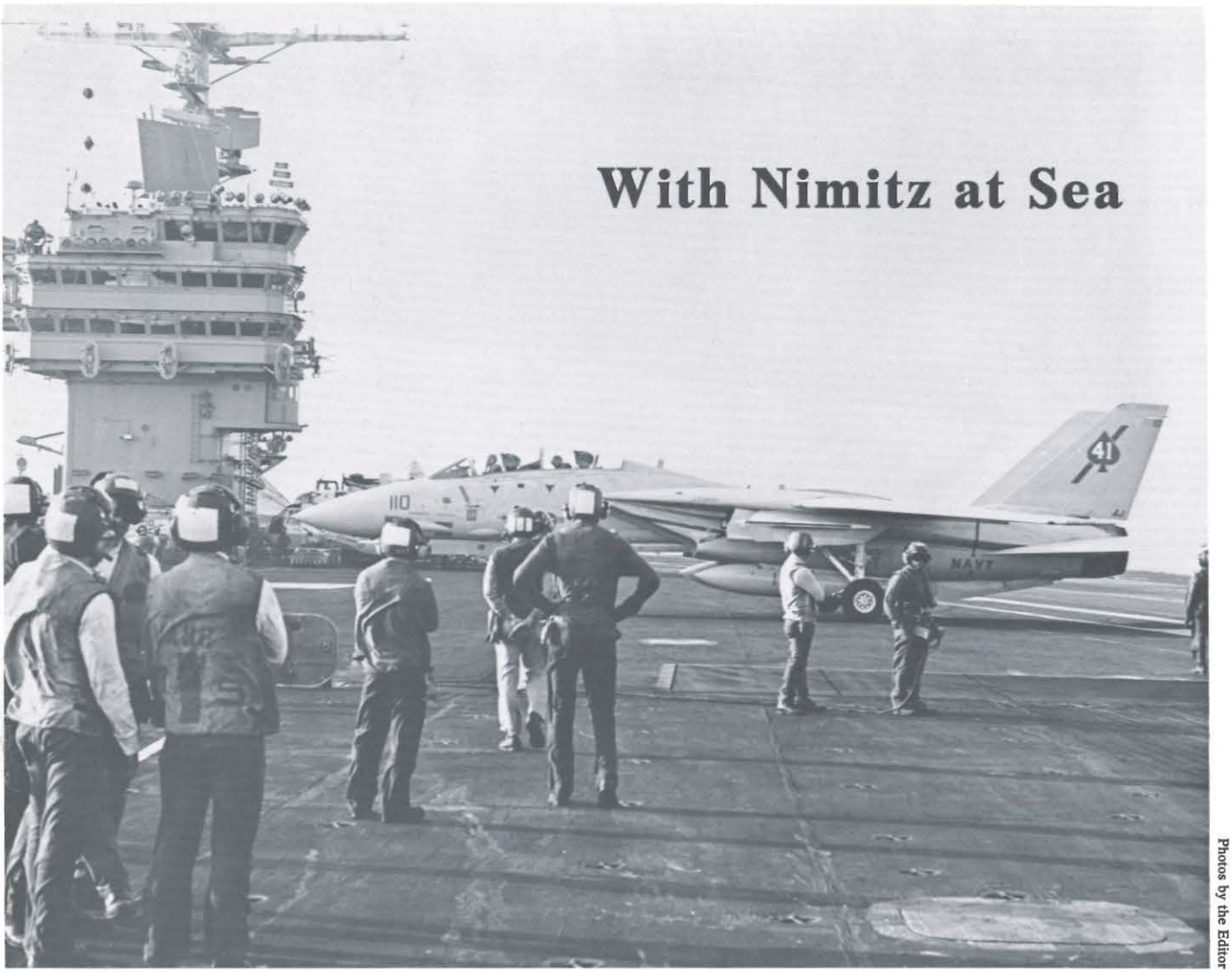
COVER: Providing medical care for a floating city of 5,000 men is a tremendous responsibility. *U.S. Navy Medicine* reports how the Medical and Dental Departments of the nuclear carrier USS *Nimitz* meet the challenge. Story on page 1. Photo by the Editor.

With Nimitz at Sea



Photos by the Editor

A pilot parks his Tomcat on a crowded deck.

The cockpit of the COD (Carrier Onboard Delivery) plane whined like the inside of a food processor. "Do you think I can get a few shots of the flight deck," I shouted above the roar. "Can't hear you," the pilot responded. He gestured with his left hand. Below us was USS *Nimitz,* a white, foamy wake marked a track through the cobalt-blue Atlantic as she steamed into the wind. We made a simulated final approach and I snapped and rewound my camera until the film ran out. "You'd better go aft and strap yourself in. We're coming in now." I took the advice. Moments later, our tailhook snagged one of the four cables stretched across the flight deck and we came to a sudden and very unforgettable stop.

For the next three days, I explored the world's largest warship as she cruised the waters off the Virginia Capes conducting training exercises for an upcoming deployment. LCDR Jeff Kramer, MSC, *Nimitz*'s medical administrator was my guide. After checking in with the Medical Department and meeting the Senior Medical Officer (SMO), CAPT Pete Bigler, MC, I began my tour.

It didn't take long to discover that a nuclear carrier is more than just a ship. If population density alone were the only criterion, this vessel is a small city. Within her 95,000-ton hull three and a half football fields long, 5,000 men live and work. To accom-

Constant drills keep Nimitz *crewmen ready for anything. Here they rig the barricade across the flight deck for a plane that may not be able to use the arresting cables.*

modate them, there are berthing spaces, storage facilities with an average 65-day supply of food, and five galleys that serve 25,000 meals around the clock.

But population aside, much of the carrier is an industrial zone. Her hold contains two nuclear reactors, four steam turbine main propulsion engines, and countless machinery spaces crammed with pumps and generators. Also below decks are machine shops where jet engines and other equipment can be torn down and rebuilt, a hanger deck that can house well over 60 aircraft, and several weapons magazines.

Even though the ship itself runs on nuclear power, it is a giant fuel depot. One sees purple-painted pipes snaking everywhere through her spaces indicating the presence of JP-5 jet fuel.* *Nimitz*'s aircraft have insatiable appetites.

*Purple is a carrier's color code for JP-5 and those crewmembers who handle it are termed "Grapes."

An aircraft carrier is designed to launch and recover aircraft, and insuring the ship's readiness to perform that mission is itself a formidable job. Monitoring the hazardous environment and keeping the crewmen healthy are no less awesome responsibilities.

Medical Department

Nimitz's Medical Department is really a 67-bed community hospital with a regular staff of two physicians, a physician's assistant, a nurse anesthetist, a medical administrative officer, and 28 corpsmen. With the air wing aboard, there are two additional flight surgeons and 11 more corpsmen. One of the ship's two regular physicians is a general surgeon, the other, the SMO, is a flight surgeon.

Main Medical has two operating rooms, a patient ward, a three-bed intensive care unit, and two quiet rooms with four beds each. One operating room serves as a backup for mass casualties and can be pressed into service in the event of a nuclear accident with contaminated casualties.

In addition to laboratory, pharmacy, and x-ray facilities, *Nimitz,* like other naval warships, has well-equipped battle dressing stations, six of them strategically located throughout the ship. During General Quarters, they are manned with physicians, dentists, and corpsmen.

Nimitz's crewmen range in age from 18 to 50 and are a very healthy population. While at sea, usually no more than five to ten inpatients occupy the ward at any one time. "The idea is to get our patients well and back to work or get them off the ship to a place where they can be made well," said Dr. Bigler. "We don't keep chronic patients aboard."

Although the Medical Department sees its share of appendectomies and hernia operations, the staff treats mostly minor injuries, falls, cuts, eye infections, and colds. With unyielding steel decks, knee problems are common.

The laboratory is as well-equipped

as those in most shore hospitals. While I was aboard, a project was underway to determine crewmembers' potential reactions to the antimalaria drug primaquine. This meant drawing over 3,000 blood samples.

Nimitz, like other carriers, shares common sanitation requirements. The Medical Department's two preventive medicine techs see to the inspection of galleys and messes as well as the potable water supply and sewage treatment. They also inspect all consumable items that come aboard. If they find any infestation, the food never makes it below decks and adjacent pallets may also be banned. This aggressive preventive medicine program translates into a virtually rodent- and insect-free ship.

What I saw elsewhere aboard *Nimitz* was a constant reminder that the ship is very much like a factory in which the workers' safety is a key consideration. Cellulube, a fluid used in the ship's deck-edge and weapons elevators' hydraulic systems, is neurotoxic. When handling it, crewmembers must wear protective clothing and respirators. Beryllium, a component of aircraft brakes, is another toxic substance the crew must be protected from.

Besides toxic substances, crewmembers face other hazards as well. *Nimitz* is nuclear and therefore lacks a fire room. However, heat stress is definitely a factor in the vessel's main turbine powerplant and catapult steam valve rooms.

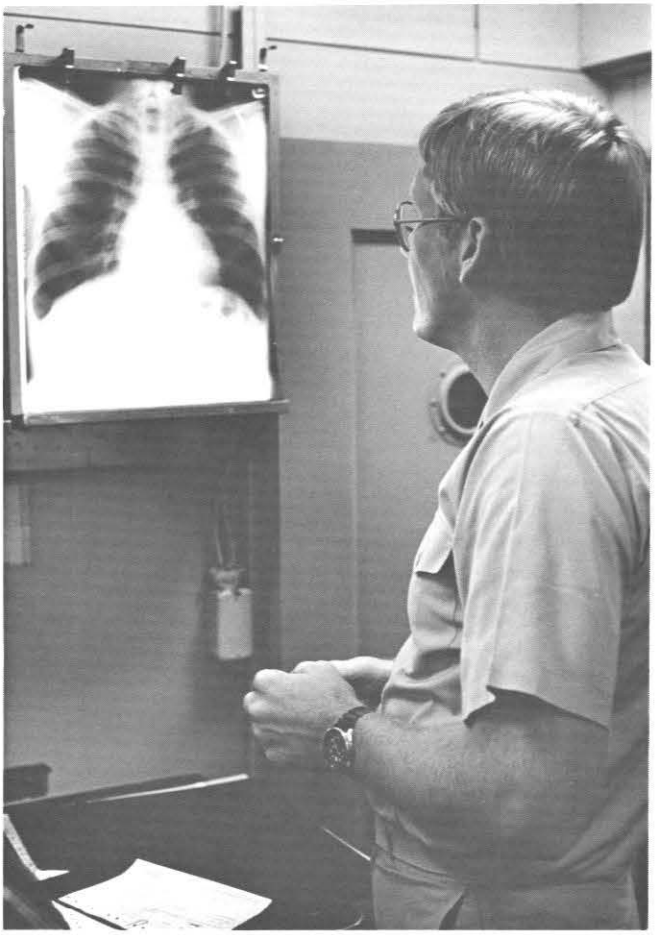
Noise is an obvious threat to health for many crewmembers both on the flight deck and in the machinery spaces. Hearing protection is of paramount importance.

As similar *Nimitz* is to other ships, she is also very different. Because her deck is free of soot and cinders, this visible evidence of a clean, healthy environment does not mean that nuclear power is not without hazard. Only constant vigilance and safety drills insure that risk is kept to an absolute minimum. As the ship's radiation health officer, the SMO is

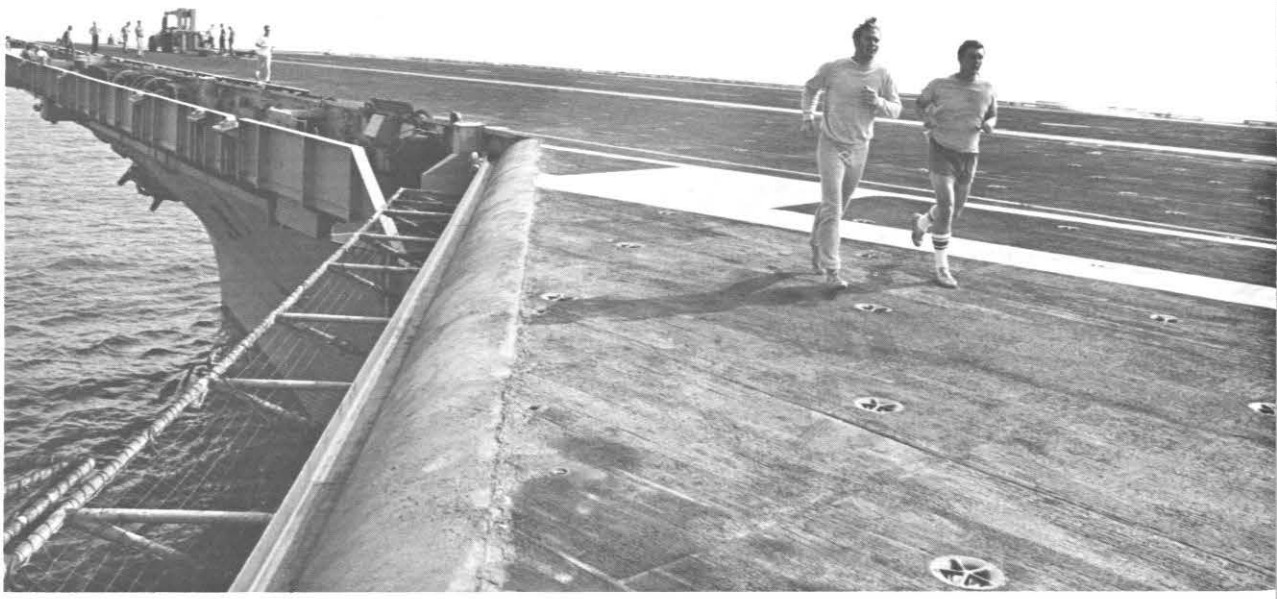
The Landing Signal Officer Platform is a front row seat during flight operations.

Thumbs up for an A-7 about to be hurled off the starboard catapult.

CAPT John Legan, MC, the ship's general surgeon, treats a postoperative abscess.

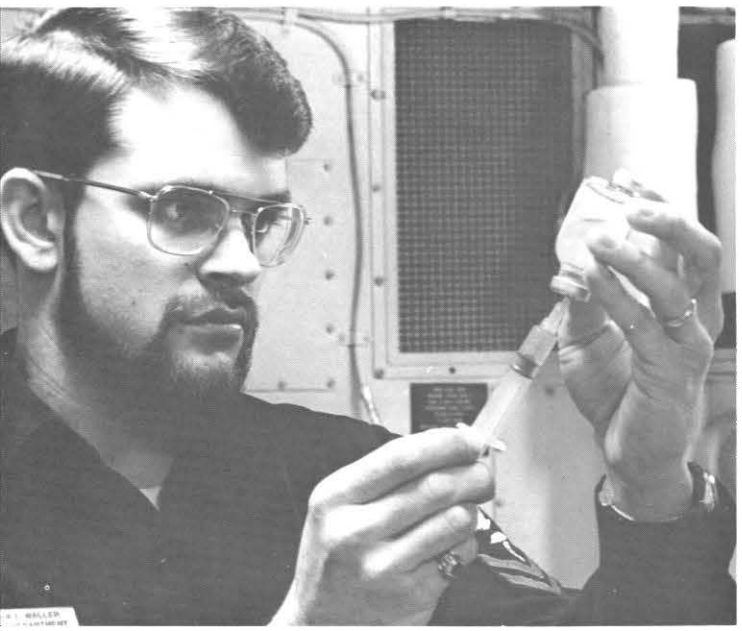


CWO3 Terry Soldo, physician's assistant, studies a patient x-ray. Besides his other duties, he is Nimitz*'s weight control officer.*



Physical fitness aboard a nuclear carrier.

Photo by PH3 Peter R. Walker



HM2 Joe L. Waller, Jr., Nimitz *Sailor of the Year, prepares an immunization.*

HM3 J.E. Balzer draws a blood sample from one of Nimitz*'s inpatients, FA Ralph Stevenson.*

Photo by PH3 Peter R. Walker

CDR Dan Golden, DC, oral and maxillofacial surgeon, practices one of his specialties. His assistant is DN Napoleon A. Morse.

The morning COD prepares to depart for NAS Norfolk.

responsible for monitoring the radiological exposure levels of those crewmen who work near the reactor spaces. A nuclear medical technician aids in this task. Personnel in the nuclear catagory receive a preradiation physical and wear thermoluminescent dosimeters. All exposures from then on are charted in their health records.

Because she is nuclear, the ship undergoes an annual and very strict Operational Reactor Safeguards Evaluation (ORSE). Such an inspection was in progress while I was aboard. Several times, loud speakers blared a similar message to test the ship's response teams: "This is a drill. This is a drill. Casualty (equipment malfunction not personnel casualty) in Number Two Reactor Room. RL and RN Division supervisors report to Number Two Reactor Room."

An afternoon on the Landing Signal Officer Platform and crouched between the two forward catapults during flight operations left me with one indelible impression. A ship like *Nimitz,* even with the emphasis on safety, may at any time be a breath away from disaster. With weapon- and fuel-laden aircraft parked on the deck and others screaming on and off every few minutes, the danger of explosion, fire, and mass casualties is an ever present one. On the afternoon before flight operations, a barricade and fire drill took place, one of many to insure the readiness of the deck, fire-fighting, and medical teams. No one could know that a month later they all would be put to the ultimate test.

Dental Department

Besides its main mission of providing dental care to *Nimitz*'s crew, the ship's Dental Department is an integral part of the medical battle readiness team. During mass casualty situations, dental officers help man four of the ship's battle dressing stations. Dentists are senior officers in charge of three of them. In the other battle dressing station, a dentist is assigned along with a physician and flight surgeon.

Nimitz's dental officers also play a key role in training dental techs, corpsmen, and stretcher bearers as well as teaching the crew first aid. They also assist by triaging the critically injured. "There just isn't enough medical manpower around in a mass casualty situation so we use the most qualified people we have," pointed out CDR Dan Golden, DC, *Nimitz*'s oral and maxillofacial surgeon.

The Dental Department's primary function, of course, is seeing to the oral health of 5,000 men. Dr. Golden, a prosthedontist, three general dentists, and the 16 dental technicians aboard have their chairs and hands full meeting the demand.

* * *

Having one's hands and days full much of the time seems a common pastime on this carrier. The day doesn't end at 1600 or at 2400. I saw *Nimitz* the way most tourists see New York City for the first time. It was Times Square at 3 a.m. with lights, people, and unrelenting activity. When I turned in well after midnight and doused the light above my bunk, there came the moans of working metal, the sound of pumps and switches, and uncountable strange noises. The City of *Nimitz* like the Big Apple never sleeps.

Almost before I knew it, my visit was over and it was time to catch the morning COD back to the mainland. The plane awaited me on the flight deck, engines idling and crew readying it for the return trip to NAS Norfolk.

Today, a 15-knot wind augmented by a 12-knot rate through the water whipped up quite a breeze. We taxied back to the fantail to take full advantage of the ship's flight deck. Our pilot locked the brakes, applied power, and with the COD again performing its buzzing, vibrating, food processor routine, we began our take-off roll. The angle of the flight deck suddenly dropped away revealing a sharp, gray bow knifing through the sea. I looked down at the blue and gold pin Jeff Kramer had given me, a pin worn by many members of the crew. It read "Teamwork-**NIMITZ**-A Tradition." From what I had seen the past few days, it was obvious that this was a creed the men of *Nimitz* truly lived by. I had no reason to believe otherwise. —JKH □

Tragedy on the Flight Deck

Two weeks after *U.S. Navy Medicine* visited *Nimitz*, a Marine Corps electronic warfare EA-6B Prowler crashed on the flight deck killing 14 and injuring 48. The ship's Medical Department treated the casualties and the more seriously injured were evacuated to NRMC Jacksonville. Four critically burned men went on to the burn unit at the Brooke Army Medical Center, San Antonio, TX.

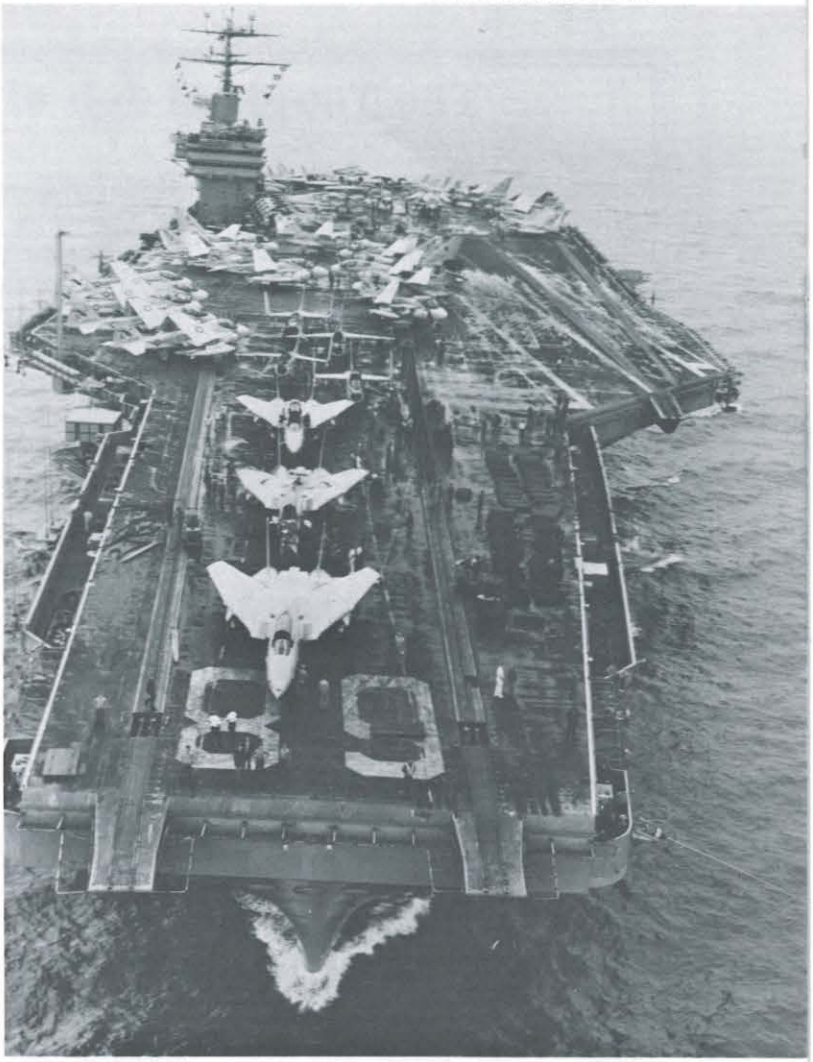
With the exception of those initially killed in the accident, all victims are still alive and recovering from their injuries. This is due almost entirely to the quality of emergency medical care provided aboard *Nimitz*, at NRMC Jacksonville, and at Brooke.

Several hours after one of Navy Air's worst disaster, the *Nimitz* Medical Department was back to normal, stocked, shipshape, and again ready to provide routine medical care for the crew.

Jacksonville Responds

At approximately 0115 on the morning of Wednesday, 27 May 1981, NRMC Jacksonville received both phone calls and naval messages stating that USS *Nimitz* had been involved in an aircraft accident and that the Center would be receiving mass casualties. At 0135, the Center received a request from CINCLANTFLT requesting that a team of medical personnel be flown to *Nimitz* immediately. At 0215, three physicians and a team of 15 corpsmen were in the air. A total recall of all military personnel and selected civilian employees was ordered at 0200, and by 0315, 96 percent of the medical staff was on board. The first group of casualties arrived at 0435, and by 0630, the last of a total of 21 casualties had arrived.

Photo by PH1 Kenneth Brewer



Three damaged F-14 Tomcats line the deck as Nimitz *steams toward Norfolk following the tragic accident of 26 May 1981.*

(Below): Nimitz*'s critically injured arrive at NRMC Jacksonville.*

The Toughest Job of All

Arresting a hurtling mass of jet-driven metal and launching it and its crew back into the sky again is one of the most dangerous jobs in the world. Engines shriek at full power. Bones, teeth, and sinuses resonate and, even with the best eye and ear protection, one's head throbs and lungs ache. The pungent, hell-hot hurricane jet exhausts bring a constant flow of tears to the eyes and slam the unwary against the nearest bulkhead —or worse—over the side. A moment of inattention, a step in the wrong direction, a head raised at the instant of launch, and a guillotine-sharp wing does its nasty work.

LCDR John Tindle, arresting gear and catapult officer aboard Nimitz, *supervises a 150-man crew. A 20-hour day in the steam catapult valve rooms below, where temperatures often exceed 125°F, or on the flight deck is not an uncommon shift for these men. LCDR Tindle talked with* U.S. Navy Medicine *and described the hazardous environment in which he and his crew work.*

USNM: From what I've seen, your men work pretty hard.

LCDR Tindle: I've never seen a harder working bunch of guys. During cyclic operations when we're landing and launching aircraft around the clock, the men have to get up two and a half hours ahead of time and start preopping their catapults. This is followed by no-load catapult firings. We then go right into cyclic operations. These are the same guys that do the post-operational checks and all their own maintenance when flight ops are over for the night.

The men who really take the brunt of it all are those in the arresting gear crew. They have to be on station for the first launch of the day just in case an aircraft must return early. They also have to be out there for the last recovery of the night.

Fatigue must really be a problem then.

Oh, yes. Long hours and not a lot of compensation. By the time you pull into port and everyone goes on liberty, there's still maintenance to be done on the catapults and these men stay behind and do it.

What about stress?

There's a lot of stress just from the tempo of the operations. Our hookup men must get right underneath the jet intakes and take tension on the catapults. When the aircraft comes to full power, they're sitting under there making

LCDR Tindle, Nimitz*'s arresting gear and catapult officer, between flight operations . . .*

. . . and at work inside the Bubble.

Tindle's men maintain the catapults.

sure all the connections are in order. They then get out of the way, making sure they don't run into a prop or get sucked into an intake.

I noticed that many of your men seem quite young. Having all that responsibility must add to the stress.

It's a lot of responsibility for an 18-, 19-, or 20-year-old to be running the machinery all day long under the pressure of knowing that if he doesn't do something right he could put a plane in the water and kill the crew. But I've got to say, we have a safe operation on *Nimitz*. In the almost six years since the commissioning of this ship, never have we had a serious aircraft accident because of the catapult or arresting gear equipment.*

What's your job during flight operations?

I sit down in the Bubble.** The deck man makes the launch valve settings, gives hand signals, and sends the aircraft down the deck. In the Bubble, we receive the inputs for the aircraft weights and actually fire the catapults. With both cats going, we launch 12 to 15 aircraft in as many minutes. It can get quite hectic.

What about the noise on deck?

Sometimes it really gets bad. The F-14 afterburner shots are incredible. With full power and afterburners on, the whole deck shakes.

How about weather?

Weather is definitely a factor. Working here off Virginia isn't so bad but down in Guantanamo Bay or in the Indian Ocean, it gets over 100 degrees on deck. Add the heat of the exhaust and you have a real problem. The exhaust itself is terrible. As you prepare for launch near the waist catapults, the exhaust blows into an area where everyone is standing. The hot gases make it hard to see and very tough to breathe.

I think all these factors are what make the carrier deck so dangerous—the fatigue, the heat, the noise, the exhaust. It's a tough job. —JKH

*Although two investigations are still underway, there is yet no evidence that the deck crew or equipment failure contributed to the flight deck accident that took place on *Nimitz* 26 May.

**The Bubble, or Integrated Catapult Control System, is a protected dome located forward on the flight deck between the two forward catapults.

Nimitz's Medical Manager

LCDR Jeff Kramer, MSC, is a medical administrator. Like all those charged with the management of a hospital, he bears a large responsibility affecting the lives and health of the citizens of his community. But unlike nearly all other communities, his is USS *Nimitz* and his job is managing a medical team of nearly 40 corpsmen and doctors and a 67-bed hospital and physical plant valued in excess of $1,000,000.

Safeguarding the crew's health involves Kramer and his corpsmen in a continual cycle of sanitation and food processing facilities inspections. The immunization program he administers guards the crew from most diseases. Constant drilling is something he emphasizes. The readiness of his corpsmen is most apparent when they respond to a serious injury. The Navy emphasizes safety in all its operations but operations at sea are inherently dangerous, whether landing a jet fighter on a pitching deck or manipulating the winches and lines for an underway replenishment. With its large Medical Department, *Nimitz* is also called upon when there is a serious injury on a smaller ship in the task force.

"It usually begins with an urgent radio message from one of the ships in company. If our doctors determine the case is serious enough," said Kramer, "we'll try to get one of our helicopters over to the ship to bring the man back here. We work closely with the ship's Air Department when we need a medevac. They're pros up there and always come through for us."

When word comes down from the bridge that the medevac is inbound, a team of corpsmen stands by so that not a moment is wasted from the time the wheels touch the flight deck until the injured man is down in Medical receiving timely treatment that may save his life.

The capable corpsmen got that way through years of training, but if the ship ever gets involved in a real war there won't be enough of them to go around. The Medical Department uses General Quarters drills to train the crew in first aid and the medical procedures necessary to keep serious injuries stable until the corpsmen can tend to all the injured.

As with all warships, *Nimitz* goes to General Quarters when preparing for battle. During Gen-

LCDR Kramer checks his gear with HM3 Carl Bernstein in the flight deck battle dressing station.

eral Quarters drills, Medical Department personnel go to their assigned station in the six battle dressing stations and to the ship's repair parties. The repair parties are trained to control flooding, fight fires, and repair structural damage. The battle dressing stations serve as auxiliary medical treatment stations and are strategically located throughout the ship.

When General Quarters sounds, LCDR Kramer hurries to Damage Control Central (DCC), where his job is Medical Coordinator. Damage Control Central is in the heart of the ship and through its sound-powered phone circuits, communications are maintained with the repair parties and other key control centers. In addition, there is a separate circuit to all the battle dressing stations for direct communication with the Medical Coordinator.

Repair parties feed all reports of damage and personnel casualties to Damage Control Central. When he receives notification of a casualty, LCDR Kramer notifies the nearest battle dressing station which sends out a stretcher team to pick up the man and return him for treatment.

During General Quarters drills, experienced corpsmen conduct simulated mass casualty drills throughout the ship using moulaged crewmembers. Volunteers "drop" near a repair party, moaning in simulated pain and "bleeding" profusely. Members of the repair party are taught to respond immediately, apply first aid, and notify Damage Control Central.

With several simulated casualties out at once, Damage Control Central often receives several casualty reports at the same time. If all are in the same battle dressing station's area, resources must be allocated to meet new requirements. "The purpose of this training is to insure the crew is ready to deal with any situation," said Kramer.

Although his work is punctuated by the excitement and tensions of medevacs and General Quarters drills, the meat of Kramer's job is the management of the people. "When I return to my deck, my time is often spent counseling the corpsmen about their careers, screening requests for special schools, and helping with personal problems. I also draft messages to hospitals ashore requesting outpatient appointments for crewmembers and deal with a myriad of situations; phone calls and conversations flow through the office continually," he pointed out.

His role as top administrator for the Medical Department keeps him from becoming desk-bound. Regularly, Kramer will go to the flight deck first-aid station during flight operations, suit up in flight deck gear (protective helmet, ear plugs, long-sleeved shirt, life vest, and safety shoes) and go out with one of the flight deck corpsmen to observe air operations up close.

"My pleasure at observing flight operations is always mixed with caution," he added. "During operations, the flight deck is an extremely hazardous place." Even behind the safety lines one is still subject to blasts of jet exhaust from moving aircraft. In spite of the danger, the choreography of the flight deck is amazing to observe. It is a safety first act achieved through teamwork, training, and experience.

"Life in the Navy at sea is unlike any other experience," emphasized Kramer, who has also served as an administrator at naval medical facilities in Portsmouth, VA and Bethesda, MD. During the Iran crisis, he and his shipmates spent five months ready for action in the Gulf of Oman and six weeks in the North Atlantic as part of a NATO exercise.

LCDR Kramer discusses the day's problems and priorities with HMCS Fulton Weston, one of his primary assistants in managing the ship's medical resources.

The hours can be long and the work exhausting, but the friendships formed in the Navy tend to be enduring and the experiences unforgettable. LCDR Kramer, who completes his tour next month, reflected on his two years aboard *Nimitz*. "In my two years, I have experienced almost everything one can experience aboard an aircraft carrier. I'm glad I went."

—Story by LTJG John Owens. Photos by PH3 Peter R. Walker.

Patient Contact Program: A Closer Look

LTJG Mark A. Walker, MSC, USN

In September 1979, BUMED directed all medical and dental commands to effect a Patient Contact Program designed to improve patient perceptions of the Navy Health Care Delivery System, reduce patient frustrations and misunderstandings, and reduce the risk of malpractice claims and congressional inquiries.

The Naval Regional Medical Center, Camp Lejeune, NC, developed a comprehensive implementing instruction on the Patient Contact Program and, since March 1980, has made significant strides toward developing it into a highly effective component of their overall Quality Assurance/Risk Management Program. In fact, these concepts would not be complete without a viable Patient Contact Program since quality assurance and risk management are aimed at identifying potential or existing liabilities and taking appropriate corrective measures.

To date, NRMC Camp Lejeune has 30 patient representatives throughout the medical center and its branch clinics. A Command Patient Representative handles the coordination. The Command Patient Representative screens each clinic patient representative to insure that they demonstrate compassion, understanding, knowledge, alertness, and neatness. Each patient representative must have the full support of the respective Chief of Service in all matters related to patient complaints or problems. Each service area has an identified space for use by the patient representative to discuss patient concerns, and patient questionnaires are provided for assessing services rendered.

Patient representatives attend a monthly meeting chaired by the Command Patient Representative. Information is exchanged regarding various complaints received during the month and the corrective action taken in each case. Minutes are taken and submitted to the Command Officer for review and appropriate action. Once the minutes are approved, copies are distributed to each representative, and the original is stored in the Joint Commission on Accreditation of Hospitals (JCAH) file.

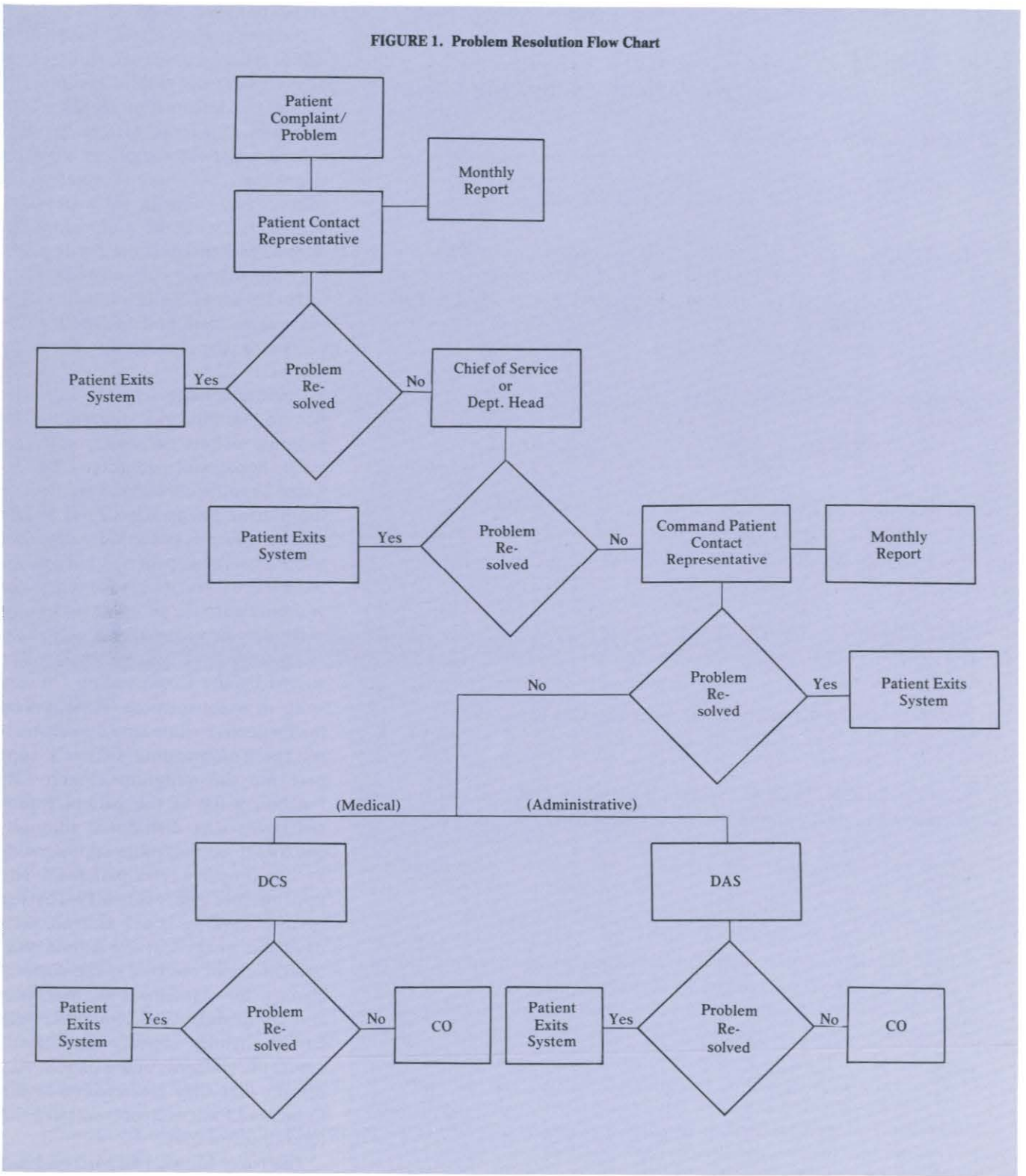
The NRMC Camp Lejeune Patient Contact Program exceeds BUMED requirements on contact point training by providing lectures on the legal aspects of health care and malpractice prevention. These lectures are conducted by the JAG-appointed legal officer for the command and are provided for and tailored to all levels of the hospital staff. Additionally, negotiations were completed in August 1980 with the local community college to provide a professional guest speaker to conduct an "Effective Communications and Human Relations Workshop." This workshop was specifically adapted for the military health care setting. During September 1980, approximately 250 staff members serving in patient contact areas completed the scheduled workshop and received a certificate for seven contact hours of continuing education.

The basic instruction for the NRMC Camp Lejeune program provides a patient complaint flow chart (Figure 1). The patient first expresses his concern to the clinic patient representative who attempts to resolve the problem to the patient's satisfaction. If the problem cannot be resolved, it is then referred to the respective Chief of Service. If the problem is not resolved to the patient's satisfaction at this level, the matter is then referred to the Command Patient Representative who either makes another effort to settle the matter or refers it to the command executive level.

Patient Encounter Logbooks are maintained within each clinic area providing data for a monthly report to the Command Patient Representative. All complaints/problems which cannot be handled at the first level are then processed through the system by utilizing a Patient Encounter Form (Figure 2). Space is provided for comments by the patient, the patient representative, the Chief of Service, and the Command Patient Representative. Once a problem is resolved at a given point within the sytem, the original form is forwarded to the Command Patient Representative's office within 48 hours. The Command Patient Representative and other quality assurance personnel review the form to identify potential risks and/or trends. At this

When this article was written, LTJG Walker was in charge of patient affairs at NRMC Camp Lejeune. He is now with Naval Recruiting District, Philadelphia, PA 19102.

FIGURE 1. Problem Resolution Flow Chart



On Growing Children

Tics

CDR Eli Breger, MC, USNR

"The chain of habit coils around the heart like a serpent, to gnaw and stifle it." Hazlitt

For many years, parents and physicians have employed the term "nervous children" referring to developing youngsters who present involuntary, sudden, frequent, and repetitive movements of circumscribed muscle groups that serve no apparently useful purpose. Such spasmodic discharges are more correctly referred to as "tics." When persistent they represent an imbalance in a child's motor functioning induced by emotional factors. Tics should be viewed as a "red flag" signaling a need for help.

Common Presentations

The patterns and varieties of tic movements are virtually unlimited and each child brings his own uniqueness to his gestures. Any area of the body may be involved but there is a clear and impressive predilection for the head, face, and neck, followed by the shoulders, upper limbs, chest, and abdomen, in that order. Perhaps the more frequent involvement of the head, face, and neck reflects the nervous system's selection of those areas to express and discharge emotional feelings and tensions throughout our lifetime and especially during the early developmental years. The movements most commonly seen are blinking of the eyelids, shaking of the head, nodding, wrinkling the forehead as if frowning, twisting of the mouth, grimacing, sniffing, throat-clearing, swallowing, coughing, jerking of the shoulders, arms, or legs, and retracting the abdominal wall. Most often, a child presents one tic at a time but it sometimes varies and merges from one form into another.

Personality Profile

Tics are a disorder of elementary school-age children. The group is characterized by great excitability, very active motion, and as yet, limited self-control. Tics are manifestations of excessive inner tension and overflow. Transient eye-blinking is rather commonplace in a sizeable portion of preschool and elementary school-age children but does not qualify as a true tic because it is of such short duration. With each passing school year, children afflicted with tics improve and cease these movements. Therefore it is an infrequent condition beyond puberty. Unfortunately, a small percentage of children persist with their tics into adult life causing considerable social and personal handicap. This observation lends weight to the importance of early intervention so as to minimize the possibility of chronicity.

Boys tic far more frequently than girls. This reflects in part the normally more complex pattern of sexual development of the boy which gives rise to greater internal psychological tension seeking discharge. It is believed children of the Jewish faith tic with far greater frequency than their proportion in the population. If true, this may reflect family environmental stresses resulting from high levels of academic expectation and other strong socializing pressures usually present in Jewish households.

Tics are rarely a singular issue and are usually associated with other behavioral problems. Children who tic are insecure, restless, overexcitable, poorly self-controlled, and generally maintain high profiles. At their core they are conscientious, ambitious, and striving. They stem from backgrounds most often characterized by emotional conflict and environmental tensions.

Tics as a Discharge of Tension

What is the nature of tics and how do they come into being? Tics are an expression of internal emotional conflict through muscular discharge. A child's dealing with tensions depends on a number of factors. As he struggles to grow from one developmental stage to the next, internal tension builds up. He also struggles with externally engendered tensions caused by realistic environmental issues and conflicts. A child's effective ability to adapt and handle the cumulative tension buildup depends on just how much tension he has to deal with, how strong a child he is by way of his constitutional coping capacity, what the tolerance for general motor activity and discharge is within his home environment, and what traditional outlets for motor discharge he may have, such as athletic interests and pursuits. Tension buildup and

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tension discharge struggle to achieve an equilibrium. When the buildup is too great, an overflow emerges taking the form of tics in children so prone by the nature of their nervous systems.

Tics as a Learned Movement

A psychological school of thought called "Learning Theory" states that tics originate as learned movements. Initially they served useful purposes but then persisted as involuntary repetition patterns based on imprinting in the brain. For example, a case reports a boy who was walking in the woods when a low overhanging branch trapped his cap, took it off his head and then rose beyond his reach. The boy worried over the loss of his cap and possible admonishment by his parents. For a time he kept turning around and looking up in a futile attempt to locate and reach the cap. This initially purposeful gesture then continued as a tic under the pressure of tension. Further examples following this theory of origin include an eye-blinking tic following an eye infection and writhing of the neck following the wearing of a collar that was too tight. In others, a tic may originate from a movement whose action was inhibited by adult authority or the child's own conscience. Simple examples could include an arm movement indicative of wanting to hit or masturbate. We know that few children with such experiences go on to tic. However, such explanations may be meaningful for those vulnerable children who do.

The intensity of tics probably correlates with the severity of tension, conflict, and emotional strain. However, this may be quite difficult to prove or understand in working with a given child. Conflict and tension are deeply internal. They are based on issues inherent in the child's development and aggravated by environmental stresses. One often looks for clearcut environmental stress factors. A deep knowledge of normal childhood development on the one hand and the patient's personality and life situation on the other may enable one to begin to understand the appearance, changes in intensity, and disappearance of tics. However, the external environmental stresses are important in everyday counseling and working with children since these issues are closer at hand. It is probably true that a majority of children with tics have this condition only to a mild to moderate degree. Therefore, even if we cannot influence internal and developmental tensions, we may see the disappearance of tics resulting from a working through and reduction of the external environmental stresses and pressures.

In earlier times, physicians postulated that tics represented lesions in the brain resulting from injury or disease. This view is no longer held to explain the commonplace tics of everyday children. Somewhat relevant are the tic-like movements we see as part of certain serious neurologic diseases. However, many other clinical manifestations invariably appear beyond the involuntary movements.

Afflictions Simulating Tics

Most often tics are quite apparent and not difficult to identify by those familiar with them. Some cases may be confusing as there are other conditions in which movements resembling tics are part of the picture. What other conditions resemble tics?

Nail-Biting, Nose-Picking, and Finger-Sucking. These phenomena are sometimes confused with tics by parents who, upon questioning their child as to why he does this, receive a reply such as, "I didn't know I was doing it," implying an involuntary act. Such movements do not meet the criteria for tics as they lack the suddenness of discharge, are not brief but rather sustained, and do have a reasonable degree of voluntary control. The child may be unaware he is doing it until it is brought to his attention, but it is within his voluntary control. They may serve a similar purpose to tics as they are tension reducers and relaxational expedients. Professionals view them as falling into the same family of phenomena.

General Motor Restlessness. This general term designates the overly active, poorly controlled, and restless child who may jerk, twist, and show movements approaching tics. In general, the movements are not localized, not restricted to particular muscle groups, can be controlled by calling attention to them and, unlike tics, continue into restlessness during sleep. As with tics, the child "settles down" as he develops maturation of the inhibitory pathways of the nervous system. This allows him to cope with his tensions better as well as to respond more effectively to the socializing environmental forces around him.

St. Vitus Dance. This condition, otherwise known as "Sydenhams Chorea," is a generalized motor restlessness always associated with rheumatic fever and may be the earliest manifestation of that condition. In time, cardiac changes and other signs of infection appear in physical and laboratory examinations. The term "chorea" refers to involuntary and jerking movements reflecting disease. They may resemble tics but their quality is different in that they have a larger range of excursion, are not restricted to the traditional circumscribed muscle groups and in time there appears writhing, rhythmic movements, muscle incoordination, and muscle weakness.

Movements as Part of Cerebral Palsy. Athetosis refers to repetitive, involuntary writhing movements which upon close study are different than tics and are part of the brain-damaged picture in cerebral palsied individuals who, of course, show many other serious changes in their muscular functioning.

Tics Following Encephalitis. Such tics closely resemble that which we have discussed and usually emerge in

severe encephalitic conditions that become chronic. In time, these tics tend to decrease. Interestingly, though these tics clearly are of an organic nature, their severity is influenced at times of stress just as in children with everyday tic conditions.

Gilles de la Tourette's Disease (Maladie des Tics). This rather widely publicized condition is a serious organically based disease of the brain involving the "extrapyramidal" tracts which are the pathways affected in most "movement disorders" such as Parkinson's Disease. The condition has come in for much attention recently as more effective treatment modalities have improved the outlook for what was previously a very severe and debilitating condition. The movements begin early, resemble everyday tics, but then the clinical picture becomes increasingly more complex including throat-clearing noises, grunting, a parrot-like repetition of statements made by others, compulsive and involuntary expulsion of obscene statements and a repetition of movements made by others. An awareness of this total picture will allow one to differentiate it from the everyday child with tics and alert parents when in doubt to seek specialized neuropsychiatric evaluation for clarification.

Therapeutic Management

Children with tics are in need of help. What can parents, counselors, and professionals do to help them? Above all, there is a need to thoroughly evaluate the total child and his family environment. We should search for issues which, if resolved, would enhance the child in his developmental passage and strengthen his adaptive forces. Within his environment, we should attempt to correct imbalances and reduce pressures and tensions. The larger milieu including his extended family, community, and school should also be studied with a similar view in mind. Although such a task seems quite demanding without professional assistance, one should not underestimate one's ability for self-analysis and self-help.

It is always best not to draw attention to the tics. Doing so either in a constructive manner or with angry admonishment enhances tension thereby worsening the situation. To exercise restraint and sit quietly while the child is demonstrating tics is a very difficult parental task; with time it can be mastered.

The child may profit from a rational explanation of the nature of his tics with reassurance that they will likely lessen in time. Every effort to build the child's confidence should be made. Encouragement and insistence for the child to develop physical outlets, particularly of a structured and disciplined nature, is central in such planning.

Correction of physical issues that may cause areas of irritation thereby enhancing tics makes good common sense.

A regular and somewhat early bedtime hour assuring the child adequate rest is important.

Appropriate drug usage to reduce anxiety or lessen overactivity is worth trying. Keep in mind that drugs do not substantially decrease tics but may play a useful role as part of a total tension reduction program.

As described earlier, some psychologists explain the development of tics through "Learning Theory" and as such have developed a therapeutic approach in which the treatment centers upon insisting the patient voluntarily repeat his own tic as fast as possible with only brief periods of rest. This theory states that consistent and rapid repetition of a single act enables the brain to build up a "reactive inhibition" to that act. It is as if a satiation takes place and in time a person can no longer perform the act even if he tries. If this is the case, then there will be established a new habit of no longer doing the action which, in time, hopefully becomes self-perpetuating. Although interesting in theory and originally greeted with high hopes, the results have been quite poor. At this time, the treatment is not advisable.

Where tics persist and do not lend themselves to the approaches here described, psychiatric consultation with a child psychiatrist or through a child guidance clinic is indicated. It is hoped that the professional's expertise, objectivity, and commitment to an ongoing treatment process will eventually yield successful results.

"There is not a quality of function either of body or mind which does not feel the influence of habit." Paley □

All Hands Editor Thanks Medical Department

Dear Admiral Cox,

There's an inadequacy about me as I write this—and well there should be. I'm only a dozen or so years late. Bear with me a minute. With any luck, I'll come out of the trees and get to the point.

As a child I was fascinated by the biblical tale of the Ten Lepers and, particularly, the bit about how only one of them came back to say thanks. That amazed me. I couldn't see how someone could take something and never say thanks. In a way, then, this letter is one of thanks—heartfelt thanks to the Navy, and above all, its doctors, nurses, and enlisted corpsmen and women.

Early in the morning of 1 Feb 1964, I got a call from the Marine Hospital on Staten Island, NY (we were living in Bayonne, NJ at the time). I should have been on guard at the onset—the caller was the doctor who had just delivered our third child. With the births of our two previous children, like calls came from nurses and corpsmen, never the doctor. This one was different but I was elated to learn that we, at last, had a boy—not another girl. The doctor told me not to visit the wife right away—give her time to rest. Later, I learned why.

Christopher was a fine baby. He had a strong body and still stronger set of lungs. He looked okay except for one think—they forgot to finish his mouth.

Admiral, I had only one thought at that time. Thank God I was in the Navy. A thing like that would put me in the poorhouse in no time. And there I was—up till that instant at least—mindless of the Navy's benefits. Hey, what's so important about free medical care to someone with the health of a rock? Which could be answered—What's freedom worth to someone who's just been captured?

A bilateral cleft lip and palate, the whole nine yards, we learned, isn't fixed up overnight. Oh sure, there are parents who rush out and get "quick fix" jobs. But the Navy advocated the "team approach"—the slow approach which kept pace with the child's development over the years. Things might seem slow at first but dividends were reaped later. We put our trust in the Navy.

Christopher had a couple of short stays at Chelsea Naval Hospital and the remainder of the work took place at Bethesda. At times—heck, all times—we were amazed. The "team approach" involved a dozen or so experts in every field of concern—doctors came from as far away as Boston to consult. Each kid, Chris was no exception, was put under the glass. Each operation was kicked around beforehand like a medical soccer ball. The surgeon's hands, as he used the knife, were guided by others; nothing was left to chance.

Christopher underwent some 14 operations—I've lost count. It was tough on his mother, more so than me. She was with him at all hours; I had the excuse that I was needed at work. She had no such escape.

Then, the Vietnam War intensified. I thought for sure that we'd have to take a seat in the back row to those terribly maimed and wounded young men who started to flood Bethesda. We wouldn't mind. Navy has its priorities; hospitals are for those who suffer.

But that wasn't the case. Somehow, in a way I still don't understand, Bethesda kept on track with Christopher. Milestones were met and achieved. On the one hand, a child was cared for—on the other, the sheer volume was met and overcome.

After each operation—each stay at Bethesda—I'd ask my wife: How much did it cost? It got to be something of a joke between us. Her answer was always: Don't ask. I feel like we just held up the place.

In dollars and cents, the whole experience has cost us only pennies. We have our home, our cars, our way of life. Without the Navy, I wonder where we would be at this date. Could I ever earn enough money to go it alone? Would Christopher's sisters have ended up with higher educations or would they be out there someplace today licking their social wounds? For that matter, would we all be together today as a family unit or would we have been torn apart by this whole business? The questions are almost endless.

Now at 17, Chris is well on his way. He's popular. He's good at sports. He has girlfriends—God does he have them. He plays sax in his high school band and he holds down a job after school. His grades aren't bad but I wish I could light that fire under him. Still, I suspect he'll make it through college, too. With his zest for life—he's bound to be an example someday to his own children. God is in his life.

Well, he has a couple of more sessions to go on the table—but the marathons should be over. Now his problem seems to be trying to decide what kind of a nose he would like and how big a tuck they should take in his bottom lip. Unlike the countless unfortunates of the ignorant past, Chris has the luxury of deciding his own future—with a little prodding from Navy doctors.

Tell me, Admiral, what is this Navy life all about? I've never been shot at. My years as an enlisted man were generally pleasant—there were a few exceptions. But I was never put to the test—I was never captured—I was never put against the wall of life. All I had to do was put in 20 years and get paid for it—on active duty as well as in retirement. Because I could handle words, the Navy took me through those years, trained me, put up with me, and—sort of as a last resort—put me where I am now. And what have I given in return?

The doctors who sweated over Chris—the nurses, the corps-people, the civilian aides—are mostly nameless at this late date. The many doctors, like LCDR T.J. Kennedy, are almost faceless—again almost nameless. Chris' latest—LCDR Jeff A. Lane—is from the same mold—magnificent. Like his colleagues before him, he came to us and started on Chris and followed through with infinite care and detail. Like the others, he was never too tired or too pressed at the end of a long, long day that he couldn't find a few minutes for the wife and me in an almost empty corridor—how many uneaten sandwiches, unfinished meals, cold cups of coffee sit on how many desks in how many doctors' offices in places like Bethesda?

And Dr. Lane—like the others, never asked:

Who are you?
Where do you come from?
How much can you pay?
How much of this service do you think you rate?

Yes, there's an inadequacy about me. Somehow I feel I have not given enough while you in Navy medicine have given, and given, and given. Thank you for making Chris whole again.

Sincerely,
John F. Coleman
Editor, *All Hands*

Clinical Diagnosis and Treatment of Oral Lichen Planus

CDR E.H. Hall, DC, USN CDR G.T. Terezhalmy, DC, USN

Lichen planus is primarily a dematological disease with frequent oral manifestations. The oral lesions may be present before, during, or after dermal eruptions, or they may represent the sole manifestation of the disease. The exact etiology of the condition is not known, but it is considered to be an autoimmune disorder initiated by a variety of local factors. Trauma, viral and bacterial infection, emotional stress, hypersensitivity reactions, and drug therapy have all been implicated.

Diagnosis

Dermal lesions appear characteristically on the flexor surfaces of the arms and legs, but they may also involve other areas of the skin. These eruptions are violet, angular, slightly raised papules with surface striations (Figure 1). Symptoms include pruritis and pain after ulceration. There are oral manifestations in about 65 percent of the patients.

Hypertrophic oral lichen planus is found primarily on the buccal mucosa, but it also may involve the tongue, lips, gingivae, hard palate, and the floor of the mouth. Bilateral symmetrical bluish-white reticular patterns (Wickham's striae) present lace-like papular projections (Figure 2). Typically, the patient may be unaware of the disease because this form is asymptomatic.

Erosive oral lichen planus is less common than the hypertrophic type,

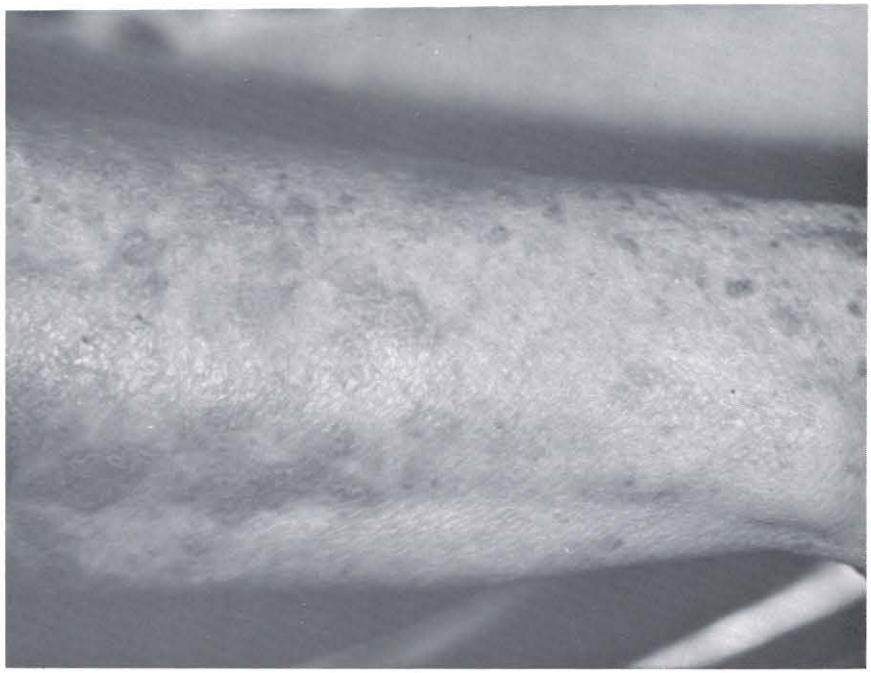

FIGURE 1. Dermal lesions of lichen planus

FIGURE 2. Hypertrophic oral lichen planus

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but it involves the same areas and may exist concomitantly. Eroded ulcerations ranging in size from a few millimeters to several centimeters may cause periods of painful exacerbation followed by remission (Figure 3).

Bullous oral lichen planus, characterized by the presence of thick-walled bullae, usually is found on the buccal mucosa and the tongue. The lesions last only a short time and then break down. This type of lichen planus may represent a phase between the hyperplastic and erosive types (Figure 4).

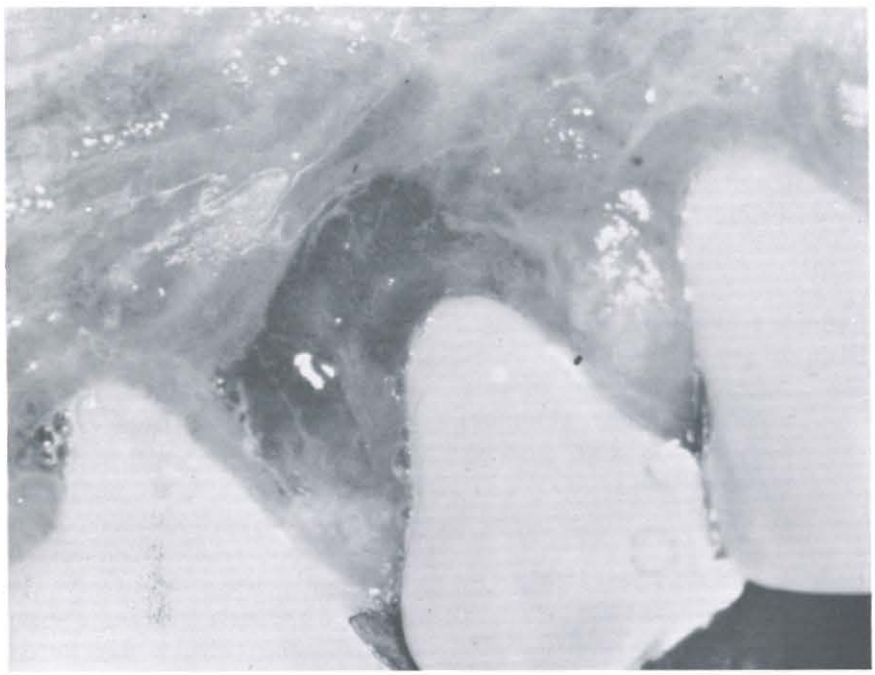

FIGURE 3. Erosive oral lichen planus

FIGURE 4. Bullous oral lichen planus

Treatment

Topical corticosteroids are the most common form of treatment for symptomatic lichen planus. (*1*) In instances of minor acute exacerbation, hydrocortisone should be tried first; (*2*) 0.5-percent preparations are available without prescription. For resistant, more serious forms, a fluoridated steroid may be more effective. (*3*) In the 0.1-percent concentration, any of the fluoridated preparations may be used interchangeably because they all appear to be approximately equipotent. (*4*) The beneficial effect of topical corticosteroids depends not only on the active compound and its concentration but also on the vehicle. Ointments probably are the most effective because of an emollient base that forms an occlusive layer over the lesion. These drugs seem to be effective in converting the ulcerations of erosive lichen planus to nonulcerative lesions and eliminating associated discomfort.

Rx

Hydrocortisone ointment, 0.5 percent
Disp: 5 gm tube
Sig: Apply to oral lesions after meal and at bedtime

Rx
Triamcinolone acetonide ointment, 0.1 percent
Disp: 5 gm tube
Sig: Apply to oral lesions after each meal and at bedtime

Rx
Bethamethasone valerate ointment, 0.1 percent
Disp: 5 (15, 45) gm tube
Sig: Apply to oral lesions after each meal and at bedtime

Intralesion injection of corticosteroids may produce a more rapid and longer lasting response than ointments. (*1,5-7*) Aqueous solutions of triamcinolone acetonide and methylprednisolone acetate have been injected directly into lesions with good results. (*8*) Involution of the lesions and relief of symptoms were noted in 72 hours. (*9*) Complete resolution may take one to two weeks and subsequently some patients may remain symptom-free.

Triamcinolone acetonide suspension, 10 mg/ml
5 ml multidose vial
Inject 0.5-1.0 cc directly into lesion

Methylprednisolone acetate suspension, 20 mg/ml
5 ml multidose vial
Inject 0.5 cc directly into lesion

Systemic corticosteroid therapy may be instituted in cases of acute lichen planus with severe pruritis and pain. If the condition includes generalized dermal involvement, the patient is best managed by a dermatologist because treatment may require large daily doses of prednisone or prednisolone, (*10*) which can produce significant untoward reactions.

Rx
Dexamethasone, 0.5 mg/5 ml
Disp: 100 (237) ml bottle
Sig: Rinse with 1 teaspoonful four times a day for 2 minutes and swallow

Vitamin A used topically and systemically has been found beneficial in the treatment of oral lichen planus. (*11,12*) It increases the dividing capacity of the cells in the stratum germinatum and simultaneously induces cytolysis in the upper strata. (*13*) Vitamin A also may increase endogenous production of corticosteroids. Both topical and systemic application produce marked improvement of hypertrophic lesions and in some cases may reduce the size of erosive lesions. Once treatment is discontinued, however, recurrence is common and toxic reactions can be expected with higher daily doses. (*12-14*)

Rx
Retinoic acid cream, 0.1 percent
Disp: 20 gm
Sig: Apply lightly to affected area once a day. (Caution: higher dose may produce toxic reaction.)

Rx
Retinoic acid capsules, 15 mg
Disp: 100 (500) capsules
Sig: 1-2 capsules daily. (Caution: higher dose may produce toxic reaction.)

Vitamin B complex deficiency may be associated with hyperkeratosis of the oral mucosa. Therapeutic replacement may be a useful adjunct in the treatment of hypertrophic lichen planus. Because the various vitamins in the B complex are water soluble, toxic doses will not build up. (*15*)

Topical anesthetics may be used temporarily to relieve pain associated with the erosive and bullous forms of lichen planus. Certain antihistamines used topically also may provide both pain relief and sedation. (*10,16*)

Rx
Lidocaine hydrochloride viscous, 2 percent
Disp: 100 (450) ml bottle
Sig: Swish with 1 tablespoonful before each meal

Rx
Diphenhydramine hydrochloride, 12.5 mg/5 ml
Disp: 4 oz bottle
Sig: Swish with 1 tablespoonful before each meal

Antibiotics. Lichen planus is not directly affected by antibiotic therapy. However, bacterial infection may be an irritating factor and there is always the possibility of superinfection of eroded areas. Aureomycin, two percent, has been used as a mouthwash to prevent secondary infection, (*1*) and antimycotic agents also may be beneficial, especially in conjunction with corticosteroid therapy, to control candidiasis. Other topical antibacterial agents of value may include 9-aminoacridine, povidone-iodine mouthwash, and chlorhexidine gluconate.

Chloroquine, an antimalarial drug, appears to produce variable results in reversing the course of lichen planus. (*17*) It was found to be ineffective against the hypertrophic type but produced good results with erosive and bullous lichen planus. (*1,18*) The suggested regimen included 250 mg of chloroquine twice a day for 10 days, followed by 250 mg once a day for 10 days, and an additional 10-day therapy of 125 mg once a day. Chloroquine therapy is contraindicated for patients with hematopoietic disorders, anemia, glucose-6-phosphate dehydrogenase deficiency, and eye accommodation disorders.

Other Agents. Arsenic and mercury were parts of the original regimen to treat lichen planus. Both substances are highly toxic, arsenic is a possible carcinogen, and the efficacy of these agents is highly questionable. (*1,16,18*) Bismuth and gold have also been used in the past. (*1,17*) They are now considered ineffective; in fact, they may produce paradoxical reactions increasing the incidence of lichen planus.

Conclusion

Corticosteroids and their synthetic derivatives are the drugs of choice for

the treatment of oral lichen planus. Topical application or intralesion injections in the oral cavity rarely produce adverse effects. (*19-23*) However, significant untoward reactions may be seen with systemic doses. Conditions that may contraindicate corticosteroid therapy include tuberculosis, diabetes mellitus, hypertension, gastrointestinal disease, pregnancy, and the presence of viral, bacterial, and fungal infections.

Recently, a new impetus has been given to finding an effective therapeutic agent for oral lichen planus because a tendency toward malignant transformation has been noted in instances of long-standing erosive lichen planus. (*11,24*) It is suggested that these lesions be evaluated periodically and a biopsy be considered every three to five years. The potential risk of oral malignancy in these patients appears to be significantly higher than that in the general population. (*25*)

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GME-1 Applications

Applications for first year graduate medical education to begin in 1982 have been mailed to junior medical and osteopathic students in the Armed Forces Health Professions Scholarship Program, the Uniformed Services University of the Health Sciences, and to interested civilians.

Completed applications and required supporting documents must be received in BUMED (MED 214) by 1 Sept 1981 to insure consideration by the selection board.

Diagnosis and Management of Botulism

LT Stephen E. Walz, MSC, USNR

Although botulism is an extremely rare illness in the United States, it still remains a public health threat. During 1970-1977, there were 268 cases of foodborne botulism reported to the National Centers for Disease Control (CDC). (*1*) Of these, there were 42 deaths resulting in a case-fatality rate of 15.7 percent. From Figure 1, it is obvious that this ratio represents a significant improvement in patient management, particularly over the last 40 years. Nevertheless, in 1977 there were 20 reported outbreaks of botulism, resulting in a total of 85 cases and seven deaths. (*1*)

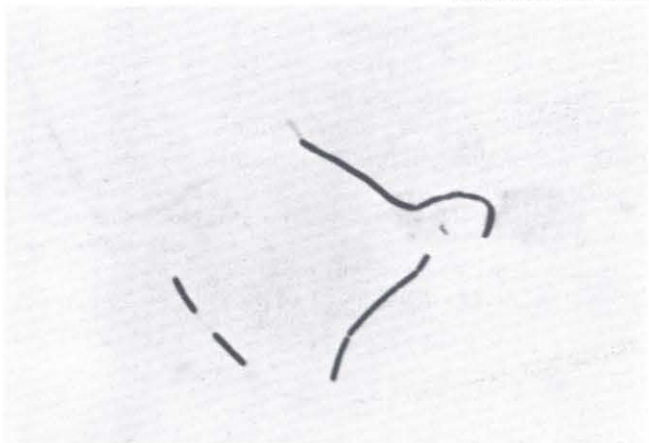
The clinical manifestations of botulism are caused by the action of a potent neurotoxin excreted by the bacterium *Clostridium botulinum*. This is one of the most lethal toxins known to man. Less than .1 x 10^{-3} ug is fatal for laboratory mice. (*2*) Although there are seven distinct types of *C. botulinum* recognized on the basis of their antigenically distinct toxins, only types A, B, E, and F are associated with illness in man. (*1*) The disease also occurs in three epidemiologically different forms, namely: foodborne, wound, and infant botulism. In foodborne botulism, an individual becomes ill after ingesting and absorbing preformed toxin produced by *C. botulinum* as it grows in a contaminated food item. In wound and infant botulism, toxin is produced as the organism grows within the infected patient.

Foodborne Botulism

Although the word botulism derives from the Latin "botulus" meaning sausage, it is ironic that meat products are rarely implicated as vehicles of intoxication. (*3*) The majority of outbreaks have been traced to home-canned vegetables. From 1899 through 1977, only nine percent of all reported outbreaks were caused by commercially processed foods. (*1*)

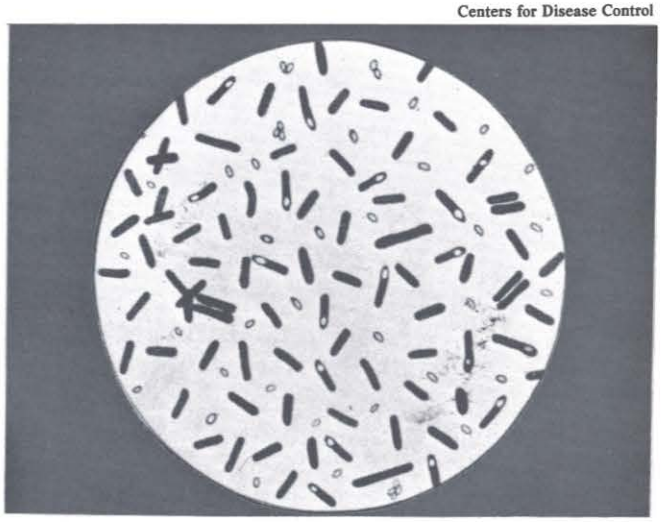
C. botulinum is widely distributed in both terrestrial and marine environments from whence it contaminates food prior to processing. (*3*) If the canning process is inadequate, heat resistant spores produced by the organism will not be destroyed and *C. botulinum* will flourish in the anaerobic environment within the can, contaminating the food product with toxin.

Centers for Disease Control



Photomic: Clostridium botulinum *type E; Gram stain of growth from 24 hours chopped meat medium (956X).*

Centers for Disease Control



Clostridium botulinum (Bacillus botulinus)

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Presenting Symptoms

Symptoms of botulism may occur from within a few hours to as long as eight days after eating food containing toxin, depending on the amount of toxin ingested. More severe illness is generally associated with shorter incubation periods. (*4*) Gastrointestinal distress, including nausea, vomiting, abdominal cramps, and diarrhea, may often precede the more significant neurologic manifestations of botulism. Patients presenting with bilateral cranial nerve impairment, manifested by symmetrical, descending weakness or paralysis, should be suspected of having botulism. Common symptoms include diplopia, dysarthria, and dysphagia. (*3*) Fever is absent as is the case with most toxin poisonings. The patient's mental status is normal and the pulse rate is normal or slow. As the disease progresses, neurologic difficulties become more pronounced, leading to paralysis of the respiratory muscles and respiratory failure.

Laboratory Specimens

Ideally, a diagnosis of botulism is confirmed by demonstrating botulinal toxin in the patient's serum; however, serum may be negative for toxin depending on the amount ingested and the time of collection of the blood sample. (*1*) Dowell *et al,* in a three-year study at the CDC achieved a 72.9 percent confirmation rate for botulism by analyzing stool specimens for toxin *C. botulinum* in addition to looking for toxin in serum. This rate was increased to 87.5 percent by examination of food, serum, and stool specimens of other symptomatic persons in outbreaks. (*5*) Although isolation of *C. botulinum* from the stool of a patient suspected with botulism is strong confirmatory evidence for the diagnosis, it is necessary to recover botulinal toxin from the food to implicate it as the source of illness. Thus, desirable specimens for laboratory examination in cases of suspected foodborne botulism include serum, stool, vomitus, gastric contents, and suspect foods. Every effort should be made to collect specimens from the patient early in the course of the illness before antitoxin treatment is begun. A 10 ml-15 ml quantity of serum is sufficient to permit specific identification of the botulinal toxin if present. Feces, vomitus, and gastric contents (25-50 gms) are best collected in leakproof containers,

FIGURE 1. Foodborne Botulism Case-Fatality Ratios United States (1900-1977)

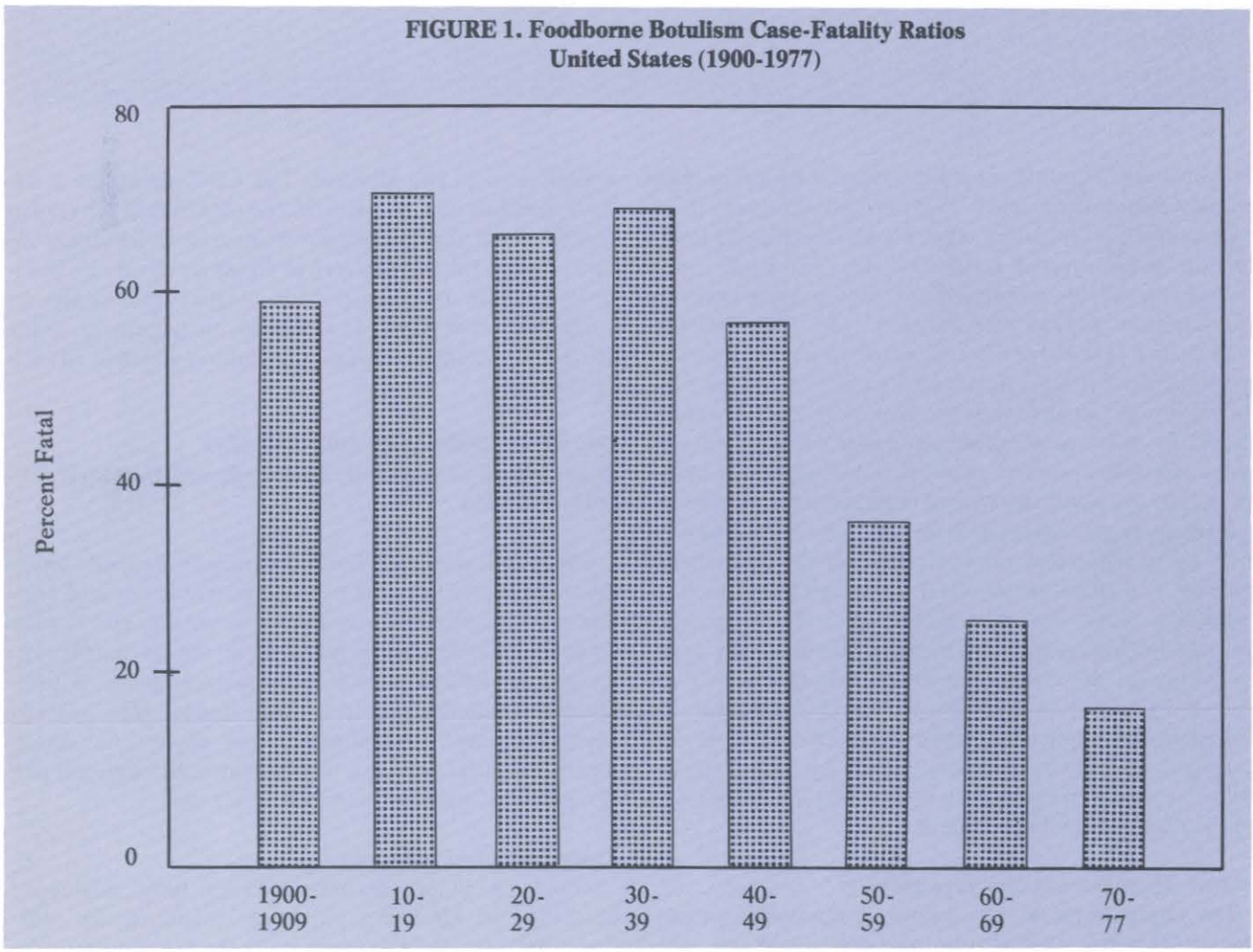

TABLE 1. Fundamental Aspects of Botulism: Diagnosis and Management

Symptoms & Signs	Differential Diagnosis	Lab Specimens	Therapy
Dysarthria	Myasthenia gravis	Serum	Cathartics
Dysphagia	Cerebrovascular accident	Stool	Enemas
Diplopia	Gullain-Barre	Vomitus	Gastric lavage
Descending symmetric motor paralysis	Tic paralysis	Gastric contents	Trivalent antitoxin
Fever absent	Chemical intoxication	Suspect foods	Respiratory assistance
Normal or slow pulse	Diptheritic polynephritis		Search for additional cases and persons at risk; bring to medical attention
Clear mental process			
No numbness or paresthesias			
Initial gastrointestinal distress			

not cardboard cups. Suspect foods should be left in their original containers if possible. When specimens are to be sent to another laboratory, they should be shipped in insulated containers with refrigerant (ice, cold packs, etc.) but not frozen. It is essential that shipping containers are appropriately packed and labeled (see BUMEDINST 6210.3) and that every effort is made to insure that the contents will not leak. Specimens should be shipped by the most rapid means available. The receiving laboratory should be contacted before shipment for any special instructions and also to establish the logistics of shipment. The presence and type of botulinal toxin in clinical specimens or food items is determined by neutralization tests using laboratory mice. Because of the specialized training and expense involved in maintaining such a capability, very few laboratories provide diagnostic services for botulism. Navy medical facilities may send specimens to the Army Veterinary Laboratory at Fort Meade, MD. The Autovon number for this laboratory is 923-2756. Although utilization of this laboratory is encouraged, in certain situations it may be more appropriate to make arrangements with a civilian laboratory geographically more convenient.

Patient Management and Treatment

The physician faced with treating a possible botulism patient (or patients) should use the services of someone experienced in this disease. The CDC maintains a 24-hour consultation service. If the consulting physician concurs with the provisional diagnosis of botulism, he can arrange for the delivery of trivalent (A, B, E) botulinal antitoxin and also provide current information on supportive treatment and patient management. This service is available through the Enteric Disease Branch of the CDC.

Day Phone (0800-1630) (404) 329-3753
Night Phone (After 1630, Weekends and Holidays) (404) 329-3644

The survival of the botulism patient depends upon rapid diagnosis followed by prompt treatment and supportive care. Since *C. botulinum* types A, B, and E most commonly cause human botulism in the United States, the prompt administration of trivalent antitoxin is indicated. (*4*) Patients should be kept under close medical supervision and respiratory failure should be anticipated. Residual toxin can be eliminated through the use of cathartics, enemas, and gastric lavage.

Epidemiological Followup

When an illness occurs resulting from foodborne botulism, the attending physician should expect additional patients. On the average, there are between two

and three patients per outbreak. (*1*) Other individuals who may have consumed the same contaminated food item as the index case should be medically observed. As mentioned previously, in the United States, most outbreaks have been traced to home processed foods such as vegetables, fish, fruits, and condiments. (*3*) Type E botulism is usually associated with marine products. The Regional Preventive Medicine Service can conduct the necessary epidemiologic investigation and thus help identify other persons at risk. The decision to give antitoxin to asymptomatic individuals exposed to the same contaminated food as a symptomatic case must be weighed against the dangers of an anaphylactic reaction to horse serum. Regardless of whether antitoxin is given, these persons should receive close medical supervision and attempts made to eliminate any unabsorbed toxin remaining in their gastrointestinal tracts.

The fundamental aspects of the diagnosis and management of foodborne botulism are presented in Table 1.

Wound and Infant Botulism

The diagnosis and management of wound and infant botulism is not appreciably different from foodborne botulism. In wound botulism gastrointestinal symptoms are absent, but the neurological symptoms are classic. This type of botulism is extremely rare, with only seven illnesses being reported in the seven-year period 1973-1979. (*1*) Infant botulism, on the other hand, is being recognized with increasing frequency. When infants, generally less than six months of age, ingest spores of *C. botulinum*, the organism can colonize in the intestinal tract and produce toxin. Constipation is usually the first symptom, followed by manifestations of cranial neuropathy. As the disease progresses, paralysis of the peripheral and respiratory musculature ensues. The diagnosis is established by demonstrating *C. botulinum* or its toxin in the feces. (*6*) Treatment consists of intensive supportive care directed particularly at nutrition and ventilation. The effectiveness of specific therapy such as antitoxin or oral antibiotics has not yet been determined. (*1*)

For those wishing a more comprehensive review of botulism, the CDC handbook, *Botulism in the United States, 1899-1977,* is strongly recommended. (*1*)

References

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5. Dowell VR, Hatheway CL, McCroskey LM, *et al:* Coproexamination for botulinal toxin and *Clostridium botulinum. JAMA* 238:1829-1832, 1977.
6. Midura TF, Arnon SS: Identification of *Clostridium botulinum* and its toxins in feces. *Lancet* 2:934-936, 1976. □

Corrections

May 1980: "An Investigation of Assessment Techniques for Body Composition of Women Marines," Table 3, page 20, has several minus (-) signs that were deleted. The first equation 3.380 should read -3.380. The second equation, .131 should read -.131; .250 should be -.250; .110 should read -.110.

May 1981: "To sBe Or Not To sBe (That is the Question!)," Table 1, page 31: Regimen A, Children Under 60 lbs. "Penicillin V, 1 mg." should read **1 gram**. Under Alternate Regimen A: Adults and Children Over 60 lbs. "Erythromycin 1 mg. orally . . ." should read **1 gram** orally.

June 1981: "MSC Survey Results," Tables 1 and 2, page 17. The first footnote in each should read **degrees of freedom.**

Root Fractures in Anterior Teeth

LCDR Robert L. Sherman, DC, USN

Few dental emergencies exert so great a psychological impact on children and parents as a traumatic injury to a child's mouth. The major problem is generally an emotional one, expressed as fear and anxiety, the child's distress being exceeded only by that of the parent. (*1*) Injuries to the mouth and face may result in the traumatic fracture of roots of anterior teeth. The purpose of this report is to review the diagnosis, treatment, and post-treatment sequelae of anterior teeth with fractured roots.

Root fractures are described according to their anatomic location on the root. Fractures occur in the apical, middle, and cervical third of the root. Vertical fractures have also been reported. (*2,3*) Most fractures occur in the middle third of the root. (*4,5*) The incidence of fractured roots is greatest between the ages of 11 and 20, and males experience three times more fractures than females. As might be expected, the accidents are frequently associated with play (particularly with bicycles), participation in athletic events, and automobiles. (*6*) In a study of 252 cases of root fracture, (*7*) 24 percent of the patients had histories of previous dental trauma. Root fractures seldom occur in young permanent teeth with incompletely formed apices; if the trauma was severe enough to fracture the root, luxation or complete avulsion would result because of the undeveloped periodontium, the small amount of root surface area, (*8*) and the elasticity of the alveolar socket. (*6,9*) However, Jacobsen (*10*) reported on seven fractured teeth with incomplete root formation. In the primary dentition, root fractures seldom occur before completion of root development. (*4*)

In a study of 50 cases of root fractures, (*11*) 35 teeth were central incisors, and all the fractures were the results of acute trauma. The preponderance of fractures in the anterior segment of the mouth has been linked with malocclusion. Hardwick and Newman (*12*) found that 86 percent of all fractures occurred in unduly prominent teeth. Sweet (*13*) pointed out that more than 90 percent of all fractured anterior teeth protruded and did not have lip coverage. He suggested that protruding permanent anterior teeth should be retracted, not to correct malocclusion but to provide lip coverage and prevent possible fracture.

The basis of any successful endodontic treatment depends on complete diagnosis. This diagnosis should be based on a thorough recorded history of the accident, not only for subsequent treatment, but also for insurance or litigation purposes. (*1*) Salient details should include the name, address, and age of the child, pertinent medical history, time and place of accident, and whether the child is in pain. It must be remembered that trauma to the oral cavity may be only part of the larger consideration of the trauma to the head. (*1*) Most oral and head injuries are caused by a blunt object's striking the head or the head being flung against a hard surface. These "blunt head injuries" can result in skull fracture or contusion, laceration, hemorrhage, and swelling of the brain. A gross neurologic and ocular examination should be included in the initial examination. The following signs and symptoms necessitate the immediate referral of the patient to a physician: dilated and unreactive pupil, severe headache, drowsiness, vomiting, convulsions, blurring vision, dizziness, and loss of smell, taste, hearing, or sight. If the child has not had a recent tetanus shot, the parent should be advised of the need for one without delay.

The patient should be examined for possible mandibular or maxillary fracture. This is done by observation of the continuity of the occlusal plane and digital examination. The condyles, which can be fractured by a heavy blow to the chin, can be checked if the examiner places the index fingers in the external auditory meatus. If the condyles are in the glenoid fossae, they can be palpated. If a condyle is fractured, the patient will experience pain upon opening and there will be a shift of the midline toward the affected side. (*1*)

The next step is a complete intraoral examination of all soft tissues. All bruises and lacerations of lip, tongue, gingivae, and cheeks should be investigated for foreign debris. Small pebbles, bits of glass, and tooth structure often become lodged in lacerations. A traumatic blow will occasionally result in the fracture of the alveolar process as well as the tooth. This is an especially common finding in the mandibular incisor region.

Diagnosis

When observing the teeth, one should evaluate:

- the position of the affected tooth relative to its neighbors,
- the degree of mobility of the tooth,
- the presence of crepitus when the tooth is moved,
- soreness upon palpation; and
- the presence of a sinus tract. (*9,14*)

If the patient has delayed treatment, there may be discoloration of the crown. (*15*) The discoloration means that

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there has been bleeding into the dental tubules but does not indicate that the tooth is pulpless. If the tooth retains its vitality, the pigment in the tubules will be at least partially resorbed. If the tooth becomes pulpless, it will not return to its natural color. (*16*)

Thermal or electric pulp tests are usually meaningless when conducted immediately following the trauma (*5*) because there is a transient paresthesia of the nerve. However, the vitality tests should be conducted to establish a reference point. (*17*)

The use of high-quality radiographs of the injured and adjacent teeth is an absolute must in diagnosing traumatic situations. (*1*) Special attention should be directed to:

- the size of the pulp chamber and the proximity of any crown fractures to the pulp tissue,
- the stage of root development,
- the presence and relative location of root fractures,
- the presence of alveolar fractures; and
- the presence of pathological effects from earlier injuries.

If the presence of foreign debris in the soft tissue is suspected, a radiograph should be taken of the soft-tissue areas as well. (*1*)

Lindahl (*18*) points out that intra-alveolar root fractures can occur in both a longitudinal and transverse plane to the long axis of the tooth. Radiographic demonstration of root fractures is facilitated by the fact that most of these fractures occur in the transverse or oblique plane. Because the lingually directed traumatic forces cause compression of the root against the alveolar bone at the coronal third on the lingual side and at the apical third on the labial side, the fracture occurs along an oblique line connecting the compression areas. (*9,14*)

Radiographs of the injured tooth made immediately following the trauma may fail to reveal the fracture. (*15*) Radiographs made one or two weeks later may disclose the fracture clearly. (*19*) This phenomenon is the result of hemorrhage, edema, or granulation tissue between the fragments pushing them apart. It has been suggested (*19*) that increased mobility of the fractured coronal portion, causing some luxation, may make the fracture line more obvious in a radiograph taken later.

Vertical root fractures are particularly difficult to diagnose. Radiographically, they may be undetectable because the segments have not been displaced or because the fracture is in a mesiodistal rather than labiolingual direction. When the root is fractured mesiodistally, the central x-ray beam is at right angles to the fracture and the fracture cannot be seen on the film. (*2,3*)

Fractured roots may also escape detection because the oblique angle in which they often fracture is similar to the normal angle at which radiographs are made. Lindahl (*18*) recommends that films be made at angles of 45°, 90°, and 110° to the long axis of the tooth in the vertical plane. The central beam should be directed at the middle of the root and should be at right angles to the line of the arch. With this technique, a root fracture could hardly escape detection. By relating the central beam to the radiographic image of the root, a good assessment of the buccolingual angulation of the fracture can be obtained.

Reactions to Root Fracture

The histologic reaction to root fractures in human subjects has been difficult to study because of the lack of material. Fractured teeth are extracted too soon after injury to be of value to oral pathologists. If the teeth maintain their vitality and go on to heal, there is no need to remove them. Further, for adequate investigation of the repair processes, the root fragments must be studied in their proper relationship to one another and to the surrounding tissue. This necessitates an extensive resectioning of alveolar bone, which is seldom indicated in human patients. (*20*) Little use has been made of autopsy material. (*21*)

The histologic reaction to root fractures has been studied experimentally in animals. Hammer, (*4*) studying experimental root fractures in dogs, found that 24 hours after surgery a coagulum developed in the fracture line; this was accompanied by hyperemic changes in the pulp. Next, odontoblasts and pulpal cells entered the fracture line to a limited extent. Later, a callus was formed.

Bevelander (*22*) also studied experimental root fractures in dogs. Two weeks after the intentional fracturing of the teeth, he found that necrosis and resorption occurred in the coronal part of the pulp that had been exposed to the oral fluids. In some instances, gingival epithelium had proliferated over the exposed pulp surface. In these pulps, a moderate round-cell infiltrate and fibrous replacement occurred in the coronal pulp, but the apical part of the pulp remained relatively normal. The presence of inflammation and necrotic tissue in the coronal pulp retarded the rate of healing.

The trauma of root fracture in man may lead to hyperemia, pulpitis, and subsequent necrosis of the pulp. (*8*) The irritation and inflammation lead to hemorrhage and increased permeability of the capillary vessels. The resulting leakage of plasma, circulatory stagnation, and engorgement of the vessels do not necessarily cause pulp necrosis. If it is not excessive, the hyperemia of the pulp is reversible, and the pulp may recover completely. (*8*)

Repair

Four types of repair have been described on the basis of radiographic and histologic observations. (*11,14*)

(1) **Healing with calcified tissue between the fragments has been described.** (*11*) Radiographically, the fracture line is discernible, but the fragments are in

Root fractures of anterior teeth

close contact with one another. Histologically, the nature of the tissue uniting the segments has been described as dentin, osteodentin, or cementum. (*14,23,24*) Omnell (*24*) found that the calcified repair tissue was preceded by resorption of dentin. The repair is never completely calcified, and in some areas the pulp and the periodontal ligament approach each other, with connective tissue interspersed. In the pulp space at the point of the fracture, a calcified "seal" or bridge forms. (*25*) The calcified tissue was perforated by channels containing blood vessels and nerves. The "seal" tissue, which is tubular, seems to be the result of modified odontoblasts. The pulp tissue in both fragments usually appears normal. Clinical examination of teeth with calcific repair shows no normal loosening, and normal or slightly decreased response to vitality tests. (*14*) This type of union is referred to as pseudoarthrosis. (*15*)

(2) **Healing with the interposition of connective tissue between the fragments has been found.** (*11*) Radiographs show evidence of peripheral rounding of the fracture edges, and a radiolucent line separates the fragments. (*4*) Boulger (*26*) described a case in which the fragments were separated by 3 or 4 mm. The fractured surfaces of both segments were covered by secondary cementum surrounded by a periodontal space. A proliferation of connective tissue was formed between the two fragments. While the pulp tissue had undergone some fibrous change, blood vessels and nerve bundles were seen coursing through the connective tissue. The tissue was completely free of inflammatory changes and necrosis. (*26*) Clinically, the teeth in this group are firm unless the fracture is located near the gingival sulcus, and the teeth give a normal vitality test response. (*11*)

(3) **Interposition of bone and connective tissue has occurred between the fragmented sections.** (*11*) Blackwood (*20*) described a case in which the fractured portions of the root were completely separated from each other by a plate of bone. This bone was continuous with the alveolar bone that made up the socket wall. The bone, which consisted of well-formed lamellar tissue, extended into the opened coronal and apical portions of the pulp chamber, but no ankylosis had occurred. The dentin bordering the fracture had undergone some osteoclastic resorption, as indicated by the rounded appearance of the root structure in a radiograph. All the resorptive surfaces were covered by cementum. The pulp tissue was replaced for the most part by cellular fibrous connective tissue. This connective tissue was continuous across the fracture with the periodontal membrane. The vessels and nerves were still intact and reacted to vitality tests. Andreasen (*11*) states that these teeth are usually not loose, but in the case reported by Blackwood, (*20*) the coronal portion was mobile.

(4) **The interposition of granulation tissue has been found.** Andreasen and Hjorting-Hansen (*11*) reported on 21 teeth that showed inflamed granulation tissue between the fragments. In nine of the teeth, there was necrotic pulp tissue in the coronal portion and vital pulp in the apical fragment. In seven teeth, the inflammation at the fracture line was caused by a pulpal necrosis. In two instances, the fracture line communicated with the gingival crevice and the infection could have originated from either the pulp tissue or the gingival sulcus. Clinically, only five of the teeth were firm. Eighteen of the 21 teeth in this group did not respond to vitality tests. On radiographic examination, radiolucencies were always present in the area of the fracture line. (*11*)

Treatment

Michanowicz (*27*) points out that too often fractured teeth are sacrificed unnecessarily. As stated earlier, numerous authors (*11,20,23,24,26*) have demonstrated that root fractures will heal. The mere loss of tooth vitality and the infection of supporting structures do not necessarily mean that extraction is indicated. (*27*)

The reduction of the displaced fragments is the initial step in the treatment of fractured roots. (*4*) After the area is anesthetized, the repositioning can be done easily with finger pressure. The ingrowth of fibroblasts and cement-

oblasts along the fracture line follows the initial hemorrhage that takes place. The development of a fibrous bridge, followed by the laying down of cementum, cements the fragments together if they are in close apposition. (*17*)

A solid union between the fragments will not develop if the coronal fragment is loosened by the trauma and is also subject to masticatory stresses. (*17*) The coronal fragment must be immobilized as much as possible, (*15*) which can be done in several ways. A splint may be constructed from orthodontic wire and the traumatized tooth may be ligated, or banded to the arch wire. (*17*) Andreasen (*4*) suggests using orthodontic bands and splinting them together with a piece of cold-curing acrylic resin. A simple wire splint is usually effective. Painting the wire with acrylic resin may make it more esthetic and hygienic. A night-guard style of splint is advocated by Weine. (*9*) He directs the patient to wear the guard for a two-month period when eating and sleeping. The fixation period should be sufficient to allow hard-tissue union; a period up to three months is recommended by others. It may also be necessary to reduce the occlusion so that further trauma is minimized. (*15*) Radiographs and vitality tests should be performed at regular intervals to disclose pupal necrosis. (*4*)

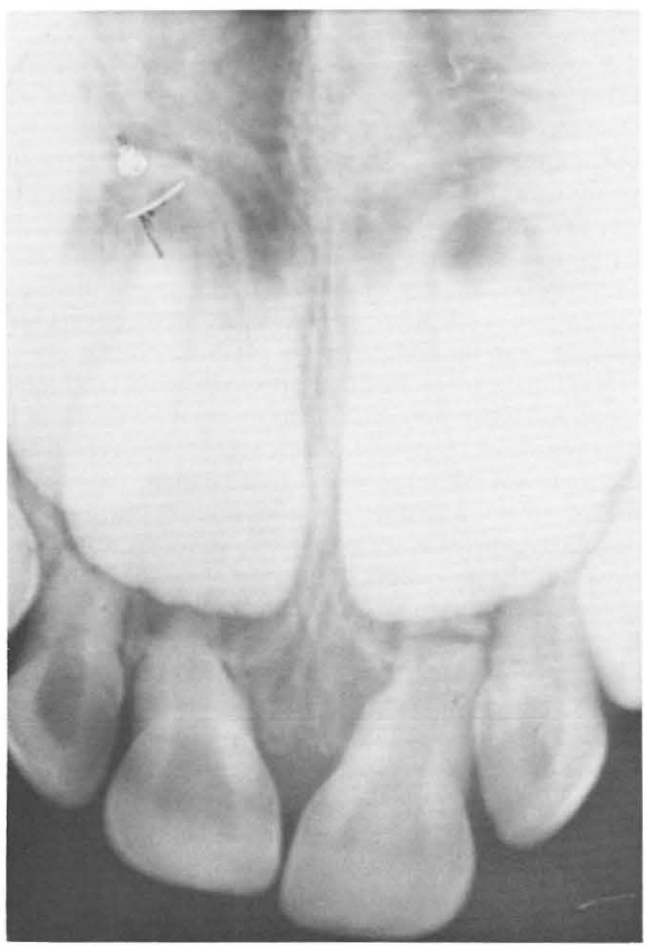
In the absence of clinical symptoms and radiographic evidence of pathosis and in the presence of a vital pulp, no surgical or endodontic therapy is needed. (*5*) Further treatment is indicated, however, if there are symptoms such as pain, loss of vitality, increased separation of parts, development of sinus tract, radiographic indications of root resorption, periapical radiolucency, or sudden increase in calcification of the canal. (*5, 15*)

The type of treatment indicated is based on the pulpal status and the anatomic location of the fracture. If the fracture is in the apical portion of the root, it must be remembered that the apical tissue is almost always vital. (*11*) Thus, endodontic treatment of the coronal fragment only may eliminate the inflammatory changes. (*27*)

If it is necessary to remove the apical portion, Weine (*28*) suggests a two-step procedure, filling the coronal portion with Tubliseal and lateral condensation of gutta-percha. He recommends Tubliseal (*9*) because it sets rapidly and flows excessively and is thus a good marker. After the canal is obturated, a flap is raised and the apical portion is removed. It must be remembered that, because of the oblique nature of the fracture line buccolingually, it may be necessary to remove an extensive amount of coronal fragment to deliver the apical portion. (*9*)

Fractures in the middle third of the root may require internal bracing if the pulp becomes necrotic or the coronal portion becomes excessively mobile. In this situation, the root canal filling material is used not only to obliterate the root canal space, but also to immobilize the segments. The canal is enlarged to a minimum of a size No. 70 and preferably to size No. 100 if root anatomy will permit. A chrome-cobalt alloy pin is then fitted to the preparation. Particular care must be taken in fitting the alloy pin. It must fit snugly throughout the canal if the segments are to be properly immobilized. The pin is cemented into place, with the sectioned silver cone scoring technique used to allow for post space. (*35*)

In some midroot fractures and in cervical-third fractures, it may be necessary to remove the apical fragment and use endosseous implants to improve the crown/root ratio. (*28, 29, 30*) Weine (*9*) suggests that a canal preparation be performed at an appointment prior to the surgery appointment. The canal should be prepared to a minimum width of size No. 100. At the surgical appointment, the apical fragment is removed and the chrome-cobalt alloy pin is placed. The pin should be fitted so that it binds snugly at the apical extent of the fragment. The pin length should approximate the removed apical segment. However, the pin must not contact the bone in the periapical region, because this will prevent the pin from fitting properly in the fragment.



Root fractures of anterior teeth

Andreasen (*29*) reported on 12 cases of chromium-cobalt implant after root fracture with a one- to three and a half-year followup. A leak was found between the post and the canal in each of four unsuccessful cases.

Fracture of the cervical third of the root can also be managed by removing the crown of the tooth and performing gingivoplasty and alveoplasty. When the root face is exposed, the root canal is debrided and the patient is given another appointment for canal filling. After the apical segment is filled, the remainder of the canal is prepared for a post, core, and crown. (*5*) The use of gingivoplasty and alveoplasty may result in a difficult periodontal and esthetic situation, however, because of the differing bone and soft-tissue levels between neighboring teeth. (*31*)

Heithersay (*31*) recommended the combined use of endodontics and orthodontics in the treatment of root fractures in the region of the alveolar crest. After the apical region of the root had been sealed, a post was cemented in the fragment. Then, with the use of orthodontic bands and wires on neighboring teeth, the tooth was moved incisally at a controlled rate. The orthodontic movement was usually completed in four weeks and then the tooth was retained for six weeks to allow for periodontal fiber stabilization. Preparation of a post-retained crown was then completed.

Recently, Michanowicz *et al* (*32*) reported the successful treatment of a central incisor with a vertical root fracture. The tooth was stabilized with a maxillary arch-bar splint. A layer of Dycal was placed over the fracture site and an acid etch procedure using unfilled resin glaze was used to cover the vertical fracture of the enamel. The tooth was splinted for six weeks. Six months later, examination showed that root development had continued, the tooth was asymptomatic, vitality tests were positive, and the unfilled resin glaze was intact.

As stated earlier, root fractures in primary teeth rarely occur, but when they do, a decision must be made on the best course of treatment. Andreasen (*4*) believes that, if the roots are fractured without dislocation, they may be preserved and a normal shedding process may be anticipated. Usually, it is not possible to splint these teeth. If, however, the fragments of the primary root are severely dislocated, the coronal fragment should generally be removed because pulp necrosis is likely to occur. To avoid possible trauma to the permanent tooth germ, no attempt should be made to remove the apical fragment. Normal physiological root resorption can be expected to eliminate the apical fragment.

Prognosis

The prognosis for the pulps of teeth with root fractures is variable. In two separate studies, Austin (*33*) (40 teeth) and Zachrisson and Jacobsen (*34*) (66 teeth) reported that 20 percent of the pulps became necrotic. On the other hand, Andreasen and Hjorting-Hansen, (*11*) (50 teeth) found no pulpal healing in 44 percent of the cases. This wide difference might be explained by the fact that, in the last study, the patients were followed from the time of the accident, and in the former reports, the patients were seen initially at a longer interval after the accident.

Kronfeld (*17*) has enumerated four conditions that are essential for the maintenance of pulpal vitality and the successful healing of the fractured root:

- The fragments must be in close apposition.
- The teeth must be immobilized in their position.
- There must be no infection.
- The patient's general health must be good enough to make reparative and regenerative processes possible.

Bevelander (*22*) found experimentally that root fracture repair in dogs occurred if the fragments of the root were aligned and stabilized in close apposition to each other. Although in some respects the repair was similar to the calcific repair in bone, it was not as rapid or as extensive in the roots. No healing occurred when the fracture communicated with the oral cavity.

The pulp is more likely to survive after root fracture than after luxation. (*21*) This may be the result of collateral communication between the circulation of the periodontal tissue and the pulp tissue across the fracture, facilitating the reestablishment of the blood supply. (*8*) Another possibility is that the fracture provides the pulp edema an avenue of escape, thus minimizing pressure buildup on the pulp vessels. (*4,8*)

Pulp necrosis usually occurs within the first two months after injury. The patient should be examined and radiographed on a regular basis during this period. If pulp necrosis does occur, it can usually be diagnosed radiographically by the radiolucency developing adjacent to the fracture line. (*4*)

As mentioned earlier, the fractured tooth often does not respond to vitality tests immediately following the injury. Gradually, however, the sensation in the fractured tooth returns, and after one or two years response may be the same as in intact teeth. (*10,21*) Thus the diagnosis of the pulp tissue should always be based on clinical and radiographic evaluation. (*4*)

Among the factors that may lead to pulp necrosis are (1) extrusion of coronal fragment at the time of injury, (2) the mobility of the fragment, and (3) the condition of the periodontium. (*34*) The factors that seem to have a positive influence on pulp vitality are (1) the immediate repositioning of the displaced coronal fragment to the normal anatomic location, (2) the fixation, and (3) the relief of occlusal stress. Splinting for more than two months gave no better results than splinting for just two months, according to Andreasen *et al.* (*11*)

The anatomic location of the fracture is an important

consideration in the prognosis. When fractures occur in the coronal third of the root, the prognosis is poor because of the difficulty of immobilizing the fragments and the possible contamination of the fracture by bacteria through the gingival crevice. There is a better prognosis for fractures in the middle third if mobility is not a problem and if there is no periodontal disease. The most favorable prognosis is for fractures in the apical third of the root. (*8*)

There is a very poor prognosis for vertical root fractures because the fractured segments will not usually unite by callus formation. The fracture invariably involves both the labial and lingual surfaces of the root, and thus repair of the labial root surface alone will not produce a satisfactory result. Extraction, therefore, is generally indicated. (*2,3*)

In Jacobsen's report (*10*) on seven teeth with incomplete formation at the time of root fracture, the teeth were stabilized for a period of 4 to 14 weeks. After fixation, two teeth were slightly mobile but responded normally to percussion and vitality tests. The young teeth went on to complete root formation and closure of the apical foramen in all cases. There was little or no change in root length and configuration in comparison with root length and configuration of the intact contralateral tooth. Partial obliteration of the pulp canal occurred in the apical fragment in three cases.

Although the pulp tissue in most fractured teeth remains vital when it is treated properly, calcific metamorphosis of the pulp does occur in many instances. Jacobsen and Zachrisson (*35*) reported that, of 51 permanent anterior teeth with fractured roots, 44 teeth (86 percent) showed some degree of canal obliteration. The coronal and/or apical fragment showed partial or total calcific metamorphosis. It was not possible to determine which fracture characteristics later resulted in either type of pulp obliteration.

Conclusion

The fractured root is not the hopeless situation it might have been a few years ago. With careful diagnosis and correct treatment, the fractured root can be encouraged to heal. If the tooth does become symptomatic, the combined use of endodontics and restorative procedures should achieve a successful result.

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