Chapter 16.

HUMAN ERROR and HUMAN RELIABILITY.

BEST quotes:

- "*We cannot change the human condition, but we can change the conditions under which humans work.*"
- *"It is a myth that humans who make an error are inherently careless, stupid, idiots, or fools."*
- *"No one plans an error."*
- *"All systems optimizations must support the human role."*
- *"The mark of a dysfunctional organization is it simply blames the last person who touched something."*
- ***"The human is not the problem. The human is half of the solution."***

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1. INTRODUCTION

Mental processes underlie human actions and errors. Intentions also define human errors. The mismatch between goals and results defines an error.

Human reliability is defined as the *likelihood that performance will be error-free*. This view helps analyze the role of humans within systems when they interact with machines, other humans, artifacts, rules, protocols, and complex tasks.

Human error is defined as a *completed action and outcome* that was (i) not intended by the human, (ii) not sought by the rules, or (iii) outside acceptable system limits[1]. Note bene: The human started the action well intended. An error is also ***never*** defined by whether a bad outcome occurred or not.

(The full chapter, in the printed book, is 16 pages long and includes 18 references)

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5. SUMMARY

The frailties of humans that make them vulnerable to making an error when circumstances get loaded against them are the opposite sides of the same coin that helped them fly a man on the moon, that let Mozart compose a piano minuet at 5 years old, and that can solve a Rubik's cube in 30 seconds.

If the system is perfect and supports the human operator, a reliable human within a system will nearly always produce the planned-for good outcomes. Reliable systems will also support the human operator in solving rare, unusual challenges.

AN EXPLANATORY EXAMPLE: That same species of human suddenly hears monitor alarms of the anesthetized ankle-surgery patient, indicating oxygen saturation and blood pressure are both falling critically low. He looks up and observes that the ventilator inspiratory pressures in its set-tidal volume mode are steadily rising. He promptly checks the oximeter on the patient's finger. He notices dark brown nicotine stains between a wrinkled hand's index and middle fingers. Next, he auscultates each lung under the sheets on the upper front chest, expecting high-pitched bronchospasm wheezes. He hears nothing over the noise of a surgical drill on the tibia. He knows extreme bronchospasm gets silent in advanced states. He knew the patient did not usually use bronchodilators, but that did not exclude bronchospasm now. He doubled the inspired anesthetic vapor to relieve any

bronchospasm, if that was the problem, as an interim measure. He pauses and ponders, "Do those nicotine stains indicate maybe something more." He had never seen such bad stains before. "The man must have *very severe emphysema* because I can't hear breath sounds in this noisy operating room," he thinks. He recalls the breath sounds were very soft when he examined the patient in the quiet waiting room before surgery. He recalled his old internal medicine professor always telling him that nicotine stains on fingers always mean trouble. Severe emphysema is often accompanied by lung bullae, which tend to form on the apex of the lungs. "Ah, Ha!" he is thinking. Maybe a bullous has ruptured, and the patient has a tension pneumothorax. He swiftly pushes the sterile sheets away to thump the upper anterior chest wall, just caudad to the clavicles. He pushes his left hand flat against the chest and thumps the flat middle finger with a firm, fast tap from the tip of his right hand's long middle finger. There is a marked difference in the thump sounds between the left and right sides. The Left is slightly dull, and the right is markedly resonant as if it were hollow. He shouts to the surgeon. "We have a right-side pneumothorax. I need an intercostal drain, please".

The surgeon stutters and says, "Nurse, call Dr. Jones, the general surgeon. I can't place an intercostal drain. Get radiology here fast. We need an X-ray first."

The anesthesiologist replies, "That'll take too long. The O2-Sats are 60% now."

The anesthesiologist feels for the trachea deep in the suprasternal notch and convinces himself it is displaced to the left. That indicates a very severe tension pneumothorax on the right side. Now he thinks to himself fast. "*The pneumothorax gas will push the lung far back from the rib cage and compress both the lung and the heart tight for the BP and O2-Sat to be so low. I can put something into that space to relieve the pressure*." He dashes to the anesthesia cart and grabs an alcohol swab, a 14G IV cannula, and a saline syringe.

He wipes the skin with alcohol at a point 2-inch caudad from the center of the right clavicle middle, inserts the 14 G intravenous cannula, and introducer needle vertically to the skin, and gently ½ inch into the skin between ribs. He then attaches the saline syringe to the steel needle hub and removes the saline syringe plunger. The syringe is pointing vertically so that the saline in the barrel does not spill. He gently advances the cannula, with its steel introducer needle and attached syringe barrel, deeper into the chest. At about an inch deeper, he feels a subtle snap in his finger gently holding the syringe barrel, and suddenly, air bubbles back through the saline in the syringe barrel. Holding the syringe and steel needle still, he advances the cannula deeper off its introducer steel needle and removes the steel needle and syringe barrel. A hissing sound is heard from the cannula. In less than a minute, the saturation climbed back to 90% on 100% oxygen, and the next automated blood pressure had a systolic value of 105 mmHg. The tension pneumothorax is now converted to an open pneumothorax under positive-pressure ventilation. Twenty-five minutes later, the general surgeon finished surgically placing a large right-side intercostal drain, which drained more air. The anesthesiologist removed his chest cannula and placed a plastic dressing over the site.

The nurse asks the anesthesiologist, "Dr. G. How many of these have you done before?"

"First one," he replies, calmly adjusting the anesthesia vaporizer setting.

That is a real personal case report of this book's author.

It took a human to save a human's life in a situation he had never experienced before. The human had to combine different pearls of wisdom he had learned, synchronize

disconnected facts he knew only from written texts, and then synthesize a remedy he had only heard of in different contexts.

"The flip side of the coin carrying the weakness of human frailty lies opposite the side baring human ingenuity. The coin sides are inseparable. "

No Artificial Intelligence (IA) driven artifact could have saved this patient's life.

Humans are brilliant but are only human.

"The human is not the problem. The human is half of the solution."

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