

Whitepaper

One in ten complex situations results in a high probability of making a mistake. How can that be changed?

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Preface

“The right information, at the right time, for the right person”. Sounds easy? It isn’t.

Questions such as “Didn’t that change” or “Where can I find this information” are routine in clinics and hospitals. The managerial staff are responsible for ensuring that the employees are capable of dealing with increasing workloads and related risks. And who hasn’t had this oppressive feeling of helplessness on the way home after going off duty: “Did I do everything right today”?

Covid-19 did not create these questions. The workload for clinic personnel was already high before the Corona pandemic. **Time pressure, frustration and a high risk of making mistakes** have long been a major problem. According to the doctor’s union Marburger Bund, many employees in the health sector are working **at their breaking point**. In a survey before the Corona crisis, numerous clinical physicians reported being under daily pressure. “The people who are there to help the patients are often not in the best of health themselves.”

Covid-19 has made the situation worse and brought the problems to the attention of the general public. During the pandemic, the **shortage of personnel in intensive care units** has become an additional problem. There is a large number of beds and respirators, but there is also a lack of doctors and nurses to take care of the patients. Currently there are about 4,000 to 5,000 open positions in the intensive care units. The clinical personnel are faced with new challenges every day. Whether due to changes in procedures, new information and rules of conduct, or entirely new tasks. Covid-19 has made

the situation worse and brought the problems to the attention of the general public. Currently, six of twelve intensive care beds are occupied by patients infected with SARS-CoV-2. Within only a few weeks, it is expected that entire intensive care units will be saturated with COVID-19 patients. The care of COVID-19 patients is extremely strenuous. For one thing, putting on and taking off protective gear is very time consuming. Sometimes it even requires help from fellow workers. For another, the patients are very ill, and the **therapy management** and the related **care measures are very complex**. Working for hours while wearing protective gear results in a high physical burden.

But what is it like for an individual to work under constant stress and uncertainty? How does that affect the frequency of mistakes? The medical service of the health insurers (MDK) assumes that there will be a significant increase in **mistakes during treatment** in 2020. This situation raises questions, which require new solution approaches: What can I do against it, and how do I have to change the daily procedures for myself and my team? Is important information communicated in a simple and direct manner? Is it available quickly enough? Are current communication channels such as e-mail, Intranet or a bulletin board the right solution?

This white paper will not give you a final solution for overcoming all the challenges of your daily work routine. But it will show you that reducing complex situations will result in a higher level of certainty.

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Introduction

Complex situations define the workday in the health sector. Doctors and nursing staff have to deal with these situations on a daily basis. But the risk resulting from the high level of complexity receives little attention:

For complex tasks in unfamiliar situations the probability of making a mistake is $1 * 10^{-1}$. Or in other words: One in 10 complex situations involves a potential for mistakes (Bubb, 1992).

What significance does that have for medical treatment? It is not a question of whether a mistake will happen, but when the next mistake will happen.

So what can we do? The logical step would be to completely avoid complex situations. Unfortunately, that is not always possible. To reduce the probability of mistakes, the complexity of procedures must therefore be reduced. It is necessary to develop safety mechanisms.

Why is this knowledge so important for the **medical and care sector**? The answer is simple: To respond to the challenge and be able to change the situation. However, the matter is made more difficult by the tight personnel situation in the hospitals. Despite the promises of politicians, there is no improvement on the horizon.

In 2019, 75.8% of hospitals already had problems filling open positions for medical services. The shortage of trained nurses in general care is even more precarious: 78.8% of German hospitals have difficulties filling positions. In general care, that equals about 12,000 full-time nursing positions. In other words: 6% of all nursing positions are vacant.

The situation in intensive care was already tense, but has worsened significantly due to the Covid-19 pandemic. The number of hospitals with personnel shortages doubled from 2011 to 2019. Even without Covid-19, there is a shortage of 4,700 full-time positions in intensive care nationwide in Germany (cp. K. Blum, 2019).

THIS SITUATION RESULTS IN

- + shorter training and indoctrination periods
- + inefficient communication
- + lack of information
- + high fluctuation due to dissatisfaction

This white paper focuses primarily on one question: **How can complex situations be reduced in order to minimise the probability of making mistakes?** Two of the most important influencing factors are stress and lack of time. We will therefore turn our attention to these factors. Due to the challenges of Covid-19 it is also necessary to consider the possible effects of the pandemic on the probability of mistakes.

Complexity

What is complexity? While use of the term is meanwhile quite common, the definition is not at all trivial. For example, complexity is often confused with complicatedness. The economist Prof. Dr. Eberhard Feess defines complexity as follows:

“Complexity is the totality of all interdependent characteristics and elements that exist in a diverse yet integral structure of relationships (system). Complexity is understood to be the diversity of possible behaviours of the elements and the changeability of the courses of effect (Feess, 2020).”

A complex task is highly dynamic. It consists of a variable number of elements with unforeseeable interactions, which are not linear, but rather simultaneous in their occurrence. **Complex processes have their own dynamics. They cannot be undone. They are unclear for the decision-maker.** That means that in a complex situation the decision-maker cannot intuitively grasp the relationships and their causality, and has to expect risks and side effects (Feess, 2020).

Even if there is extensive information about the number, type and relationship to each other, the overall behaviour cannot be clearly described. This is due to the lack of clear if-then relationships, through which the foreseeability of cause and effect is lost (Kaiser, 2018).

Are all difficult situations complex?
No. The degree of difficulty says nothing about the system.

The difference between a complex, complicated, simple and chaotic situation. The Cynefin framework of Dave Snowden (cp. Fritz, 2018):

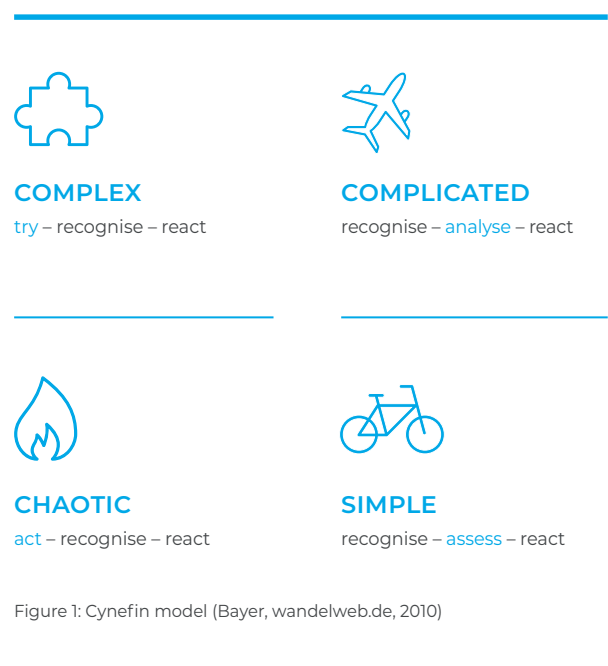


Figure 1: Cynefin model (Bayer, wandelweb.de, 2010)

Problem situations explained based on examples:

+ SIMPLE PROBLEMS

Simple problems have a direct cause-and-effect relationship. There is a correct solution. This is “best practice” and requires no further discussion (for example, control of vital parameters in medicine).

+ COMPLICATED PROBLEMS

Analysis of the problem can create a cause-and-effect relationship. Repeated analysis makes it possible to delimit and solve the problem quickly. This solution is known as “good practice”. Automation by means of expert systems (expert advice as a solution strategy) is possible.

+ COMPLEX PROBLEMS

Complex problems, as described above, do not exhibit a relationship between cause and effect. There is no single correct solution. One has to work on the basis of assumptions and hypotheses. The goal is to identify patterns. These lessons learned are incorporated into the broader solution to the problem until the complexity gives way to complicatedness. This requires agile approaches and organisations.

+ CHAOTIC PROBLEMS

Chaotic problems, like complex problems, exhibit no cause-and-effect relationship. They are characterised by high turbulence and require “novel practice” in action and recognition. This situation occurs especially when explanation and action are oversimplified, therefore overstraining the system (cp. Bayer, wandelweb.de, 2011).

+ DISORDER

A fifth situation is disorder, which – as an intersection – is in the middle. Here the particular situation is still unclear. In the Cynefin model the borders are flowing and largely dependent on perspective and insight. It is possible therefore that situations are assessed differently by different people within an organisation.

Consequences of complexity

How does the knowledge of complexity help us? What consequences does this knowledge have for me as a doctor or nurse?

Complexity determines the frequency of mistakes and the time until a mistake occurs. If you reduce the complexity, you also reduce the frequency of mistakes.

What can we do to reduce complexity? How will that affect my workday routine?

First it is necessary to examine the situation that one is in. For simple systems there are controllable best practice solutions. For complicated systems one must find the best approach by means of analysis. Complex systems require experimental and prudent actions. Chaos requires an immediate reaction.

But what should you do in a complex situation? Fundamental reduction of the complexity is the top priority. There are three organisational approaches to achieve this (Fritz, 2018):

+ ORGANISATION

Complexity management must be based in organisation. Provide training in how to better deal with ignorance and uncertainty. Constantly review solution strategies and learn to reject established solution strategies.

+ DIGITISATION

The complexity of problems can be reduced efficiently by means of digital solutions. However, this requires more than just combining separate solutions.

+ AGILITY

About 80% of all problems are simple or complicated. The characteristic of agility is therefore not necessary for the entire structure of an organisation. It must be present only for solving complex problems (Fritz, 2018).

Why is it important to reduce complexity in my medical workday routine?

The frequency of mistakes and the time until a mistake occurs are interrelated (Bubb, 1992). An essential aspect for dealing with complexity is knowledge of the causal relationships and the ability to reduce complexity (Feess, 2020).

Example: While person 1 assesses a situation as simple or complicated with a low level of difficulty, person 2 can assess the identical situation as complicated with a high level of difficulty or complex.

What is the reason for this difference in perception? According to Bubb (Bubb, 1992) the frequency of the executed task, as well as stress and/or time pressure have a significant effect on the probability of mistakes.

Mistakes in complex situations

There are several stereotypical forms of behaviour that have negative effects on the solution to a situation (Quinlivan, 2013):

- + **IGNORANCE MISTAKES**
We are aware of the problem. Performance-oriented teams with little time often work on the basis of tacit assumptions (e.g. that the employees are up to date) and immediately start the search for a solution. They overlook the fact that the same situation is assessed differently by different people.
- + **ROUTINE MISTAKES**
Back to old patterns. Acting on the basis of specific behaviour patterns corresponds to the approach of known situations. If one's own behaviour pattern does not fit the situation, however, the problem is not solved or the situation is transformed into chaos. Example: The behaviour pattern "do something quickly and willingly" works in the case of simple problems, but not in complicated situations (analysis is necessary).
- + **BEST PRACTICE MYTH**
It worked in the past – let's use it again. Best practice works in the case of simple problems, since it specifies the best single solution. As long as the problem does not change, this solution can be further automated. This approach cannot be applied to complicated and complex situations.
- + **PLANNING ILLUSION**
The higher the complexity, the more important is detailed planning. Since complexity is not controllable, not even detailed planning can lead to a solution. More important is general planning with feedback loops and fine adjustment during solution of the problem.
- + **THE LION TRAP**
Decisiveness at all costs. The mistake of postponing a decision finds its opposite in an over-hasty decision. Fast decisions are necessary in the case of simple and chaotic situations. In a complicated situation, there must first be an analysis.

Frequency of mistakes

How do I reduce the frequency of mistakes? In the medical environment, a mistake can cost a human life. Absences, shift changes, communication problems, stress and shortage of time are just a few examples of possible causes of mistakes.

In addition to the general frequency of mistakes, according to Zulley and Knab (Zulley & Knab, 2009) there are also peaks at certain times of day. The frequency of mistakes is especially high between midnight and 6:00 AM. The peak is reached at around 3:00 AM. Another peak is reached at around 3:00 PM. This corresponds to a series of tests conducted by Bubb, who already demonstrated an increased mistake rate for simple activities performed at night.

Mistakes therefore occur especially under time pressure.

If the person is additionally confronted with a new or complex task, the risk of mistakes increases drastically. But stress and resulting mistakes can be avoided by eliminating the stress factors (stressors). Examples of stressors in the clinical environment are time pressure, lack of information, and insufficient preventive measures during performance of complex activities. Reduction of stressors can reduce the probability of mistakes exponentially.

Reducing the complexity can decrease the frequency of mistakes in 1 of 10 situations to 1 of 100 or 1 of 1,000 situations. Bubb estimated the increased probability of mistakes during higher stress levels as follows (cp. Bubb, 1992):

CATEGORY	PROBABILITY OF MISTAKES	MEAN TIME
Simple and frequently executed tasks with low stress.	$1 \cdot 10^3$	30 minutes
Complex, frequently executed tasks in a normal situation without time pressure	$1 \cdot 10^2$	5 minutes
Complex tasks in an unfamiliar situation under high stress and/or high time pressure.	$1 \cdot 10^1$	< 30 seconds

Stress and causes of mistakes

What is stress? How much stress is okay? What causes stress?

Stress situations and time pressure are ubiquitous in clinics. Shortage of resources, especially in the area of nursing, brings medical personnel to the limits of what is possible. Doctors and nurses have to do their best to compensate for the shortage of resources. It is impossible, however, to constantly withstand such stressful situations. Concentration suffers as a result. The consequences are impairment to health and mistakes, triggered by stress.

Schmidtke and Hoffmann (Schmidtke & Hoffmann, 1964) have long proven the relationship between stress and frequency of mistakes (Figure, Dhillon, 1986).

Human performance is highest under moderate stress. Very low and very high stress reduce performance tremendously. Low stress is hardly a problem in medicine and nursing care. The probability of mistakes or mean time relates to high stress.

STRESS OR ANXIETY

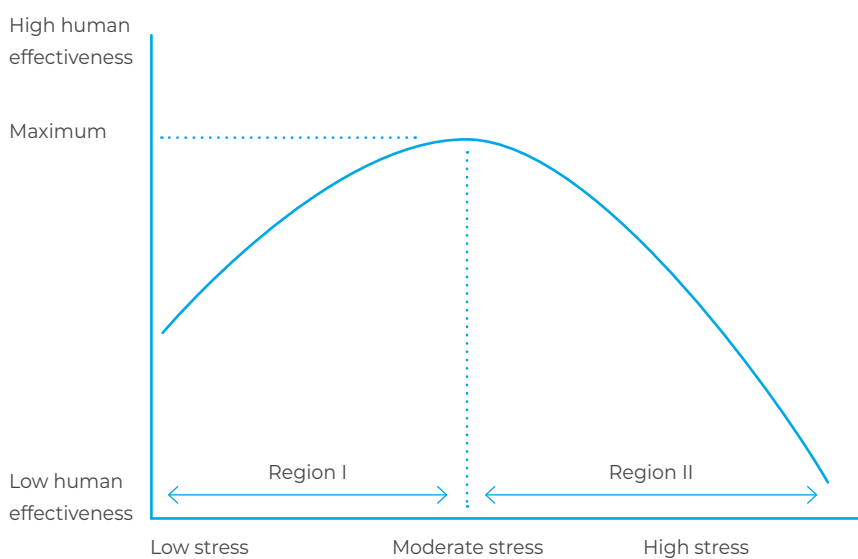


Figure 2: Human performance versus stress (Dhillon, 1986)

Stressors

The causes of stress are known as stressors. There are different types of stressors. They differ in terms of their cause, which can be internal or external. Or in terms of their effect: social, emotional, psychological, or psychological-mental (cp. Richter, 2020).

People are exposed to numerous stressors especially in their workday routine. Stressors can be caused by individuals themselves or by their environment. The standards individuals set for themselves, inordinate ambition or extreme perfectionism are examples of inner stressors that can result in pressure and burdens. The medical and nursing sector, with its proclivity for altruism and self-sacrifice, is an especially favourable environment for such stressors.

External stressors can be triggered by other people (co-workers, supervisors) and environmental factors. Stress factors such as time pressure, overtime, communication and coordination problems, and uncertain situations create a psychological and mental burden. Fear of failures and of one's own shortcomings are likewise stress factors.

STRESS-CAUSING FACTORS

- + change of shift
- + short-term absence of employees due to sickness
- + shortage of resources
- + insufficient information/knowledge
- + insufficient communication

Especially the psychological/mental stressors are closely related to the social and emotional stressors. Aspects such as lack of recognition and esteem can also trigger stress situations.

Every human being reacts to stressors differently and in varying degrees of intensity. Feelings are influenced by individual perception and by external circumstances. Depending on whether the situation continues for long or is assessed as threatening, the stressor can become a burden and cause corresponding reactions (cp. Dragano, 2007). The effect of stressors therefore cannot be determined wholesale.

Just as different as the reactions to stress are the consequences for the individual's health. There are short-term and long-term consequences. The short-term consequences occur during or shortly after the experienced stress. Long-term consequences arise when stress becomes a constant state, with no breaks.

Stress can become chronic if the stressors burden the body constantly, such as constant pressure at work.

If the burden is not overcome, it can manifest itself in the form of various symptoms, such as cardiovascular complaints or a weakened immune system (cp. Butcher, 2009).

Increased stress situations due to Covid-19

Stress and Covid-19. How to handle it? As a result of Covid-19, there has been a tremendous increase in stress for doctors and nurses: “Due to the current Covid-19 pandemic, health care professionals of all occupational groups face huge challenges in attempting to deal with the crisis. This results in numerous extraordinary stressors and risks for both the physical and psychological health of health care professionals (Petzold, Plag, & Ströhle, 2020).”

Covid-19 is a complex situation. The increase in stress can be attributed above all to the new situation, in combination with new risks – whether at the organisational or personal level. The complexity is confirmed by diverse publications:

“In daily intensive medical practice, the special challenges of infection with the “severe acute respiratory syndrome coronavirus 2” (SARS-CoV-2) and its treatment become clear. They exist in the development and therapy of lung and multi-organ failure, as well as severe inflammatory syndrome. For these severe courses of disease there is little evidence about which interventions are most effective.

In addition to the findings of clinical studies that were carried out quickly, the treatment is therefore also based on analogies to other syndromes, such as sepsis and microphage activation syndrome.” (Wiesner, Busch, & David, 2020) Here it becomes clear that the medical sector has correctly assessed the complex situation and is attempting to minimise the complexity of the problem via the lessons learned approach.

The treatment of Covid-19 patients is accompanied by an increased psychological burden for nurses and doctors.

This was shown in a study of 3,669 employees in the health sector. Also, nurses are more prone to stress than doctors. Consensus regarding the subjective psychological burden is especially striking: For example, those who cared for Covid-19 patients said frequently: “Due to the pandemic, I have much less time for my private life”, which is why the author of the study, Prof. Dr. Alkomiet Hasan, emphasises: “Especially for nursing staff and employees in COVID-19 risk areas there should be low-threshold methods for identifying the beginnings of stress-associated illnesses and safeguarding psychological health (Dierbach, 2020).”

Covid-19 increases the probability of making mistakes.

The newness of the disease in combination with stress and lack of time results in a tremendous increase in the probability of making a mistake, by as much as 10 times (cp. Bubb, 1992). Further worsening of the situation, possibly resulting in overload, could further increase the probability of mistakes (cp. Karagiannidis, et al., 2020).

The state of emergency requires drastic reduction of the orientation processes and the assignment of personnel from other wards. According to the DKG president, nursing staff with intensive care experience could be fit for action within one week.

This would require one day of theoretical training and six days of practical training (cp. Wahl, 2020).

Stressors relate not only to the occupational environment, but are also present in all areas of life.

Doctors and nurses are moving into the public focus: "The eyes of the public are on the performance of the people working in intensive care/medicine (Wiesner, Busch, & David, 2020)". At the same time, many people forget that medical treatment and nursing care are provided by people who have families. They therefore face the same challenges as the rest of society, for example as regards child care: "(...) 36 percent of persons surveyed have children in need of supervision.

The majority state that the burden of childcare has increased in the past months" (Karagiannidis, et al., 2020). It only makes matters worse that the recommended ratio of nursing staff to patients already does not correspond to the ratio of 1:2 recommended by the DGIIN, but in reality is 1:2.7. And this does not take into account any overload in intensive medicine due to Covid-19 (cp. Karagiannidis, et al., 2020).

Solution approaches

What can I do to improve the situation?

Organisations can prepare for complex situations and develop preventive coping strategies. The most important points of departure for reducing complexity are knowledge and time. Time continues to be a scarce resource. Changing the situation through knowledge is therefore a promising approach. Organisational means for achieving this include digitisation and automation.

And it bears repeating: The same situation will be assessed differently by two different people.

Example: While an experienced doctor can deal with a situation in only a few minutes (simple situation with a low probability of making a mistake), an inexperienced colleague is faced with a complex situation (little time, new on the job, no store of experience).

Reduction of a complex situation to the individual level can be achieved by organisational means. The simple transfer of information and knowledge substantially reduces the complexity of the situation. A problematic aspect in this respect is the IT environment of clinics and hospitals.

These institutions are generally limited to “administrative software solutions”. New solutions for knowledge transfer should be simple with respect to the creation, distribution and management of information. Accessibility should be independent of place and time.

An alternative is offered here by Cayoo cayoo.online/en/news

RECOGNITION AND CLASSIFICATION OF A SITUATION

First it is important to recognise the situation and interpret it correctly. The difference between

- + simple
- + complicated
- + complex
- + chaotic

is the basis for the solution. If the situation is complex, it is necessary to go through the cognition process (clock-wise).

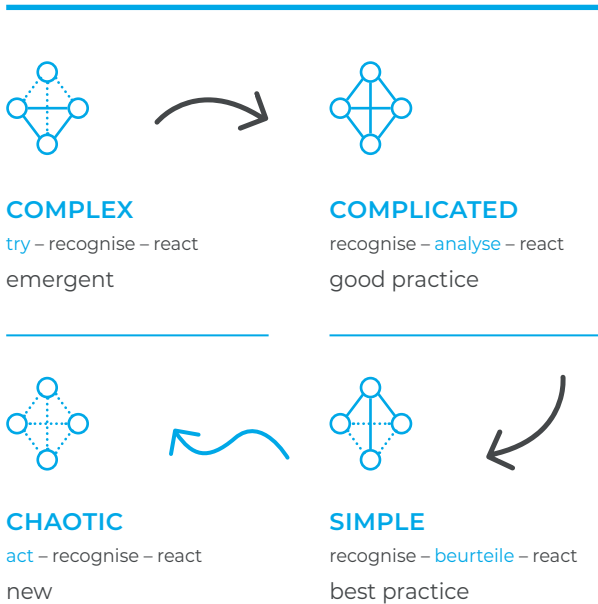


Figure 3: Recognition process according to Cynefin (Bayer, wandelweb.de, 2011)

Important: Organisations and people can perceive other situations or classify them differently.

The complex situation results in the highest probability of making a mistake. That is why it is necessary to avoid them, if possible. One point of departure is knowledge. Knowledge can be used to create cause-and-effect methods. A complex situation is therefore transformed into a complicated one, or ultimately into a simple situation.

THE THREE MAIN POINTS OF DEPARTURE FOR THE FREQUENCY OF MISTAKES ARE

- + stress
- + time
- + ignorance

The task of the organisation is to enable and foster the reduction of complexity. This is achieved through organisational development, digitisation and agility. It is also necessary to avoid basic solution mistakes:

AVOID BASIC SOLUTION MISTAKES

- + Ignorance mistake: We are aware of the problem
- + Routine mistake: Back to old patterns
- + Best practice myth: It worked in the past – let's use it again
- + Planning illusion: The higher the complexity, the more important is detailed planning
- + The lion trap: Decisiveness at all costs

Covid-19 has redefined numerous solution approaches. However, access and procedural integration are not always ensured. There are simply no resources. Some examples:

+ CRISIS MANAGEMENT – ESTABLISHMENT OF A CRISIS STAFF (INTERNAL SECURITY, 2016)

“Crisis management is the central instance for treatment of all incidents classified as a crisis. The crisis management organisation is temporarily activated and bears the responsibility for a fast and effective solution to the crisis in accordance with its authority granted by the head of the institution. The crisis management organisation has to handle diverse incidents. [...]”

For successful crisis management it is essential that everyone involved in the crisis management team is up to date and has the same understanding of the situation. The crisis management team can then make well-founded decisions quickly. This is the only way to get from a position of pure reaction to a position of action and organisation (known as “predictive policing”).”

+ 12-HOUR SHIFTS

The crisis staff at the Ludwigshafen clinic introduced 12-hour shifts to reduce the duration of contact between personnel (cp. pflegen-online.de, 2020).

+ EFFORTS TO BUNDLE KNOWLEDGE AND SHARE EXPERIENCES

For example, the university medical network of the German Federal Ministry of Education and Research. <https://www.netzwerk-universitaetsmedizin.de/>

+ TRAINING AND E-LEARNING

For example, Corona training for self-protection of personnel: “To improve the safety of nursing staff, the corona training measure “Self-protection in the context of COVID-19” provides practical information on basic hygiene, as well as putting on and taking off personal protective gear. Participation in the e-learning event, which takes 15 – 20 minutes at the individual’s convenience, is confirmed with a certificate.” <https://campus.bibliomed.de/corona-schulung/>

Cayoo – Information always and everywhere, specifically for your clinic

Cayoo was already in use in Germany and Switzerland before the Covid-19 pandemic. The app-based solution discusses the basic problem of the ability to directly access information in a wide range of different situations. Everyone knows the situation: I am faced with a problem. I am under stress. I am uncertain. I don't know what comes next. What should I do?

Why is it not possible to access information provided by the organisation in this situation. Not via the Intranet or other outdated, slow or hard-to-access solutions. Why not via a smart phone or browser. Why not together with fellow employees from throughout the organisation?

This problem is solved by Cayoo. The system enables access to knowledge and information. No matter where and/or when it is needed. Because it is created and distributed according to a simple principle: Keep it simple.

Cayoo reduces the frequency of mistakes. For the user, that means: Complex situations are transformed into complicated ones, and complicated situations into simple ones. Stress and the frequency of mistakes can therefore be permanently reduced.

This is achieved by means of a modern, cloud-based IT infrastructure. It does not require an IT installation in the clinic. The clinic is the owner of the data. The employees create content or migrate it from the Cayoo database. In addition, the Sharing & Migration function allows networking and sharing of information with other institutions. As soon as content is released, it is allocated to the individuals involved in an agile team structure.

SOUNDS COMPLICATED? IT ISN'T.

Cayoo was developed with users for users. Because if it weren't simple, it would not be used by medical or nursing professionals. There are no resources for additional complexity. Cayoo supports teams across units with SOP management, news, QR codes, an agile team structure, and the capability of interlinking with other institutes.

Interested?

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