Pushing Laboratory Medicine to the Extreme

As scientists, our curiosity propels us to push existing boundaries in our quest for knowledge to drive medical breakthroughs that will improve patient care. The practices of pathology and medical research are performed everywhere—beyond the walls of traditional clinical or medical laboratories.

Extreme environments—Antarctica, space, and combat zones—test our physical, psychological, and interpersonal abilities to adapt and survive in these settings. They also require innovation in adapting laboratory practices as well as equipment to perform effectively in remote locales.

This issue of *Critical Values* explores several extreme environments where ASCP members practice pathology and laboratory medicine and the significance of their work in the advancement of medicine. For instance, what can we learn about how the human body responds in outer space, 200 miles from Earth, where atmospheric temperatures can reach 250 degrees below zero? In his article “Health Monitoring and Clinical Laboratory Diagnostics for Astronauts,” NASA’s Brian Crucian, PhD, MT(ASCP), notes that scientific learning has come a long way since the first space launch in 1961. Spaceflight can have many adverse effects on the human body, from loss of bone density and muscle strength to fluid redistribution.

In an article on laboratory medicine in Antarctica, Dr. Crucian takes us on a virtual journey to one of the most fascinating, yet isolated regions on Earth, where scientific exploration yields amazing insights. The challenges of practicing medicine in Antarctica are daunting, and scientific teams that reside there during the winter months must deal with medical emergencies autonomously.

Concordia Station, a French/Italian research facility approximately 600 miles inland from the Antarctic coast, is equipped with laboratory space. It is possible to operate basic medical laboratory instrumentation, yet operation of the instruments can be hampered by temperature, humidity, and static electricity.

Our quest to find solutions can lead us in unexpected directions, often yielding surprising outcomes. Marianne Hamel, MD, PhD, FASCP, a forensic pathologist, collaborated with Nikki Johnson, an artist and forensic photographer, to create “Death Under Glass,” a collection of photomicrographs of human tissue from autopsies conducted to determine the cause and manner of deaths. These images offer “the pathologist’s view of the world,” Dr. Hamel writes in her article, and document the histologic signs of infectious disease, trauma, substance abuse, and poisoning in each photomicrograph. Each is accompanied by a description of the significance of the pathology found within.

Detective work is also required by the medical laboratory professionals who conduct an intricate process of drug testing on elite athletes to determine if they are using performance-enhancing substances. Anthony Butch, PhD, MT(ASCP), DABCC, a member of the Olympic Drug Testing Committee, describes drug testing programs that use World Anti-Doping Agency (WADA)-accredited laboratories to test for prohibited substances. His article highlights the operations and methods used by WADA-accredited laboratories to detect doping in sports at all levels of competition.

All of these scientists work in medical laboratory settings that are often hidden from view. Yet, they share a willingness to put themselves in unimaginably challenging conditions in their quest to advance the frontiers of science for our benefit.

For additional articles and information on extreme environments, download the app version of *Critical Values* for bonus content.

As always, thank you for your continuing support of ASCP. Please send me your comments and suggestions at Blair.Holladay@ascp.org. My very best to each of you.

E. Blair Holladay, PhD, SCT(ASCP)CM

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Dr. Holladay is Executive Vice President of ASCP.
Getting the Job Done

Drug Testing Laboratories and Sports Doping: An Inside Look

About Critical Values
E. Blair Holladay

Leadership Messages

Getting the Job Done
William G. Finn

Making a Difference in Exceptional Environments
Diana Kremitske

Making an Impact Beyond Your Lab in Not-So-Atypical Ways
Maria Hintzke

3

6

10

14

content
in this issue

Health Monitoring and Clinical Laboratory Diagnostics for Astronauts

Death Under Glass Highlights Forensic Histology

Beyond the Laboratory

18  40 Under Forty: The Top 5
20  Drug Testing Laboratories and Sports Doping: An Inside Look
    Anthony W. Butch
24  Health Monitoring and Clinical Laboratory Diagnostics for Astronauts
    Brian Crucian and Kathleen McMonigal
28  Death Under Glass Highlights Forensic Histology
    Marianne Hamel and Nikki Johnson
32  Laboratory Medicine at Concordia Station, Dome C, Interior Antarctica
    Alex Salam, Alexander Chouker, and Brian Crucian
36  ASCP News
Getting the Job Done

This issue of Critical Values features the delivery of laboratory medicine services under conditions of extreme isolation or stress—including at Concordia Station in Antarctica, and aboard the International Space Station. In the case of Antarctica, a core of medical laboratory services is available to researchers stationed there, including fairly complex technologies required to support ongoing research—a testament to the commitment of laboratory professionals and pathologists to get the job done even in the face of substantial adversity.

The stories conveyed in this issue reflect our collective character as a unique group of healthcare professionals. Our profession has braved the stress of workforce shortages, the closure of training programs, and the rapid development of new needs in clinical laboratory diagnostics. We continue to deliver in response to conflicting mandates: keeping laboratory medicine practice at the cutting edge of emerging technologies and maintaining impeccable quality, while also meeting ever-increasing demands for cost-effectiveness using limited resources.

The pathology and laboratory medicine community has a long history of innovation in the face of daunting challenges. Decades of transforming discoveries have been translated quickly and efficiently to clinical use by the legion of experts in our field—experts from all walks of our discipline, in industry, in academic practice, in private practice, in applied research, in basic research, in public health, and in public policy. Paradoxically, the extraordinary productivity of “bench to bedside” discovery in our field often resulted in relative indifference regarding re-
remarkable advances in laboratory medicine, and this in turn led to concerns about the commoditization of laboratory medicine. In a sense, the process of advancement was so seamless that its magnitude flew below the radar, even to some within our profession.

“Black box” automated analyzers didn’t sprout from trees; they were invented by the intelligent and creative minds of laboratory professionals and pathologists. The highly functional, automated nature of the laboratory (which, ironically, led to concerns of commoditization) was the product of decades of insightful and dedicated work converting once manual, subjective testing to automated, consistent, systems-based analysis. This allowed for rapid production of panels of analytical information that could then be converted into precise diagnostic algorithms. “Precision diagnostics” may be a recently coined phrase, but the concept has been with us since the mid-20th century.

Fortunately, there seems to be a new wave of recognition of this remarkable transformation. Those who may have overlooked laboratory medicine are now rediscovering its wonder in the form of genomics, proteomics, and computational medicine—areas currently undergoing the transition to automation that began decades ago for a generation of testing now considered routine. The modernization that took place in the second half of the last century is reborn in a new generation of analytical diagnostics.

There are amazing opportunities in this rediscovery, but there are also risks. On the one hand, we have a renewed
opportunity to unite around the common mission of bringing the highest-quality and most efficiently applied scientific methods to the noble calling of patient care, while reaching a legion of hearts and minds that may have eluded us in the 20th century era of laboratory achievement. We also have a new opportunity to place pathologists and laboratory professionals at the center of consultative clinical care as essential components of the medical team.5,6,7 On the other hand, we risk losing today’s enthusiasm to another generation of passivity as today’s high-tech cutting edge becomes tomorrow’s automated black box. We need to walk the fine line of designing new paradigms in analytical diagnostics while being careful not to reinvent established processes of analysis, quality assurance, and validation through a lack of understanding of our own history. Our opportunity here is not only in scientific and medical advancement, but also in education: We must educate today’s trainees (residents, fellows, laboratory professionals) to embrace and appreciate the miracle of innovation and productivity that is taking place in the real time of their training—an opportunity that may have been incompletely realized in the previous generation of laboratory medicine training.

As our members and our patients navigate through extreme challenges, ASCP is there to provide leadership and support. Our Institute for Science, Technology, and Policy is actively engaged in health services research to derive data to fuel the development of smart policy and practice. Innovative educational products such as Lab Management University and Training Residents in Genomics are continually being developed in cooperation with our many partner organizations to support the ability of our members to face the rapidly changing practice environment. The ASCP Board of Certification continues to expand its categories to provide robust credentialing in emerging fields such as molecular diagnostics, tissue repositories, and informatics. We are the only pathology organization represented in the American Board of Internal Medicine’s Choosing Wisely campaign, aimed at the most efficient and effective use of our healthcare dollars. We continue to be a globally engaged organization, working with the Centers for Disease Control and Prevention, the World Health Organization, the Clinton Global Initiative, the George W. Bush Foundation, and many other partners to expand the availability and increase the quality of health care worldwide. As specialists in the application of analytical methods to the diagnosis and management of human disease, pathologists and laboratory professionals can be proud to continue the tradition of rapidly adapting emerging technologies to real clinical use. Just as ASCP was there to drive and support the productivity miracle of the 20th century, so will we be there to drive and support the current revolution in laboratory medicine. As the representative organization for the entire diagnostic laboratory team, we are uniquely situated to get the job done. And we are, as always, stronger together.

References


Dr. Finn is Medical Director of Warde Medical Laboratory and a partner at IHA Pathology and Laboratory Management in Ann Arbor, Mich.
The American Society for Clinical Pathology offers information and education that can aid your practice as pathologists or laboratory professionals. Whether you read the printed journals or get your information online, the American Journal of Clinical Pathology (AJCP) and Lab Medicine provide the latest research, reports, and studies. Digital editions of the journals are available to download for both Apple and Android devices. Here are some highlights from recent issues.

AJCP
The August issue of AJCP highlights several interesting case reports, which are now published quarterly. In the September issue, Drs. Andrew S. Williams and Kelly Dakin Hache describe their study evaluating pathologists’ accuracy in identifying tissue-marking dye colors for use in surgical pathology. In the October issue, Dr. Richard L. Haspel and colleagues describe how they used survey and knowledge questions for the 2013 Pathology Resident In-Service Examination (RISE) to determine the current state of pathology resident training in genomic and molecular pathology. Read the results at www.ajcp.com, where these articles and others can be accessed as part of your ASCP membership.

Lab Medicine
The Summer 2014 issue of Lab Medicine features an article on a 13-question approach to resolving discrepancies in transfusion medicine laboratories, by Dr. Jovana Yudin and Ms. Nancy Heddle. In a Laboratory QA article, Drs. Lindsay Haldiman, Hamid Zia, and Gurumukh Singh discuss the role of pathology students as consultants for improving the appropriateness of blood utilization.

Personalized medicine is a hot topic in laboratory medicine circles. If your lab wants to get in on the action, you'll need to start a molecular diagnostics department. The Lab Medicine website offers a primer that walks you through the process: http://labmed.ascpjournals.org/site/professional-resources/molecular-diagnostics.xhtml.

Do you like to listen to podcasts? Check out the latest additions to the podcast series on the website: http://labmed.ascpjournals.org/site/includefiles/multimedia.xhtml.

Lablogatory: The Blog for Medical Laboratory Professionals has new posts about the Food and Drug Administration’s oversight of Laboratory Defined Tests. Follow the blog for updates as we track this ever-shifting landscape: http://labmedicineblog.com.
The practice of laboratory medicine reaches into many different settings to address healthcare needs. At one of my organization’s departmental strategic retreats, we recognized that the laboratory professional’s practice and influence extend far beyond the confines of the laboratory’s four walls. Part of the discussion included, for example, conceptualizing how we can elevate even higher the quality assurance of geographically dispersed lab operations and how technology can support those ideas. The discussion left me with a deeper appreciation of how our analytical ways of thinking coupled with innovative uses of technology contribute to improvements in delivering high-quality patient care in and out of the laboratory. And in order for laboratory professionals to be significant contributors to the delivery of improved healthcare services, we must sometimes think beyond conventional laboratory models.
In addition to practicing laboratory medicine on our home fronts, laboratory professionals are venturing out and meeting the challenges of providing clinical laboratory services or consultations in a variety of atypical settings. Sharing our unique perspectives is vital to help broaden our vision and underscore an appreciation of laboratory professionals as integral contributors to health care, locally and globally. For example, a medical technologist in our department volunteers on an annual medical mission trip to Nicaragua, where providing good patient care can be challenging due to limited resources. Also, after reading the profiles of the individuals recognized in the 40 Under Forty Program, it is evident that these young professionals are passionate about their work and the contributions they make to health care, as some utilize their training and skills to provide lab services outside of a typical laboratory, or collaborate as part of a patient care team in other parts of the world. The work experiences of the ASCP Council of Laboratory Professionals and local ASCP representatives throughout the U.S. also showcase practices in vastly different lab environments. Below, I highlight some of the exceptional work being done among the 189 ASCP local representatives and the regional representatives from eight areas of the country.

**Beyond the Conventional Lab**

To tell their stories, I prepared a few simple questions for the individuals who offered to share their experiences for this article: Describe the laboratory and a typical day. What impressed you the most about this experience? What concerns did you have in carrying out your laboratory duties in this atypical location? Was there anything different you or the team had to do in this environment to keep the patient in center focus? What lifelong impressions are you left with as
Patients would otherwise have had to drive two hours to the nearest hospital for lab and other healthcare services. To ensure the patient was the central focus, Dr. Oloyede and other members of the healthcare team addressed two distinct needs: improved patient awareness about the importance of healthcare, and engagement in the monitoring process for their particular treatment. He took it upon himself to go door to door reminding patients of their appointments and performing phlebotomy services, which sometimes included coagulation testing to monitor compliance with Coumadin therapy. The diabetic clinic on the reservation also sent nurses to patient homes to administer insulin.

Jack Hager, MS, MT(ASCP) SBB, Immediate Past Chair of the Council of Laboratory Professionals, told of his experiences with apheresis and transfusion services while he was deployed at Balad Air Force Base, Iraq. He encountered several unusual challenges in this environment, including distances for blood product delivery, extremely high temperatures, and the availability of running water. To deliver blood products safely and efficiently to those in need, a high degree of organization and coordination amongst laboratory and logistics personnel were paramount. Mr. Hager described the laboratory as a series of interconnected tents and ISO shelters. The standard trauma panel was a type and screen and hematocrit. To keep the patient in central focus, mission-critical considerations involved donor prescreening to ensure product safety and supply for emergent situations, rescreening apheresis donors every 30 days, and overcoming challenges associated with the heat extremes in Iraq. According to Mr. Hager, it was impressive to see the willingness of the U.S. military and civilian contractors to donate blood products to meet needs, and the support given by members of the team to accomplish the mission.

Why Telling These Stories is Important

Why should we build awareness about these experiences? Because recounting them demonstrates the courage it takes to participate in demanding situations and perhaps step out of our comfort zone. Moving beyond our comfort zone promotes self-discovery, continual learning, and further development of leadership skills. Perspectives are broadened by exposure to different values and cultures.

As I reflect on what drives individuals to embark on these types of professional journeys, I ask myself: Is it their desire to influence the change needed to deliver healthcare that meets a patient’s needs in these unique environments? Yes. Do they demonstrate the importance of the laboratory professional as a member of a team caring for patients, at times a life-saving team? Most definitely.

Clinical laboratory knowledge, skills, and analytical training are certainly transportable to address immediate healthcare needs, help solve longer-term problems, and bring the hope of improving health and saving lives to the communities served. Society needs qualified laboratory professionals to take on these challenges. Those who are involved in these ventures make a difference, deeply understand it takes a team effort to care for patients, feel that the experiences leave lasting impressions on their life perspectives, and, in general, would do it again.

I would like to gratefully acknowledge my colleagues from the Council of Laboratory Professionals, Dr. Babatunde Oloyede and Mr. Jack Hager, for contributing their stories, as well as those colleagues who shared their experiences with me, including David Oravitz.

Ms. Kremitske is Interim Vice President, Lab Operations, for Geisinger Health System in Danville, Penn.
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Leadership Messages

Message from the Chair of the Resident Council

By Maria Hintzke, MD

Making an Impact Beyond Your Lab in Not-So-Atypical Ways

When I learned the theme for this issue of *Critical Values*, I thought to myself, “What is a girl who has stayed in the state of Wisconsin her entire life, with the exception of meetings and vacations, going to write about?” However, after taking some time to think about it, I’ve realized that you do not need to travel far to go beyond your lab.

During the Association of Pathology Chairs/Program Directors meeting in Boston this past July, I came across a poster that instantly grabbed my attention. “Pathology Student Interest Group (PSIG):
A Success Story” highlighted the successes of the University of Maryland PSIG since its inception in 2009.1

Over the past five years, the group has become the most active subspecialty interest group on campus, now with more than 60 members. Impressively, the group has seen an eightfold increase in medical student participation in group events as well as a sevenfold increase in medical students enrolling in a pathology elective during their training. This very active group provides opportunities for students to interact with pathology residents and faculty and offers numerous fun and educational events, including fine needle aspiration labs using limes and chicken livers, Halloween-themed forensic pathology lectures and pumpkin painting, and monthly lunch meetings. The group credits strong resident participation, grant funding from the Intersociety Council for Pathology Information, and Pathology Department support for its amazing successes.

While we as residents focus so much on being the trainee and
worry about becoming competent pathologists, passing the boards, and finding a fellowship or job, we often forget about our roles as educators and mentors. In our daily practice, residents have an amazing opportunity to educate our clinicians and medical students. Not only is resident teaching a required core competency expected of all graduating residents by the Accreditation Council for Graduate Medical Education, but it also happens to be one of the pathology milestones.

The benefits are twofold. According to an article in the *Journal of Graduate Medical Education*, “Medical students benefit greatly from having residents as teachers: it has been estimated that nearly one-third of their learning in the clinical setting comes from residents.” Having residents as teachers also benefits the resident-teacher. Not surprisingly, residents who teach have greater job satisfaction. The benefits extend beyond real-time resident-student encounters. Studies have shown that “medical students’ career choice has also been linked with good resident teaching in surgery.” Given the projected pathology workforce shortage, residents can serve as some of the best advocates for the profession through interactions with medical students despite concerns regarding the current job market.

In addition to the job market and passing the board exam, one of the top three concerns for residents listed in an informal survey at the ASCP resident reception at the 2013 Annual Meeting is general professional development and training, including having the appropriate resources for the fellowship application process. When dissecting this issue, residents cite a lack of mentorship and pathology-specific resources, including assistance with CVs, cover letters, and personal statements, as key elements of the problem. Most likely, medical students applying for pathology are in the same situation regarding the residency application process, which is, as you are all aware, in full force now. According to the 2013 ASCP Fellowship and Job Market Survey, residents indicated that medical schools need to provide more hands-on experience for students to decide if they want to pursue pathology as a career. Even for medical students not entering the pathology field, residents have expressed a need for opportunities to interact with pathologists and learn more about reading pathology reports.

Residents are not only excellent advocates for the field, but we can also serve as a resource for information about the residency application process. Do you know a medical student who may be considering pathology as a career? Please refer them to the ASCP Resident Council–developed Medical Student Road Map, an online tool modeled after the *Choose Your Own Adventure* books. Medical students of all levels can use this road map to explore their potential interests in pathology and get some advice on next steps to take in the residency application process. Test out the road map here: ascp.org/Medical-Student-Road-Map.html.

Additionally, I encourage residents to go beyond the lab and to reach out to your local medical student pathology interest groups. Please let the impressive work of the University of Maryland PSIG serve as an inspiration. Would you or your medical students like to start a local interest group? Does your local interest group have great ideas but not necessarily have the funds to make them happen? ASCP offers $250 interest group grants to help support group events and can assist in finding speakers for events. Find the application here: ascp.org/PDF/Education-and-Assessment/PIGS-Grants-application.pdf.

As ASCP works to encourage the future of pathology coming into the lab, there is also much support for residents to obtain education beyond their own environment. Since their establishment in 2009, ASCP subspecialty grants have been very popular among residents. These grants help defray the costs of an away elective, which allow residents to broaden their training, learn new material, and gain exposure to potential future fellowship opportunities and employers. Residents who are awarded a grant receive $500, $1,000, or $2,000 to support one-, two-, or four-week rotations, respectively, at an outside institution. Last academic year, 11 grants were awarded, totaling $22,000. Find more information about the grant and the application here: ascp.org/grants.

On behalf of myself and the other 11 members of the Resident Council, I hope you have a wonderful academic year and take time to make an impact outside of your lab. Please email us with any questions, suggestions, or concerns at ResidentCouncil@ascp.org. We look forward to seeing you at the Annual Meeting in Tampa!

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Dr. Hintzke is a fourth-year pathology resident at the Medical College of Wisconsin in Milwaukee, Wis.
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ASCP’s 40 Under Forty program shines the spotlight on pathologists, residents, and laboratory professionals who are shaping the future of pathology and laboratory medicine. The Top Five outstanding achievers each received free registration to attend the ASCP 2014 Annual Meeting in Tampa, Fla., Oct. 8–10, along with a $1,000 stipend toward airfare and lodging, and special recognition at the Annual Meeting.

“ASCP is pleased to introduce this new program, which recognizes future leaders of the profession and their remarkable contributions to the field,” says ASCP’s Immediate Past President Steven H. Kroft, MD, FASCP. “The field of pathology and laboratory medicine offers professionals almost unlimited opportunities for change and growth, and ASCP is proud to support and encourage the next generation of leaders as they develop in their careers.”

The Top Five are among the 40 honorees who were named to ASCP’s inaugural 40 Under Forty program for their significant contributions to the profession and the leadership they have demonstrated within each of their workplaces. A combination of ASCP members voting online, blogging activity of the 40 Under Forty honorees, and a final selection committee review determined the Top Five.

Throughout the summer, the 40 honorees shared their knowledge about topics pertinent to pathology and laboratory medicine with a personal blog on ASCP’s ONELab online community.

“It has been a lot of fun,” says honoree Patrick A. Reese, HTL(ASCP)®QIHC, a laboratory manager for Boone Dermatology Clinic PA in North Carolina. “Everyone in this group is energetic and has a lot of ideas that we get to share.” Mr. Reese is a member of the National Society for Histotechnology Health and Safety Committee and has been an enthusiastic participant in the ONELab blog throughout the summer.

Another Top Five honoree, Shree G. Sharma, MD, Little Rock, Ark., is fascinated with the idea of integrating technology in the laboratory. He has already filed a patent on automating grossing in anatomic pathology, and is in the process of developing the automation. An assistant professor of Pathology at the University of Arkansas for Medical Sciences, in Little Rock, Ark., Dr. Sharma received the 2011 Outstanding Teacher Award from the residents in the department.

Anna M. Moran, MD, FASCP, Philadelphia, believes that performance improvement is the key to developing an outstanding laboratory. As lead physician for Performance Improvement at Penn Presbyterian Medical Center, she led an award-winning project to improve troponin turnaround times on third shift. Within four weeks, her laboratory reduced the turnaround time reporting of troponins to less than one hour for more than 95 percent of its specimens. A past chair of both the ASCP Resident Council and ASCP Fellow Council, she practices at Penn Presbyterian Medical Center and teaches at the University of Pennsylvania’s Perelman School of Medicine in Pathology.

Heather Vaught, MLS(ASCP)®SBB®, is the director of Technical Operations at Indiana Blood Center, Indianapolis, where she has worked for almost 15 years. She is the president-elect and communications committee chair for the Indiana State Association of Blood Banks, where she also serves as editor for the organization’s newsletter, Circulations. As a 2010/2011 ASCP Career Ambassador, she spoke to hundreds of high school students about career opportunities in the medical laboratory.

Carlo Ledesma, SH(ASCP)®MT(ASCP), is clearly proud of Diagnostic Laboratory of Oklahoma, in Oklahoma City, where he works as a laboratory professional. “When it comes to natural tragedies, disasters, we are prepared!” he wrote on his ONELab blog. He praised the extensive crisis training that the laboratory staff has received with helping address the aftermath of a major tornado that hit their area last year. Mr. Ledesma is passionate about his work. Born and raised in the Philippines, he credits a professor of hematology with sparking his interest in the specialty. He is a recipient of the ASCP Regional Member Award and a member of the Council of Laboratory Professionals.

Ms. Montgomery is Communications Writer for the American Society for Clinical Pathology.
In recent years, the sports world has seen a number of scandals involving athletes and performance-enhancing drugs. Though these cases have received much media attention of late, sports doping dates back to ancient Olympic Games held around the third century BC. Modern Olympics were introduced in 1896, and during the Games in 1904 the first near death from doping occurred after a marathon runner took a combination of strychnine and alcohol. The practice of doping rapidly spread with stimulants (cocaine and amphetamines) being used to improve performance in speed and endurance sports, and anabolic steroids taken to promote muscle mass in strength and power sports.

In response to the sports doping epidemic, the International Olympic Committee medical commission created a list of prohibited substances in 1967 and introduced drug testing the next year at the Olympic Games. Early drug testing programs failed to curb doping because the testing meth-
ods lacked sensitivity and detected only a limited number of drugs. However, as drug testing methods improved and the list of prohibited substances expanded, sporting fans soon discovered how widespread the problem was as doping athletes were stripped of their Olympic medals.

To harmonize the fight against doping in sports and establish global anti-doping principles, the World Anti-Doping Agency (WADA) was created in 1999. Anti-doping organizations have further developed drug testing programs that use WADA-accredited laboratories to test for prohibited substances. At this time, there are 32 WADA-accredited laboratories in the world, with two in the United States. The WADA anti-doping program deals with all aspects of doping control and contains multiple documents, including the World Anti-Doping Code (Code) and the Prohibited List. Anti-doping organizations that are WADA signatories are required to develop drug testing programs in accordance with the Code and use WADA-accredited laboratories for drug testing.

The Prohibited List

The WADA prohibited list is updated annually and contains numerous classes of compounds that are banned at all times and several classes of compounds that are banned in competition. Anabolic-androgenic steroids, other anabolic agents, peptide hormones, growth factors, beta-2 agonists, hormone and metabolic modulators, diuretics, and masking agents are prohibited at all times. In addition to these classes of compounds, stimulants, narcotics, cannabinoids, glucocorticosteroids, beta-blockers (some sports), and ethanol (some sports) are prohibited in competition. Each class of substances contains many compounds; 46 exogenous anabolic-androgenic steroids and 64 stimulants are on the 2014 prohibited list. The International Standard for Labo-
ratories mandates that WADA-accredited laboratories must develop testing methods such as top-down and bottom-up proteomic approaches to detect as many substances as possible on the prohibited list.6

Urine Collection and Processing

Drug testing of athletes begins with supervised collection of urine to prevent adulteration or substitution with artificial or drug-free urine. The collected urine is placed into two bottles (“A” and “B”) and is certified by the athlete. Urine samples are usually shipped at ambient temperature; chain of custody documentation begins when the samples arrive in the laboratory and is maintained throughout the testing process. Urine samples are initially inspected for evidence of tampering, leakage, abnormal color and/or clarity. The pH and specific gravity are measured as additional checks for adulteration or substitution. Between three and seven aliquots are prepared from the “A” sample for testing based on the testing needs of each client.

Sample Cleanup

Sample cleanup procedures remove unwanted nonspecific interfering substances and isolate specific compounds of interest such as steroids or stimulants. Some tests for substances such as chorionic gonadotropin and luteinizing hormone do not require sample cleanup. Other tests such as the anabolic-androgenic steroid screen require enzymatic deconjugation to remove glucuronide moieties from steroid molecules and solid phase extraction to separate the relatively nonpolar steroids. Trimethylsilyl groups are then added to steroid functional groups during derivatization to improve chromatographic and mass spectral properties of the isolated steroids. The steroid cleanup procedure takes approximately six hours.

Instrumentation and Testing Procedures

Most of the instruments in a doping control laboratory are gas chromatography (GC) and liquid chromatography (LC) separation systems that are coupled to mass spectrometers (MS) for detection of parent compounds and/or drug metabolites. GC-MS and GC-MS/MS (GC triple quad) systems are routinely used to detect anabolic steroids and stimulants. GC-MS/MS systems have increased sensitivity, fewer interfering peaks, and less background noise compared to GC-MS systems, but are considerably more expensive. LC-MS/MS systems are used to detect selected anabolic steroids and the majority of other compounds on the prohibited list. Fully automated immunoassay analyzers, which are common to routine clinical laboratories, are used to measure urinary chorionic gonadotropin and luteinizing hormone concentrations. A GC-combustion-isotope ratio MS is used to detect use of testosterone or testosterone precursors such as DHEA. Isoelectric focusing and polyacrylamide gel electrophoresis techniques are also used to detect various erythropoiesis-stimulating agents such as recombinant erythropoietin.

Urine samples being analyzed for the same class of compounds are processed in batches (15 to 30 samples) and are loaded and analyzed on one instrument. Confirmation testing would be performed on any samples that screen positive for a prohibited substance. If a sample does screen positive, it is retested separately from other unknown athlete samples. For the retest, the sample cleanup procedure would be optimized for the compound identified in the screen and multiple GC-MS ions or full scan mass spectra data would be evaluated to confirm identification of the compound. If LC-MS/MS or GC triple-quad instruments are used, multiple transitions would be evaluated for compound identification. In all cases the confirmation data would be reviewed by two certifying scientists before being reported as positive (adverse analytical finding) and would be required to satisfy all criteria in the WADA technical document on compound identification.7 Athletes with a positive “A” sample have the right to have the “B” sample tested to confirm the findings, and are entitled to witness the entire “B” sample testing process with representation—for example, a lawyer or forensic toxicologist.

Legal Aspects

The use of a prohibited substance without a valid medical reason is considered an anti-doping rule violation. An athlete has the right to appeal an anti-doping rule violation and in some cases can appeal directly to the Court of Arbitration for Sport. The anti-doping organization must establish that an anti-doping rule violation has occurred to the “comfortable satisfaction” of the hearing panel. In all cases this is more than the mere balance of probability, which is higher than the 50 percent standard, but less than proof beyond a reasonable doubt. For WADA signatories, sanctions can range from
a simple reprimand to a maximum of two years of ineligibility based on the athlete’s degree of fault. Non-WADA signatories (professional sports) have their own rules for ineligibility.

An athlete has the right to appeal a sanction and laboratories that performed the testing are often called upon to testify during the appeal process. Although each case is different, a laboratory expert, typically the laboratory director, is required to explain and defend all aspects of the testing process. In addition, the expert might be asked details about the prohibited substance such as what the drug is, why it is considered performance enhancing, possible adverse effects from taking the drug, when the drug was taken, and how much was administered. Some of these questions can be difficult to answer since pharmacokinetic data is often unavailable for many of the illegal drugs. Two of the most difficult questions asked at appeals are whether the substance would enhance performance based on the detected concentration and if the substance was intentionally or unknowingly (contaminated supplement) ingested by the athlete.

**External Quality Control**

WADA requires that accredited laboratories participate in their external quality assessment scheme (EQAS) and correctly identify prohibited substances in a minimum of 20 samples provided annually. Several double blind samples are included that are disguised as regular athlete samples and are not known by the laboratory to be quality assessment samples. EQAS samples often contain very low concentrations of a prohibited substance, a prohibited substance that is rarely identified in routine doping control samples, or more than one prohibited substance (diuretic and low-concentration anabolic steroid). WADA enforces a point system to evaluate the performance of all accredited laboratories. A total of 25 points in one EQAS round or more than 30 points during a 12-month period can result in suspension or revocation of a laboratory’s accreditation. Laboratories reporting a false positive result earn 25 points and a false negative result earns 10 points. A z-score >3 for a threshold substance (ephedrine, morphine, etc.) results in 10 points, and a z-score between 2 and 3 earns the laboratory 5 points. This stringent quality assessment program helps ensure that all accredited laboratories maintain the highest possible testing standards.

**The Doping Problem**

While doping has received a lot of media attention recently, the question remains whether doping in sports is a real problem. In 2013, WADA-accredited laboratories reported 3,518 positive urine samples, which represents only 1.35 percent of the total number of urine samples analyzed. The percentage of doping athletes would be even smaller if positive results from repeat testing (“B” bottle) and athletes with medical conditions using therapeutically approved drugs were excluded from these statistics. This low positive rate suggests that doping is not a real problem. Yet, recent scandals such as the one in cycling suggest that doping is widespread in some professional sports. What should we believe? The truth probably lies somewhere in the middle; doping is a larger problem than the numbers reveal because some doping athletes are not caught, but the problem is not widespread throughout all sports.

Although having control programs and sanctions in place for doping violations helps deter athletes from using prohibited substances, additional steps are needed. Unannounced drug testing programs need to be expanded, better testing strategies need to be developed, and additional testing methods need to be created. The next major challenge accredited laboratories face will be to develop sensitive methods for detecting gene and cell doping, a technology that is just around the corner.

**References**


Dr. Butch is Professor, Pathology and Laboratory Medicine, at the UCLA David Geffen School of Medicine. He is also Director of the UCLA Olympic Analytical Laboratory.
Space Shuttle mission STS-107 Pilot William C. McCool checks a blood sample and enters data onto the keypad of a portable clinical blood analyzer as part of a medical experiment compliment. Mr. McCool is in the Spacehab Research Double Module in the payload bay of the Shuttle. Photo courtesy of NASA

Jeffrey Williams, Expedition 22 Commander, prepares to spin blood tubes in the HRF Rack 2 Refrigerated centrifuge in the International Space Station’s Columbus module. Photo courtesy of NASA

By Brian Crucian, PhD, MT(ASCP), and Kathleen McMonigal, MD

Health Monitoring and Clinical Laboratory Diagnostics for Astronauts

On April 12, 1961, human beings launched a whole new way to travel, venturing far outside Earth’s atmosphere and into outer space. Space travel and the potential for scientific learning beyond our own planet has come a long way since that first launch by the Soviet Union, including how laboratory medicine plays a role in keeping astronauts healthy both on the ground and in zero gravity.
Astronaut Selection and Training

Astronauts are chosen following a rigorous selection process that includes a medical screening. After new astronauts enter the NASA Astronaut Corps, their medical care is coordinated by flight surgeons and other medical specialists through the Flight Medicine Clinic at the Johnson Space Center (JSC) in Houston.

Because of the extreme environment in space, astronauts must be in excellent physical health by the time their mission launches. Pre-flight, they follow a vigorous physical fitness regimen, nutritional recommendations, and preventive medicine guidelines, including immunizations. All astronauts are followed annually through the JSC Clinic with a thorough physical examination and comprehensive laboratory testing. Given astronauts’ exceptional health, their laboratory results are generally entirely normal, but flight surgeons are still needed to provide medical oversight of astronaut training, which can range from the routine, such as hyperbaric (underwater) and hypobaric (altitude) exposures, to intensive training in remote environments, such as the Aquarius undersea habitat or winter survival training in Russia and Canada. Training takes place primarily in the U.S. (Houston) and Russia (Moscow and Star City), although additional specific training, usually involving international partner flight hardware, may take place in Germany, Japan, or elsewhere in the world.

NASA currently deploys U.S. astronauts to the International Space Station (ISS) for missions of up to six months, although longer missions of up to one year are being planned. An astronaut is approved for flight by an international medical board composed of space medicine specialists from all of the countries participating in the ISS. The approval is granted after comprehensive medical and laboratory exams and after any medical condition that could interfere with a successful
space mission has resolved. During a specific mission, an astronaut’s health is overseen by a dedicated flight surgeon, also known as a crew surgeon, and a deputy surgeon. Medical capabilities on the ISS are very limited, which means not only must an astronaut be in excellent health pre-flight, but also health monitoring during spaceflight is imperative.

Unique Health Risks During Spaceflight

Factors associated with spaceflight may result in many adverse health effects.1 These can include loss of bone density and muscle strength due to hypokinesis, or altered cardiac function due to significant fluid redistribution. It was recently determined that fluid shifts may result in intracranial hypertension. Cancer risk increases with prolonged radiation exposure, and recent evidence indicates that immune function is also altered during spaceflight,2, 3 to an extent that causes the reactivation of latent herpes viruses.4 Causal factors for immune alterations may include crew member stress, isolation, altered nutrition, and/or disrupted circadian rhythms. Crew members may also be exposed to unique environmental dangers such as chemical hazards and possibly pathogens with increased virulence.5

During ISS flights restricted to Earth’s orbit, crews remain relatively healthy, as in-flight countermeasures such as exercise and improved diet and fluid intake lessen the microgravity effects of bone and muscle loss. Immune alterations during orbital flight generally do not result in significant clinical disease. However, the adverse health risks associated with flight generally increase as mission length increases. It is almost a certainty that health risks to astronauts will increase during upcoming deep-space exploration missions.6 Such missions—to the moon, asteroids, or Mars—will see crews travel beyond the radiation-protective Van Allen belt surrounding Earth. Such exploration missions may last up to several years, with no quick-return option and limited clinical care capability. One of the primary functions of the ISS is to investigate all medical consequences of prolonged spaceflight and to develop and validate countermeasures. The countermeasures are necessary to enable deep-space missions beyond Earth’s orbit.

Health Monitoring During and Following Spaceflight

Once assigned to a space mission, the astronaut participates in required medical laboratory testing. Specific tests routinely performed on all astronauts before flight, per NASA medical requirement MEDB 2.1, include a CBC with differential, a clinical chemistry assessment, CRP, TSH, bone markers, iron profile, and urinalysis. Following launch to the ISS, the crew surgeon and deputy crew surgeon follow all of the astronaut’s daily activities, ranging from the mundane ISS maintenance activities (changing filters, monitoring systems, etc.), to conducting interesting research on behalf of investigators worldwide, to the heightened anticipation and preparation surrounding spacewalks. The crew surgeon has weekly private medical conferences with each astronaut during the six-month mission to discuss any medical issues, use of medications (analgesics, creams for dry skin, etc.), and scheduling issues. A separate ground-based behavioral health team is also assigned to each astronaut and family for crew support.

Returning from space is a dangerous and stressful event, comprising a high-gravity re-entry and re-adaptation to terrestrial gravity following prolonged body deconditioning that occurs during flight. The period immediately following landing includes careful medical and laboratory assessment of any decrements that occurred during the spaceflight. Post-flight laboratory testing—similar to that of pre-flight testing—is performed, and as the astronaut recovers from any adverse health effects, values are monitored to verify the return to pre-mission baselines.

Intensive astronaut rehabilitation, including activities to improve balance and strength, take place during the initial six weeks following spaceflight and, to a lesser extent, over the next few months. The astronaut also participates in a number of research studies on the physiological changes that take place during six months of microgravity. When the astronaut has recovered to the baseline level of health, he or she will resume normal activities within the astronaut corps and await the next spaceflight assignment.
Medical Laboratory Instruments Onboard the ISS

To enable health monitoring of astronauts and basic clinical research, medical laboratory instrumentation is listed as a requirement for life onboard the ISS. At present, however, very little laboratory instrumentation is deployed to the station, resulting in many unmet requirements. The equipment that is deployed includes blood collection supplies and a working fixed-angle centrifuge housed in the European Space Agency’s Columbus module, a glove box, and a −80 °C freezer. Instruments such as the iSTAT (a small commercial hand-held blood analyzer) and a portable ultrasound have been flown as science payloads for research studies, and then converted for clinical use.

All other diagnostic instrumentation is currently unavailable on space vehicles, as most terrestrial laboratory instrumentation is not compatible with the unique constraints of spaceflight. Terrestrial instruments, such as hematology analyzers or cytometers, are generally large, heavy, and have significant power requirements. They may use liters of liquid reagents to operate, and generate liters of liquid biohazardous waste. Instruments using liquids may also employ complicated optical fluid physics that may be altered during microgravity, such as the laminar flow/hydrodynamic focusing used in flow cytometers. All of these properties are unsuitable for the confined environment of the ISS.

To be appropriate and functional for spaceflight, any laboratory instrument must be extremely miniaturized, use minimal power, have minimal moving parts, use minimal liquid reagent, and generate minimal liquid biohazardous waste. Such an instrument must also be extremely robust and vibration tolerant. Reagents must be stable at room temperature for prolonged periods of time. Also, the user interface must be fairly intuitive and the analysis must be rapid. During missions, crew members’ time each day to perform work is extremely limited, and they routinely perform several operations at once. Obviously, most terrestrial laboratory instruments do not meet this description, which is why, to date, large laboratory hematology instruments or flow cytometers have not flown in space. It is, however, possible to re-engineer terrestrial instruments such as cytometers to achieve compatibility with spaceflight.

Surprisingly, there is no capability for performing a simple white blood cell (WBC) count or differential analysis during spaceflight. In fact, a WBC count is currently an unmet NASA medical requirement during spaceflight, because no available analyzer has been compatible with the unique constraints of flight. But recently, NASA evaluated a novel miniaturized prototype flow cytometer onboard the ISS. The performance was found to be comparable to those of terrestrial cytometers, and construction of the actual working flight cytometer is slated to begin soon.

Conclusion

Astronauts work within an extreme environment and routinely encounter a variety of operational hazards. Additionally, they experience physiological changes and are at increased risk for certain diseases due to the environmental hazards associated with spaceflight. Medical monitoring of astronauts is essential; however, in-flight diagnosis is constrained due to the challenges associated with deploying clinical instrumentation to space. On board the ISS, progress is being made toward improved clinical care, countermeasures and treatment, and miniaturized microgravity laboratory equipment. This progress will result in less risk to astronauts who undertake future missions beyond Earth’s orbit.

References


Dr. Crucian is Lead for the Immunology Laboratory at the Johnson Space Center, Human Health and Countermeasures Element (JSC-SK4). Dr. McMonigal is Director of the Clinical Laboratories and the Crew Health and Safety Chief Physician for the Space and Clinical Operations Division at the Johnson Space Center (JSC-SD).
Beyond the Laboratory

Dr. Hamel

Ms. Johnson

By Marianne Hamel, MD, PhD, FASCP, and Nikki Johnson, MFA

Death Under Glass
Highlights Forensic Histology
Despite the enormous amount of attention the forensic sciences have received over the past 25 years in the popular media, pathologists on television seem to be unaware that the post-mortem examination is often composed of two phases—the anatomic and the microscopic. Microscopes on the various iterations of the program “CSI” seem to exist solely as props in the background of the shot to indicate the seriousness of the science being conducted within the laboratory. But in reality, the microscopic examination of tissues generated during an autopsy is one of the pillars on which death investigation often rests.

*Death Under Glass* is a collection of photomicrographs (high-resolution images captured through the microscope) of human tissue from autopsies conducted to determine the cause and manner of violent, unexpected, or unexplained deaths. Images in the exhibition document the histologic signs of infectious disease, trauma, substance abuse, and poisoning, and each photomicrograph is accompanied by a panel documenting the significance of the pathology found within. *Death Under Glass* was created and curated by us, a forensic pathologist and a forensic photographer, and the exhibition is currently on view at the Mütter Museum of the College of Physicians of Philadelphia. Since 1858, the museum has housed collections of medical and historical esoterica such as antique medical equipment, articulated skeletal specimens (including those of a giant and a dwarf), and human tissue specimens preserved in formaldehyde. The museum recently renovated its Thomson Gallery to display medically related art.

Documentation of the artistic tension between anatomic tissue specimens (which are often aesthetically unappealing, if not grotesque) and the beauty of their microscopic appearance is not a new concept, as evidenced by the active collector’s market for the images of neurons hand-drawn by Nobel laureate Santiago Ramón y Cajal in the late 19th century. In a more modern vein, electron micrographs of human tissue were included in the 1967 *Once Invisible* show at New York City’s Museum of Modern Art. However, to our knowledge, *Death Under Glass* is the only exhibition devoted solely to the display of photomicrographs of human tissue.

*Death Under Glass* came about from one simple question: What if everyone could experience a pathologist’s point of view and see the beauty of cell morphology and microscopic anatomy? The general public has had extensive exposure to the most explicitly gruesome aspects of forensic pathology through television and print, but the beauty of human tissue at high magnification has been entirely overlooked. Although people interested in death investigation may not know it, they are being denied images of and information about one of the most interesting and complex parts of the post-mortem examination.

One of the reasons, historically, for the lack of exhibitions featuring human histology was the difficulty in generating high-resolution, quality photomicrographs appropriate for magnification and display. Previously, the general public could experience the beauty and diagnostic power of histology only by reviewing slides at a double-headed microscope with a cooperative physician. However, with the recent advent of commercially available digital cameras capable of capturing microscopic images in full color and high resolution, museum visitors can now see “the pathologist’s view of the world,” so to speak. Mütter Museum curator Anna Dhody notes that “*Death Under Glass* is a wonderful example of the conflation of science and art. It grants us permission and allows us to see the microscopic beauty that is sometimes found in death.”

*Death Under Glass* displays the beauty of post-mortem histology while highlighting the utility of microscopy in death investigation. Images were chosen both for their aesthetic appeal and for the clues they offer to the forensic pathologist about the decedent’s lifestyle and its contribution to their death. For instance, the effects of chronic drug use are shown in the pairing of *Intravenous Drug Abuse (IVDA)—Light and Intravenous Drug Abuse—Dark.* Illicit drugs like heroin and crushed prescription drugs like oxycodone contain inactive ingredients—bulking agents, binders, fillers, and colors—that are deposited in the lungs of drug abusers when administered intravenously. Although the foreign materials can be seen under the microscope with standard hematoxylin (pink) and eosin (purple) stains, the use of polarized light makes the deposits glow. Such a finding provides incontrovertible evidence of chronic substance abuse and should spur an attentive forensic pathologist to look for changes in the coronary arteries and heart tissue that may have contributed to the patient’s demise.

A physician’s signature on a death certificate testifies not only to the cause of death but also to the identity of the dece-
The increasing popularity of tattoos offers death investigators an excellent method of identifying a decedent if the designs are sufficiently unique. Tattoos are particularly useful in the identification of bodies that are slightly to moderately decomposed; sloughing of the outer layer of skin is among the first signs of putrefaction, and efficiently exposes the underlying dermis, making any tattoos present clear and easy to characterize. Tattoo pigment trapped within the cells of the dermis can be seen in Tattoo 100X, and in fact individual intracellular pigment granules are visible at high magnification in Tattoo 400X.

In some instances, the application of dyes to human tissue highlights diagnostic abnormalities of tissue or cellular structures. Many of these dyes, called special stains, are brilliant deviations from the standard pink-and-purple parade of most slides. The trichrome stain is a favorite among pathologists for its ability to differentiate tissue types by color—blue for connective tissue, red for muscle and keratin, and black for nuclei. The trichrome stain applied to a specimen of small bowel results in a riot of color and brings out the complex infrastructure of the wall of the intestine (Trichrome Stain of Small Bowel No. 1). The application of Oil Red O, a dye that binds fat, highlights tiny intracellular fat deposits in the liver sometimes associated with excess alcohol consumption (Microsteatosis Oil Red O).

Works included in Death Under Glass have previously been shown in the 2013 Cell Mates exhibition at the Walsh Gallery at Seton Hall University in South Orange, New Jersey, as well as in the 2014 You Only Die Once show in London.

Death Under Glass represents a unique opportunity for the public to view photomicrographs both as works of art and as tools to understand the power of histological analysis in death investigation. The exhibition will be on view at the Mütter Museum through December 16, 2014.

For more information about the show, please go to www.deathunderglass.com or twitter.com/deathunderglass.

Dr. Hamel is a board-certified Forensic Pathologist practicing in Pennsylvania and New Jersey. Ms. Johnson is a Forensic Photographer at the Office of Chief Medical Examiner of the City of New York.
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Pathologists, residents, and oncologists should take note of Friday’s 3-hour case-based session, The Diagnosis, Classification and Clinical Care of Peripheral T-Cell Lymphoma (PTCL).

This course will:

• Examine barriers to early and accurate PTCL diagnosis and classification
• Highlight the impact of inaccurate diagnosis and classification
• Provide practical tools and knowledge to address these issues

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Laboratory Medicine at Concordia Station, Dome C, Interior Antarctica

By Alex Salam, MBChB; Alexander Chouker, MD; and Brian Crucian, PhD, MT(ASCP)
Antarctica may be the most fascinating, yet isolated and extreme environment on Earth. The Antarctica ice sheet contains 90 percent of the world’s ice, and at its thickest point is 15,669 feet deep. With an average annual temperature of -56°F at the South Pole, temperatures are so dangerous that to venture outside during the Antarctica winter requires donning protective gear similar to an astronaut preparing for a spacewalk. Because Antarctica lies below the polar circle, parts of the continent experience up to six months of continuous darkness (depending on specific location) in the winter, and summers have a corresponding period of 24-hour daylight.

For purposes of exploration and scientific research, the world’s Polar Agencies have populated Antarctica with expedition stations, with most lying along the coastal region. These coastal stations (e.g., Dumont d’Urville of France; Neumayer III of Germany; Casey of Australia; McMurdo of the United States) are relatively easy to resupply via ship and plane, and generally experience normal atmospheric conditions and comparatively milder temperatures as compared to interior stations. The few interior bases (e.g., Concordia Station of France–Italy; Amundsen–Scott South Pole Station of the United States) are at significant elevation and experience persistent hypobaric hypoxia, which is a state of reduced atmospheric pressure combined with reduced oxygen content. Interior bases also experience much more extreme temperatures.

A small number of expeditioners may “overwinter” at an Antarctica station, meaning they stay approximately one year, deploying in the summer transition, remaining during the winter period of darkness and isolation, and returning the following summer. Antarctica overwinter at any station is characterized by the dangers of the extreme environment coupled with the loneliness and stress associated with the profound isolation from the rest of the planet. In fact, Antarctica overwinter conditions are so extreme, it is generally not possible to resupply via air or to even evacuate ill expeditioners, adding a very real factor of danger and seclusion to overwinter deployment. Given these conditions, it is important that bases be as well-equipped as operational constraints allow, including from a clinical care/laboratory medicine perspective.

Concordia: A Unique Station in the Dangerous Antarctic Interior

Concordia station is a French/Italian research facility located approximately 621 miles inland from the Antarctic coast.
The station serves as a research platform for glaciology, astronomy, atmospheric chemistry, seismology, geo-magnetism, and human biology. It is jointly operated by the French Polar Institute and the Italian Polar Institute. The next closest human presence is at the Russian Vostok research facility, 347 miles away. The French coastal research station Dumont D’Urville is 683 miles away, and the geographic South Pole is 1,037 miles from Concordia.

Concordia is situated on a plateau known as Dome Charlie (Dome C). Dome C is at an altitude of 10,606 feet, and its atmospheric pressure is equivalent to an altitude of about 12,467 feet at the equator. The “summer” daylight period lasts three months, while the winter lasts nine months, slightly longer than at the coastal stations. The average temperature is -22°F during the summer and -76°F during the winter, with the lowest recorded temperature being -120°F. During the winter, the extremes of temperature pose a real threat to safety. Frostbite injury is common, and temperatures are so extreme that eyelashes freeze together, camera equipment tends to fail, and it is easy to lose oneself amongst the never-ending darkness. There is relatively little wind and precipitation, in contrast to conditions at many of the coastal stations. The average wind speed is only 6.3 miles per hour. Dome C, essentially a “polar desert,” receives a total of less than one inch of snow precipitation per year.

During the summer, the station is populated by 50 to 70 people. Only 12 to 16 scientists and technicians remain for the nine-month winter period, however. During the winter, there is no possibility of evacuation or deliveries to or from Concordia, in part because of the environmental extremes and location of the station. Historically, there had also been no access to the Internet, although a satellite phone is available and recent attempts have been made to better connect the station to the World Wide Web. Crew members are relatively self-sufficient during the winter period, and they must deal with any medical (e.g., appendicitis) or technical (e.g., power failure) emergency themselves.

Clinical Care and Laboratory Medicine at Concordia

Because crew cannot be evacuated during the winter, Concordia is equipped with laboratory space and a basic medicine facility; a medical doctor is assigned to each overwinter crew. The medical facility includes a clinical consultation room; a patient bedroom (which can be observed from the consultation room); a dentist’s chair; and an operating room. Blood sample collection also routinely occurs at Concordia, for both medical and research purposes. Equipment includes a hematology indices analyzer, a Roche Reflotron basic chemistry analyzer, a microbiology microscope, a ventilator, an oxygen concentrator (delivery 4 L/min), limited oxygen cylinders, and an inflatable hyperbaric chamber. Basic surgical instruments that would allow for simple neurosurgical, orthopedic, or abdominal surgery are also available. A low-definition video satellite connection is available for remote guidance during surgery, if necessary, and various drugs for common medical conditions (e.g., pulmonary edema, infections, epileptic seizures) are kept on hand. Recently, thrombolysis for myocardial infarctions was added to the formulary. Still, despite these medical capabilities, the ability to manage a critically unwell patient is very limited.

Concordia station also has a dedicated clinical research laboratory. The European Space Agency deploys an additional physician, usually general practice, to overwinter in order to implement medical research projects, typically focused on the effects of isolation, confinement, hypobaric hypoxia, or altered circadian rhythms on crew physiology and behavior. These studies may also use clinical laboratory instrumentation. For example, one recent study deployed a water bath, a centrifuge, and a fully functioning flow cytometer for a project investigating the effects of stress and hypobaric hypoxia on the immune system. To our knowledge, this may be the first time flow cytometry has been performed in the harsh environment of the interior Antarctic continent. Generally, the instruments, kindly provided by Partec/Germany, functioned well. However,
significant optical re-alignment was necessary following air transport and initial setup, and the low humidity resulted in a persistent issue with static electricity.

**Conclusion**

It is important to be able to provide clinical care, including laboratory diagnostics, during remote deployment in hostile environments. As demonstrated by medical support available at Concordia, even at the most remote locations on Earth it is possible to successfully deploy and operate some minimal basic instrumentation. There are real operational constraints, however, to deploying more significant instruments. Shipping conditions, temperature, humidity, and static electricity are all factors that may make operation of instruments difficult in Antarctica. Also, supply of reagents and proper disposal of waste must be appropriately considered. Coastal Antarctica stations, considered less remote and therefore easier to service, may have even more clinical support capability and laboratory instrumentation. Interior stations, particularly those with tenacious air or overland supply capability, may have more minimal facilities. We anticipate the development of novel miniaturized or hand-held diagnostic laboratory devices, such as small blood analyzers or hand-held laboratory instrumentation, which will greatly improve laboratory support capability in these remote locations.

**Dr. Salam** is a Physician at Chelsea and Westminster Hospital, London, United Kingdom. Dr. Chouker is Professor of Anesthesiology at the Hospital of the University of Munich, Germany. Dr. Crucian is Lead for the Immunology Laboratory at the Johnson Space Center (JSC-SK4).
New Opportunities Abound for the Future of Pathology and the Medical Lab

The healthcare profession is in a constant state of change and disruption—from regulatory and reimbursement changes, to personal health records and new technologies, to advances in molecular medicine. With more than 150 carefully compiled educational sessions, ASCP 2014 Tampa, Oct. 8–10, will equip pathologists and laboratory professionals with the knowledge that is essential for growth, improved patient outcomes, and preparation for the future.

“This year’s Annual Meeting exemplifies more than ever ASCP’s mission to provide valuable career information and resources to help pathologists and laboratory professionals from the time they begin training in their field, as they advance into leadership positions, and throughout their careers,” says Zubair Baloch, MD, FASCP, chair of the Annual Meeting Education Working Group and a member of the Annual Meeting Steering Committee.

Prominent healthcare attorney Jane Pine Wood, Esq., and Michael Talbert, MD, FASCP, chairman of the Department of Pathology and director of the Pathology Residency Program at the University of Oklahoma College of Medicine and chief of Pathology Services at Oklahoma University Medical Center, will headline the scientific general session, “Evolving Pressures on Laboratories in 2014 and Beyond,” from 11:15 a.m.–12:30 p.m. on Thursday, Oct. 9.

APF, a collaborating society of ASCP, is presenting this scientific session and has also developed an education track focusing on Laboratory and Business Management that is designed to hone the skills of individuals currently in management positions and those who aspire to become managers or supervisors. Working cooperatively with other specialty medical organizations such as APF allows the Society to harness the expert resources of those organizations for the benefit of members, while also elevating the profile of laboratory medicine.

Disruptive Technologies Yield Opportunities

Medical futurist Bertalan Meskó, MD, PhD, will present the general session, “A Guide to the Future of Medicine—Bringing Disruptive Technologies to Life in Health Care,” from 8:30 a.m.–9:30 a.m. on Wednesday, Oct. 8. Dr. Meskó will hold an invigorating discussion focusing on ways that new technology, such as genomics and next-generation sequencing, are providing pathologists and medical laboratory professionals with valuable tools to improve patient care. Described by Forbes Magazine as “The Geek Who’s Changing
the mentor and protégé need to work together as a team that first year, it is important they are compatible and closely aligned in their specialty and career goals, according to Dr. LiVoltsi. UPenn’s Pathology Department also has a mentoring program for new faculty members, who are paired with a more senior faculty member to guide them as they develop their teaching skills.

Dr. Hunt, who assumed her position as a department chair at UAMS before the age of 40, will discuss the best practices in a mentoring program from the perspective of a protégé.

Her former mentor underscores the critical importance of mentoring younger colleagues. “These individuals are the lifeblood of the next generation,” Dr. LiVoltsi says. “If pathology is going to survive, we have to have people who are smart, very hard working, intellectually curious, and who want to impart to the generation they’re going to teach the principles they learned from my generation.”

**Cultivating the Next Generation**

Building the future generation of pathologists and laboratory professionals needs to begin before students actually enter college in order to address the current workforce shortage, which is projected to become even more severe as the nation’s population ages and requires more medical care.

Continuing its commitment to expand awareness of the medical laboratory profession among high school students, ASCP will host its third annual “Building a Laboratory Workforce for the Future Day,” in conjunction with the Annual Meeting. On Friday, Oct. 10, 200 students from Hillsborough County Public Schools in Tampa—one of Florida’s largest school systems—will be immersed in real-life scientific learning alongside more than 1,500 pathologists and laboratory professionals.

A group of ASCP Career Ambassadors, a program in partnership with Roche, will lead students in hands-on educational exercises, such as looking at cells under a microscope, building DNA, and learning about the human genome. The students will also mingle with some of the world's most renowned medical laboratory experts.

This year, ASCP is redoubling its commitment to building the laboratory workforce by presenting two students with the 2nd annual ASCP STEM Student Scholarship Award. Each student will receive a $2,500 scholarship, provided by ASCP’s ONELab Fund, which is generously supported by the Society’s members.

**Recognizing Giants in their Fields**

ASCP has many outstanding volunteers among its 100,000-plus members. The Society’s most exemplary volunteers will be honored at the 2014 ASCP Annual Meeting. Several volunteers will be recognized for career-long achievements. Six volunteers will be honored for their commitment to support ASCP locally. Two Resident Representatives will receive the highly coveted Resident Leadership Representative Award for demonstrating leadership and promoting ASCP membership and resident activities.
Among those being recognized are the following individuals who have made major contributions to the field of pathology and laboratory medicine and to ASCP:

C. Bruce Alexander, MD, FASCP—Professor and vice chair in the Department of Pathology and director of the Pathology Residency Program at the University of Alabama School of Medicine, Birmingham, Ala.; a past president of ASCP and the Academy of Clinical Laboratory Physicians and Scientists; and a member and past chair of PRODS and the Resident Review Committee for Pathology of the Accreditation Council for Graduate Medical Education.

Zubair Baloch, MD, PhD, FASCP—Professor of Pathology and Laboratory Medicine at the Perelman School of Medicine at the University of Pennsylvania and director of the Cytopathology Fellowship Program at the UPenn Medical Center. He is chair of the Annual Meeting Education Working Group and a member of the Annual Meeting Steering Committee, and president of the Philadelphia Pathology Society and the Papanicolaou Society of Cytopathology.

John Tomaszewski, MD, FASCP—A past ASCP president; professor of Pathology and chairman of the Department of Pathology and Anatomical Sciences within the School of Medicine and Biomedical Sciences at the University of Buffalo; reviewer for the American Journal of Clinical Pathology and Annals of Internal Medicine; past chair of the ASCP Commission on Education and the ASCP Annual Meeting Committee; a member of the Arthur Purdy Stout Society of Surgical Pathologists and the Association of Directors of Anatomic and Surgical Pathology.

Teresa Harris, MT(ASCP)SBBCSM, CQIA, CQA(ASQ)—A distinguished 36-year career in blood banking and transfusion medicine; a recognized teacher and mentor who worked with the Red Cross from 1981 until 2011, retiring from the position as a senior associate in operational support and in immunohematology reference laboratories; a past chair of the ASCP Council of Laboratory Professionals; and a past member of the ASCP Board of Directors, the Executive Board, and the ASCP Governance Task Force.

JoAnn Fenn, MS, MT(ASCP)—Professor and division chief of the Medical Laboratory Sciences division in the Department of Pathology and co-director of the MS program in Laboratory Medicine and Biomedical Science at the University of Utah School of Medicine; a member of the ASCP Joint Generalist Examination Review Committee from 1996 to 2002, and chair from 2000-2002; and a consultant with ASCP Global Outreach.

Karen J. Honeycutt, ME, MLS(ASCP)CSM—Director of the Clinical Laboratory Science Program in the School of Allied Health Professions at the University of Nebraska Medical Center; a member of the graduate faculty of the University of Nebraska; and served on the ASCP exam committees and as a consultant with ASCP’s Global Outreach for the President’s Emergency Plan for AIDS Relief.

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