Human Error in Medicine

Edited by
Marilyn Sue Bogner
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Foreword

James T. Reason
University of Manchester

This last decade or so has seen a growing openness on the part of the medical profession regarding the part played by human error in mishaps to patients. The pursuit of safety is a multidisciplinary enterprise, and this is as true for patient safety, hitherto an exclusively medical domain, as for any other kind. This new spirit of *glasnost* has led to an increasing number of fruitful research partnerships between doctors (particularly anesthetists) and human factors specialists. One of the most important results of these collaborations has been the awareness that medical accidents share many important causal similarities with the breakdown of other complex sociotechnical systems, such as the Chernobyl Unit 4 reactor. Some idea of what factors are involved in these accidents is provided by the sad story of Valeri Legasov, the chief Soviet investigator of the Chernobyl accident.

FRONTLINE ERRORS ARE NOT THE WHOLE TRUTH

In August 1986, 4 months after the world's worst nuclear accident at Chernobyl, a Soviet team of investigators, headed by academician Valeri Legasov, presented their findings to a meeting of nuclear experts, convened in Vienna by the International Atomic Energy Agency. In a verbal report lasting 5 hours, Legasov described both the sequence of events leading up to the accident and the heroic attempts to contain its aftermath. In his address, Legasov put the blame for the disaster squarely on the errors and especially the procedural violations committed by the plant operators. The report was

acclaimed for its full and frank disclosures. "At last," said the headline in a Viennese newspaper, "a Soviet scientist who tells the truth" (Read, 1993).

On the morning of April 27, 1988, 2 years to the day after the Chernobyl accident, Valeri Legasov hanged himself from the balustrade of his apartment building. He had just learned that his proposal for establishing an autonomous institute of industrial safety had been turned down by the Academy of Sciences. Some time before his suicide, he confided to a friend, "I told the truth in Vienna, but not the whole truth."

What was the "whole truth?" Fortunately, Legasov had an opportunity to give us an inkling. Just prior to his death, he began dictating his innermost thoughts about the Chernobyl accident into a tape recorder. The excerpt that follows is taken verbatim from the ninth of 10 tape recordings.

> After being at Chernobyl, I drew the unequivocal conclusion that the Chernobyl accident was the apotheosis, the summit of all the incorrect running of the economy which had been going on in our country from many decades. There are not abstract but specific culprits for what happened at Chernobyl, of course. We now know that the reactor protection control system was defective, and proposals were made on how to eliminate this defect. Not wishing to get involved in quick additional work, the designer was in no hurry to change the protection control system.
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> What happened at the Chernobyl power station itself had been going on for a number of years: Experiments were carried out, the program for which had been drawn up in an extremely negligent and untidy way. There were no rehearsals of possible situations before the experiments were conducted. . . . The disregard for the viewpoint of the designer and scientific leader was total, and the correct fulfillment of the technical procedures had to be fought for. No attention was paid to the state of the instruments or the state of equipment before it was time for planned preventive maintenance. One station director actually said: "What are you worried about? A nuclear reactor is only a samovar; it's much simpler than a heat station. We have experienced personnel and nothing will ever happen."
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> When you look at the chain of events, at why one person acted in this way while another acted in that way, and so forth, it is impossible to name a single guilty person, the initiator of the events . . . because it is precisely a closed chain: The operators made a mistake because they wanted without fail to complete the experiment—they considered this a "matter of honour"; the plan for conducting the experiment was drawn up in a very substandard and undetailed manner and was not sanctioned by those specialists who should have sanctioned it.
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> I keep in my safe a record of the operators' telephone conversations on the eve of the accident. It makes your flesh creep when you read such records. One operator telephoned another and asked: "The program here states what must be done, but then a great deal has been crossed out, so what am I to do?" His interlocutor thought for a moment, then said: "Act according to what has been crossed out." This was the standard of preparation of serious documents at a project such as a nuclear station: Someone had crossed something out, and the operator might interpret correctly or incorrectly what has been crossed out and perform arbitrary actions. The whole weight of the blame cannot be shifted onto the operator because someone drew up the plan and crossed something out, someone signed it, and someone did not agree to it. The very fact that station personnel could independently carry out some actions not sanctioned by professionals is a flaw in the professionals' relations with this station. The fact that representatives of the state committee for the supervision of safe working practices in the atomic power industry were present at the station, but were not apprised of the experiment being conducted or of the program is not only a fact of this station's biography.

How is this story concerning nuclear power operations in a now-defunct state relevant to human errors in medicine? The answer is in many ways and at many levels. Some of these lessons for the study and prevention of medical mishaps are discussed in the following.

THE BLAME TRAP

The first lesson is that blaming the fallible individuals at the sharp end (i.e., those people in direct contact with vulnerable parts of the system—in medicine, this would be surgeons, physicians, anesthetists, etc.) is universal, natural, emotionally satisfying, and legally (also, in this instance, politically) convenient. Unfortunately, it has little or no remedial value. On the contrary, blame focuses our attention on the last and probably the least remediable link in the accident chain: the person at the sharp end.

Blaming also leads to ineffective countermeasures: disciplinary action, exhortations to "be more careful," retraining, and writing new procedures to proscribe those actions implicated in some recent accident or incident. These measures can have an impact at the outset of some necessary safety program, but they have little or no value when applied to a well-qualified and highly motivated work force. Indeed, they often make matters worse.

People do not mean to commit errors, and the best practitioners sometimes make the worst mistakes. Violations of procedures, on the other hand, do involve an intentional component, but the intention is usually to bend the rules for what seem like good or necessary reasons at the time. Except in the case of saboteurs (and these lie well outside the scope of this book), there is no wish to bring about the damaging outcomes that occasionally follow these deviations. Most people understand this very well, at least in regard to their own errors and violations, so why are we so quick to blame others?

There are various tangled issues here that are worth unravelling if we are

to break out of this unproductive "blame trap." One very clear issue is that, from a legal perspective, it is much easier to pin the responsibility for an accident upon the perpetrators of those unsafe acts that had an immediate impact on the integrity of the system or the well-being of the patient. The connection between these proximal actions and the bad outcome is far more easily proved than are any possible links between prior management decisions and the accident, as was clearly shown in Britain by the failed prosecution of the shore-based managers of the capsized ferry, the *Herald of Free Enterprise.*

The convenience for lawyers in chasing individual errors rather than collective ones is further reinforced by the willingness of professionals, such as pilots, ships' masters, and doctors, to accept responsibility for their actions. As part of a professional package that contains (after a long and expensive period of training) considerable power, high status, and large financial rewards, they both expect and are expected to carry the can when things go wrong. This also suits the victims and their relatives who, in trying to come to terms with an injury or a bereavement, find identifiable people a more satisfactory target for their anger and grief than some faceless organization.

But why is the need to assign blame so strong in almost all of us, even when, as so often is the case, it is both misplaced and maladaptive? There are three powerful psychological forces working together to create this reaction.

The first is called the *fundamental attribution error.* Should we observe someone acting in an odd or unsatisfactory fashion, we are automatically inclined to attribute this behavior to some dispositional feature of the individual. The person is viewed as careless, incompetent, or reckless. But if we asked the people so observed why they were acting in that fashion, they would almost certainly emphasize the situational aspects that forced them to do what they did. The truth, of course, lies somewhere in between these dispositional and situational extremes.

The second influence is the *illusion of free will.* We all place a large value on personal autonomy, the feeling of being in control of one's actions. People denied this sense of free will can become mentally ill. We also attribute this freedom of choice to others, so that when we learn that someone has committed an error, we are inclined to think that the individual deliberately chose an error-prone course of action. Bad actions presumed to be deliberate attract exhortations, warnings, and sanctions. These have little or no effect on the organization's error rates, but their continued occurrence fuels greater anger and exasperation on the part of system managers, because the work force has now been warned yet still makes errors. And so the blame cycle goes round and round.

The third factor is our strong tendency to match like with like, termed

similarity bias. In seeking explanations for puzzling events, the human mind, as Bacon noted in 1620, "is prone to suppose the existence of more order and regularity in the world than it finds" (Anderson, 1960, p. 50). One means of simplification is to presume a symmetry of magnitude between causes and consequences. In the face of horrific manmade catastrophes like Bhopal, Chernobyl, and the King's Cross Underground fire, it seems natural to suppose some equally monstrous act of incompetence or irresponsibility as the primary cause. But a detailed examination of the causes of these accidents reveals the insidious concatenation of often relatively banal factors, hardly significant in themselves, but devastating in their combination.

ACTIVE AND LATENT HUMAN FAILURES

Perhaps the most important lesson to be learned from the Legasov tapes is that Chernobyl, like other accidents, was the product of many different failures, distributed widely in both space and time over the whole Soviet nuclear power generation system. The errors and violations of the operators on the night of April 25–26, 1988 simply added the finishing touches to a disaster that had been in the making for many years. They supplied just those ingredients necessary to breach the various defenses-in-depth. Some of these barriers and safeguards were actively switched off by the operators, others proved to be inadequate for their purpose, and others were slowly eroded through time and custom.

It is convenient to divide the human contributions to the breakdown of well-defended complex systems into two categories: active failures and latent failures (Reason, 1990). The distinction hinges both on who initiated the failures and how long they take to have an adverse effect.

Active failures are errors and violations committed by those in direct contact with the human–system interface. Their consequences are apparent almost immediately, or at least within a few hours. These are what Legasov focused on in his Vienna speech, and—until quite recently—occupied center stage in most accident investigations in any country and in any sphere of operation.

Latent failures are the delayed-action consequences of decisions taken in the upper echelons of the organization or system. They relate to the design and construction of plant and equipment, the structure of the organization, planning and scheduling, training and selection, forecasting, budgeting, allocating resources, and the like. The adverse safety effects of these decisions may lie dormant for a very long time. For example, the wooden escalator installed in the King's Cross Underground Station in the late 1930s was recognized as a fire hazard over 50 years ago; many of the latent failures

leading to the Chernobyl explosions originated with the inception of the Soviet Union's atomic power program in the late 1940s and early 1950s; the history of the Challenger disaster goes back at least 12 years prior to the actual disaster, and so on.

Latent failures often only become apparent when they combine with active failures and local triggering events to penetrate or bypass the system's defenses and safeguards. However, once they are recognized for what they are, latent failures can be diagnosed and remedied before they combine to cause bad outcomes. This is what makes them so important relative to active failures, whose precise modes and times of occurrence are extremely difficult, if not impossible, to predict in advance. Who can say exactly when a surgeon's scalpel will slip and cut a nerve, or when an anesthetist will perform an incorrect intubation, or when a nurse will misread a prescription and administer the wrong drug or an inappropriate dose?

It is important to appreciate that the decisions giving rise to latent failures in the system at large need not necessarily be mistaken or ill-judged ones, though they sometimes are. It is probably true to say that all strategic decisions, even those judged as good ones, will have a downside for someone, somewhere in the system, at some time. Top-level decisions are rarely, if ever, optimal. They invariably involve some degree of compromise. Like designers, decision makers are perpetually hedged around by local constraints. Resources, for example, are rarely allocated equitably; there are always winners and losers. Similarly, in forecasting uncertain futures, managers will sometimes call the shots wrongly.

They key point is this: Latent failures are inevitable. Like resident pathogens in the human body, they will always be present. The trick, then, is not to commit limited resources to the futile task of trying to prevent their creation; rather, we should strive to make their adverse consequences visible to those who currently manage and operate the system in question. Doing this is the essence of what Hollnagel (in press) termed *synchronous risk management*; that is, the continuous assessment of the parameters that determine a system's "safety health" and then remedying those most in need of attention.

Many organizations treat safety management like a negative production process. They assess their negative outcome data (accidents, incidents, near misses) and then set themselves reduced targets for the coming accounting period. The trouble with this is that errors and accidents, by their nature, are not directly manageable. Much of their determining variance lies outside the control of system managers and in the realms of chance, Sod, and Murphy's Law. A most effective model for safety management is that of a long-term fitness program, designed to bring about continuous, step-by-step improvement in the system's intrinsic resistance to chance combinations of latent failures, human fallibility, and hazards. This entails managing the manageable; that is, the organizational factors lying within the direct spheres of influence of the system operators and managers.

THE ORGANIZATIONAL ACCIDENT

Legasov's final tapes tell us that Chernobyl, like other well-documented disasters, was an *organizational accident*. That is, it had its origins in a wide variety of latent failures associated with generic organizational processes: designing, building, operating, maintaining, communicating, managing, and the like.

The etiology of an organizational accident divides into five phases: (a) organizational processes giving rise to latent failures, (b) the consequent creation of error- and violation-producing conditions within specific workplaces (operating rooms, intensive care units, pharmacies, etc.), (c) the commission of errors and violations by individuals carrying out particular tasks at the sharp end, (d) events in which one or more of the various defenses and safeguards are breached or bypassed, and (e) outcomes that can vary from a "free lesson" to a catastrophe.

Viewed from this perspective, the unsafe acts of those in direct contact with the patient are the end result of a long chain of causes that originates (for the purposes of systemic improvement, at least) in the upper echelons of the system. In theory, of course, one could trace these precursors back to the Big Bang, but that would have little practical value. One of the basic principles of error management is that the transitory mental states associated with error production—momentary inattention, distraction, preoccupation, forgetting, and so on—are the last and least manageable links in the error chain because they are both unintended and largely unpredictable. Such states can strike anyone at any time. We can moderate human fallibility, but it will never be eliminated entirely. The reason is that errors have their cognitive origins in highly adaptive mental processes.

Correct performance and errors are two sides of the same coin. Human fallibility is not the result of some divine curse or design defect, rather it is the debit side of a cognitive balance sheet that stands heavily in credit. Each entry on the asset side carries a corresponding debit. Absent-minded slips and lapses are the penalties we pay for the remarkable ability to automatize our recurrent perceptions, thoughts, words, and deeds. If we were perpetually "present minded," having to make conscious decisions about each small act, we would never get out of bed in the mornings. The resource limitations on the conscious "workspace" that allow us to carry through selected plans of action in the face of competing situational demands also lead to informational overload and the leakage of memory items. A long-term memory

store that contains specialized theories of the world rather than isolated facts makes us liable to confirmation bias and cognitive lockup. An extraordinarily rapid memory retrieval system, unmatched by any known computer, leads our interpretations of the present and anticipations of the future to be overly influenced by the recurrences of the past.

Unsafe acts then are like mosquitoes. You can try to swat them one at a time, but there will always be others to take their place. The only effective remedy is to drain the swamps in which they breed. In the case of errors and violations, the "swamps" are equipment designs that promote operator error, bad communications, high workloads, budgetary and commercial pressures, procedures that necessitate their violation in order to get the job done, inadequate organization, missing barriers and safeguards . . . the list is potentially very long, but all of these latent factors are, in theory, detectable and correctable before a mishap occurs.

Whereas even the simplest accident, such as tripping on the stairs, has some organizational roots, it is probably the case that certain systems are far more prone to organizational accidents than others. Indeed, it could be argued that for certain complex, automated, well-defended systems, such as nuclear power plants, chemical process plants, modern commercial aircraft, and various medical activities, organizational accidents are really the only kind left to happen. Such systems are largely proof against single failures, either human or technical. But they can often be quite opaque to the people who work with them (see Woods, Johannesen, Cook, & Sarter, 1994). Perhaps the greatest risk to these high-technology systems is the insidious accumulation of latent failures, hidden behind computerized, "intelligent" interfaces, obscured by layers of management, or lost in the interstices between various specialized departments.

THERE IS NOTHING UNIQUE ABOUT MEDICAL ACCIDENTS

The main reason for beginning with the Legasov story was to emphasize what many contributors to this book have done in a far more detailed and relevant fashion, namely that nearly all accidents have organizational and systemic root causes, and that these latent factors are more amenable to diagnosis and remediation than are the ephemeral error tendencies of those at the sharp end. It would be tragic if this burgeoning field of medical error studies should have to repeat the mistakes made in the longer established areas of aviation or nuclear power generation and become fixated on the medical equivalent of pilot or operator error. The pressures to pursue this largely unprofitable path are very great, as discussed earlier, but the penalties are also considerable. Even though the human contribution to accidents

has been studied over many decades in these more established areas, only over the past few years have they broken free from the trap of concentrating on the psychology of fallible individuals at the human–system interface rather than on the situational and organizational latent failures that they inherited. It is, of course, true that people at the sharp end commit errors and violations, but—as Legasov came to appreciate—it is not the whole truth, nor even the most important part of that truth.

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