Human Factors

?!?!?

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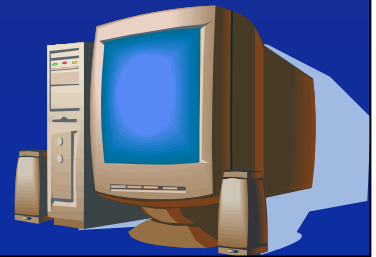
PPC 2004

What Do You Perceive?

8/4/2003

_____

6:30

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In the next few slides you'll see some examples where human factors come into play.

Is it month/day/year or day/month/year?

Is it 6:30 AM or PM?

The interpretation is often a factor of the environment and local norms. For example, in Canada, we tend to use the day/month/year format (ascending order of information). In healthcare we commonly use the 24-hour clock, so 6:30 would mean the AM; 18:30 would be PM.

What's wrong with this picture?

3 of hearts is black.

What is the difference?

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At quick glance it is difficult to see a difference, as the labelling is so similar.

Rely on the user to read carefully.

Labelling is very similar.

Prednisone
Prednisolone

Vincristine
Vinblastine

Valacyclovir
Valganciclovir

If these drugs were next to each other, would you always pick the right one off the shelf?

If these drug names were handwritten, would you always be able to read them clearly?

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If these pairs of items were next to each other in a tray or on a shelf, could/would you always select the right one?
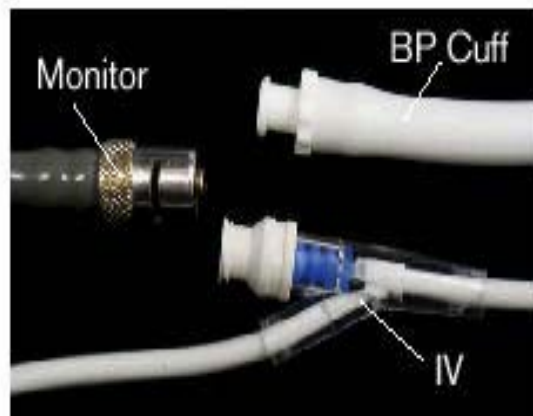
Figure 1. Monitor tubing with male Luer connects easily with either BP cuff tubing or Y-site of IV tubing. Note similar appearance with propofol in IV tubing.

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There are many examples of connections being possible between therapeutically incompatible items.

There were deaths attributable to anaesthetic gas line mix-ups because the connections were all the same. For example, you used to be able to connect a patient's oxygen line to the nitrogen gas feeder line.

We use the same types of tubing to deliver drugs by enteral, intravenous and epidural routes.

**Would you know how to use this…
in an emergency?**

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Is the use of an EpiPen intuitive?

If you're a healthcare worker, injections usually mean that you depress a plunger to deliver medication. Where's the plunger here? There isn't one.
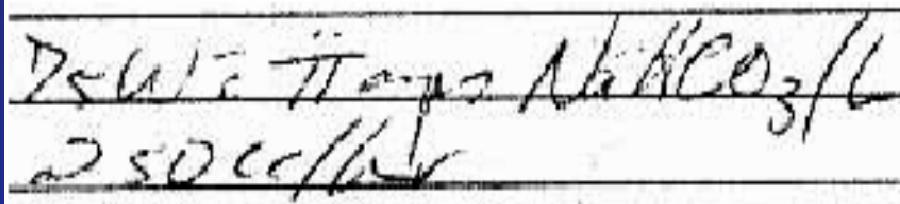
With the EpiPen, you need to remove the grey top cap…

Do the pictures help?

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It shows you to remove the grey top cap, but what's happening in frames 2 and 3? Are the actions different?

The top order was interpreted as 250 cc/h.

It actually read @50 cc/hr.

The order was dispensed as "Take one tab 5 days per week".

It actually read "q day", i.e., every day.
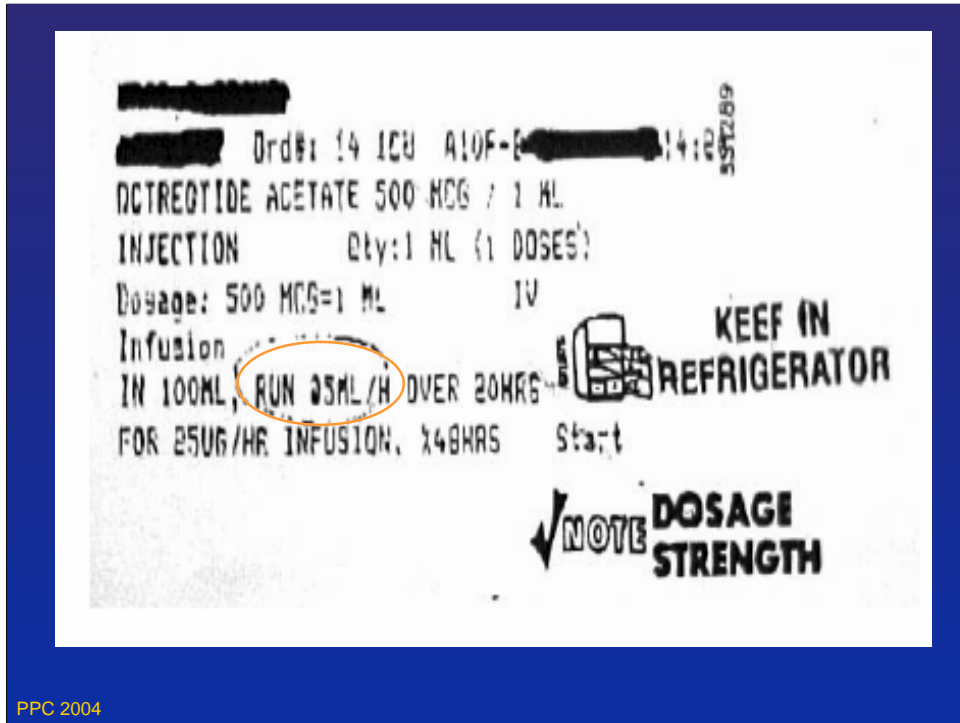
The label was interpreted as showing the infusion rate to be 25ML/H.

It actually read @5ML/H.

Is something wrong?

Pumping Fingers   Red Lines
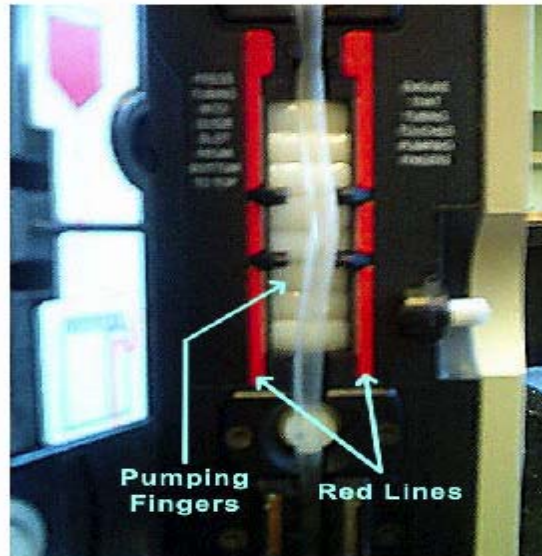
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No alarm went off when this tubing was placed and the infusion started.

Because the placement was incorrect, it resulted in overinfusion.

Do we all work similarly and at the same speed?

How do you manage repetitive tasks?

What happens when your stress level rises?

What is the noise level in your work area?

What is the temperature in your work area?

The piece of equipment that underlies all human factors:

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Adapted from: Croskerry P. The Science of human factors in health care. QHN, Fall Forum, October, 2003.

"One of the major impediments to convincing people of the prevalence and seriousness of cognitive error is the faith they have in their own thinking abilities."[1]

PPC 2004

1) Croskerry P. The Science of human factors in health care. QHN, Fall Forum, October, 2003.

As professionals, we all believe that we have the capability and intelligence to perform the tasks required of us perfectly.

However, we are all human….

> **"Human factors engineering,
> or human engineering,
> is concerned with ways of
> designing machines,
> operations,
> and work environments
> so that they match human
> capacities and limitations."[2]**

6) Adapted from: Chapanis A. Man-Machine Engineering. 1965.

Human factors engineering considers how humans interact with their environment and then works to design appropriate technology, systems and processes.

Human Factors[3]

- **Human physical characteristics**
  - Physical dimensions, skeletal system
  - Muscles and other systems in the body
  - Interactions with the environment
  - Work, rest and work/rest cycles

The human characteristics that need to be taken into consideration include…

Human Factors, cont'd[3]

- **Human mental characteristics**
  - **Attending**
  - **Sensing**
  - **Remembering**
  - **Decision-making**
  - **Learning**
  - **Responding**

- **Personnel selection and training**
  - **Reducing system complexity**

3) Adapted from: Chapanis A. Human Factors in Systems Engineering. 1996.

Handbook of Human Engineering Data[4]

Sample headings:

- Anthropometrics
- Vision
- Audition
- Skin sensitivity and proprioception
- Motor responses
- Factors influencing physiological conditions – sleep temperature, drugs, altitude
- Intelligence
- Learning – acquisition, retention, transfer, motivation

4) The Special Devices Center Office of Naval Research. Handbook of Human Engineering Data. 2nd ed. 1951.

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The U.S. Navy published data on human factors in 1951.

There are engineering standards that have been developed for technology and signage. These are frequently updated according to changing norms and needs in technology.

Human Factors, cont'd[5]

- **Visual presentation of information**
  - Type, handwritten, gauges, dials, touchpads, TV, PC keyboard, PDA

- **General principles of display**
  - Illumination
  - Viewing distance
  - Ensemble of displays
  - Design of controls: switches/toggles/dials
  - General environmental conditions

Human factors need to be considered in how information is presented to the individual.

Can the user instinctively determine the meaning or usage? (E.g., The "Start" button is clicked to shut down a PC.) Remember when the mouse became a part of PC use?

What about infusion pump keypads and displays? Often, readout text is truncated.

Is it easy to find the gas cover release in your car? The hood or trunk release? Is the meaning always clear when an icon lights up on your dashboard?

Human Factors, cont'd[6]

- **Human factors considerations are key to work space design**
  - Physical convenience
  - Physical comfort
  - Effects on activities and workflow
  - Safety, security
  - Health
  - Opportunity for group interaction
  - Opportunity for privacy
  - Aesthetics

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6) Adapted from: McCormick EJ. Human Factors Engineering and Design, 5th ed. 1982.

Human factors are standardly considered and applied in work space design. The applied science here is called "ergonomics", which is concerned with designing and arranging things people use so that the people and things interact most efficiently and safely.

We see it in play in unit dose picking station design, desk and counter height determinations, seating, cushioned floors where activities are primarily performed while standing, unit dose cart and patient bin design to minimize physical stress for staff performing cart exchanges, etc.

Human Factors, cont'd[6]

- Effect of experience and common sense

- Consideration/weighing of risks

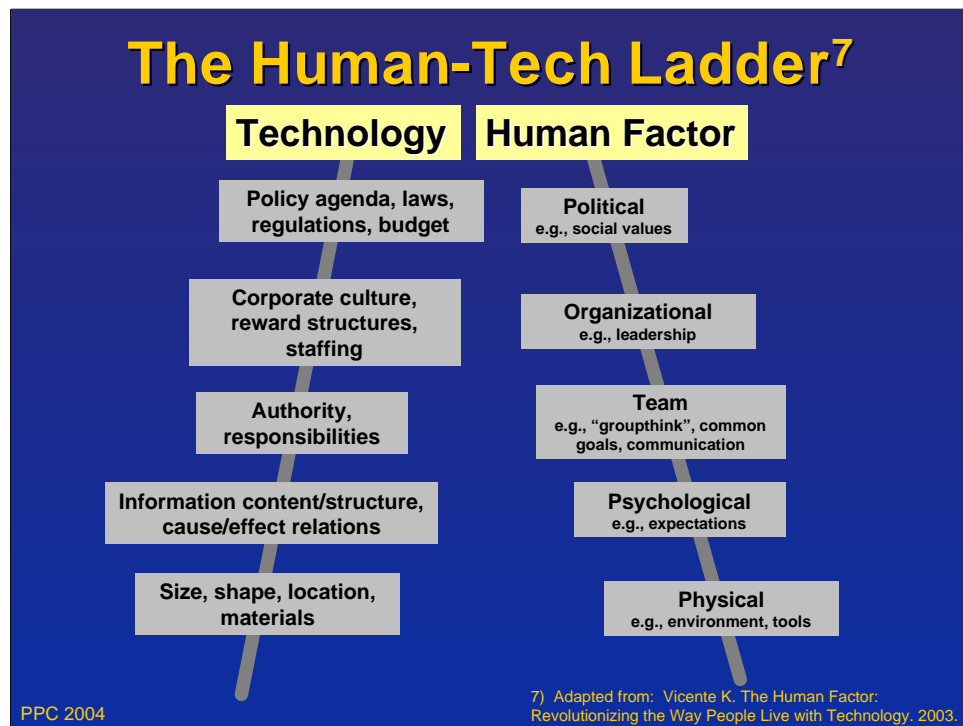- Extrapolation to different situations

6) Adapted from: McCormick EJ. Human Factors Engineering and Design, 5th ed. 1982.

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Other "human factors" include individual experience and common sense; how one appreciates risks and extrapolates one's experience to different situations.

We no longer think about how to use the "Start" button on our PCs.

Certain icons are automatically understood in our culture and circumstances, e.g., a red octagonal sign at an intersection means "stop", whether or not the word "STOP" is written on it.

Comprehension and understanding can be gained through experience or training.

The Human-Tech Ladder[7]

Technology	Human Factor
Policy agenda, laws, regulations, budget	Political e.g., social values
Corporate culture, reward structures, staffing	Organizational e.g., leadership
Authority, responsibilities	Team e.g., "groupthink", common goals, communication
Information content/structure, cause/effect relations	Psychological e.g., expectations
Size, shape, location, materials	Physical e.g., environment, tools

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7) Adapted from: Vicente K. The Human Factor: Revolutionizing the Way People Live with Technology. 2003.

Kim Vicente, a professor of engineering at UofT, has written a book about the interface between man and technology, entitled The Human Factor: Revolutionizing the Way People Live with Technology. Here, the term "technology" refers also to organization and structures.

His hierarchy describing human factors and technology is presented as a ladder. At the base are the physical and psychological components of human factors – these have been the more commonly considered issues in HFE. They relate to technology in terms of size, shape, colour and materials used and how information is presented.

Beyond these two factors is the team, as we commonly work and live in groups. This now represents responsibility and authority which is a little different from the individual's.

Then comes the organizational human factor, which involves leadership and how it is exercised and perceived. The parallel is the corporate organizational culture.

At the top is the political human factor representing social values. This relates to laws, regulations, policies and budgets on the "non-human" or technological side.

Solutions[8]

- **Design jobs for safety; pay attention to human factors**

- **Avoid over-reliance on memory and problem solving**

- **Use constraints and forcing functions**

- **Avoid reliance on vigilance and sustained attention**

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8) Adapted from: CIHSP. Suggested Practices for Preventing and Reducing Medication Errors. 2001.

The California Institute for Health Systems Performance published a document called "Suggested Practices for Preventing and Reducing Medication Errors" in 2001. In it they outline HFE principles and guidelines.

Design jobs for safety – consider factors that contribute to increased chance of error, e.g., fatigue, stress, time pressures, workload, noise, lighting.

Avoid over-reliance on memory – simplify key processes and provide mental and visual prompts, provide guidelines, protocols, on-line drug info., built-in systems

Use forcing functions – make it hard to do the wrong thing, e.g., incompatible connections between IV and intrathecal lines, remove concentrated KCl from floor stock

Avoid reliance on sustained attention – rotate staff, avoid long shifts, require use of checklists

Simplify key processes – eliminate transcription processes, purchase premixed preparations of commonly used drugs, limit formulary and dose strengths

Standardize work processes – reduce availability of different strengths of certain drugs (e.g., morphine infusions), limit the number of different types of equipment used to do similar things

Improve verbal communication – use "hear-back" or other form of repetition, develop a culture of free flow of communication, regardless of authority/hierarchy

Create learning environment – encourage HFE education, encourage reporting of safety concerns, errors and near misses, facilitate learning from internal and external incidents

Promote team functioning – promote interprofessional co-operation, establish orientation procedure which involves team interaction, include patients and families as part of safety efforts

Humans make mistakes – anticipate that when new technology is intriduced, mistakes will occur, anticipate safety implications when organizational changes take place (e.g., downsizing, mergers), have reversal agents available for high-risk medications, conduct failure mode analysis when implementing a new process or system redesign

Safety Precedence Sequence[9]

1. Design for Minimum Hazard
2. Install Safety Devices
3. Use Safety Warnings
4. Control with Procedures / Administrative Controls
5. Personnel Action by Training, Awareness, Knowledge
6. Accepted Risk

Effectiveness, reliability

9) American Institute of Chemical Engineers. Center for Chemical Process Safety, Guidelines for Investigating Chemical Process Incidents. 1992.

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The Safety Precedence Sequence shows that numerous barriers must fail before operator action can cause an accident. Personnel action is almost at the bottom of the list. From this perspective, operator errors, excluding wilful negligence or malfeasance, are often symptoms and not really root causes.

Solutions, cont'd[10]

- **Review labels and displays**
  - Legibility – font, UPPER vs lower case, **bold**face, *italics*, size, colour
  - Readability – glossy paper, curved surface, limited space, underlining, bar codes

- **Establish procedures and task guidance**
  - Policy, procedure, protocol, process
  - Checklists

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10) Adapted from: Handyside J. Applying human factors science. QHN, Fall Forum, October, 2003.

Labels can be problematic, especially if limited in size for the amount of information required; if they're curved around syringes; if auxiliary labels are attached, taking up additional space; if they smudge; etc.

Task guidance can help avoid slips, lapses and omissions. Checklists can help overcome errors resulting from unexpected interruptions and keep staff on track for unfamiliar activities. If there are problems, consider changing the procedure.

Patient Safety

8/4/2003 = 08Apr03, April 8/03

6:30 = 6:30PM, 18:30, 1830

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Identify a specific format and stick with it, facility-wide, in all applications and under all circumstances.

Dates and times can affect medication times and stop dates.

Figure 1. Before - Sterile Water for Injection label.

Figure 2. After - New Sterile Water for Injection label combines colour, information display and redundant cues to help differentiate the product from IV solutions.

Actual change made to 1L bags of sterile water for injection.

Patient Safety

Prednisone
PredniSOLONE

VinCRIStine
VinBLAStine

ValACYclovir
ValGANCIclovir

Use TALLMAN letters for key distinguishing parts of drug names.

This could apply to dispensing labels, stock labels and storage location labelling.

Patient Safety

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Consider reviewing the look, labelling and packaging of a product before making a purchasing decision.

Store items which look alike separately, even if sequential alphabetically.

Carefully review storage of look-alike products in arrest boxes and trays. (Also check for proximally located look-alike drug names and labels on arrest boxes and trays.)

FENTANYL/BUPIVACAINE
For Epidural Use Only

CONTAINS MORPHINE
Not For Epidural Use

"Sameness" distracts from label reading.
Auxiliary labels help differentiate the products.

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Use auxiliary labels to help provide key information for the user and that are clear and distinguish between products.
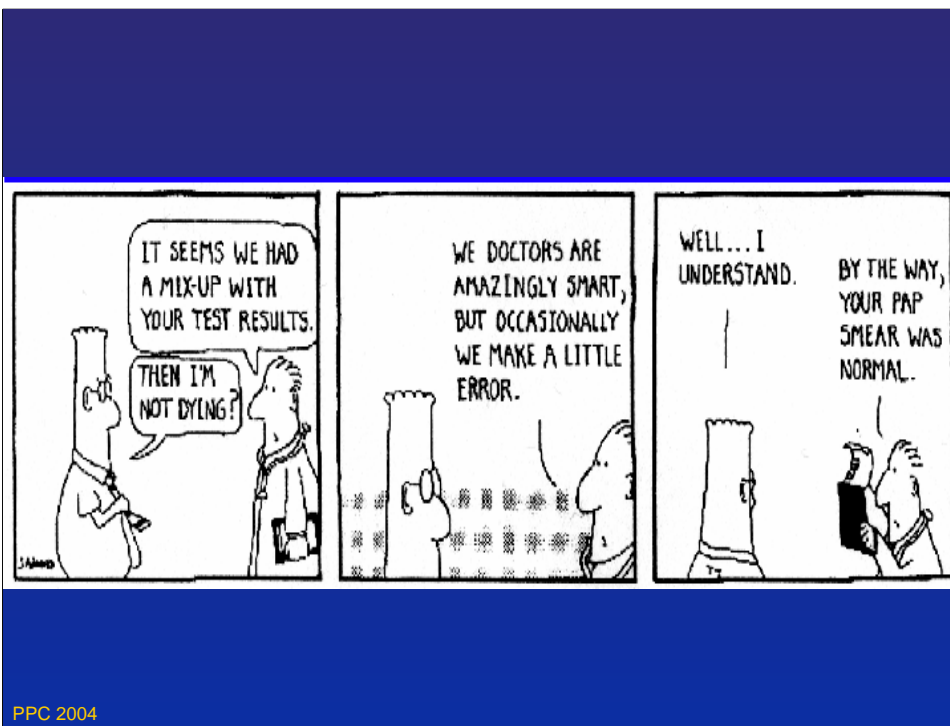
And, of course, we're all just human!